

Modeling a Plate Boundary

LAB 1
ES2L1

Introduction

The lithosphere is divided into moving segments called **plates**. The plates move as units relative to all other plates. All major interactions occur among individual plates along boundaries. Scientists first attempted to outline the plate boundaries by using locations of earthquakes. Later research showed plates bounded by three distinct types of boundaries, which exhibit different types of movement.

A **convergent boundary** is formed when two plates slowly move together. At this boundary, the leading edge of one plate is bent downward, sliding beneath the second plate. This process is called **subduction**, and the convergent boundaries are called **subduction zones**. The surface expression produced by one plate sliding below another plate is an **ocean trench**.

Just south of the Aleutian Islands in the northern Pacific Ocean, the Pacific plate moves northward and is subducted beneath the North American plate. A large number of earthquakes occur in this region. In this investigation, you will use earthquake data from one part of this region to form a model of the convergent boundary between the two plates.

Problem

How can you use earthquake data to model a convergent boundary between two plates?

Pre-Lab Discussion

Read the entire investigation. Then work with a partner to answer the following questions.

1. **Posing Questions** Write a question that summarizes the purpose of this investigation.

2. **Controlling Variables** What is the dependent variable in this investigation?

3. **Controlling Variables** What is the independent variable in this investigation?

4. **Inferring** Why should the graph of earthquake depth vs. earthquake latitude have a zero at the top of the vertical axis?

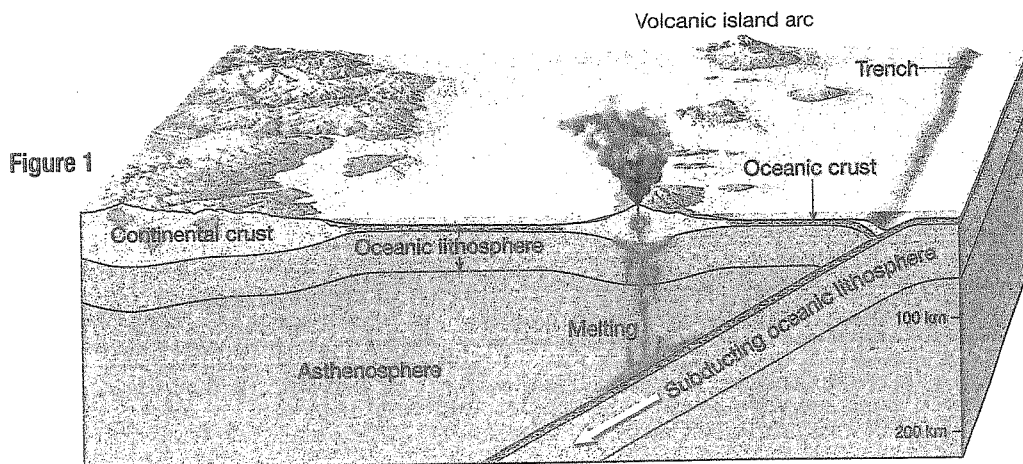
5. **Predicting** How do you think earthquake depth is related to the distance from an ocean trench?

Materials (per pair of students)

- ruler
- protractor
- Resource 3 in the DataBank

Procedure

1. Examine the map on Resource 3 in the DataBank. Study the convergence of the Pacific plate and the North American plate just south of the Aleutian Arc of volcanic islands in the northern Pacific Ocean.
2. Draw and label a diagram showing how the edges of the Pacific plate and the North American plate converge. Use Figure 1 to help you draw this diagram.



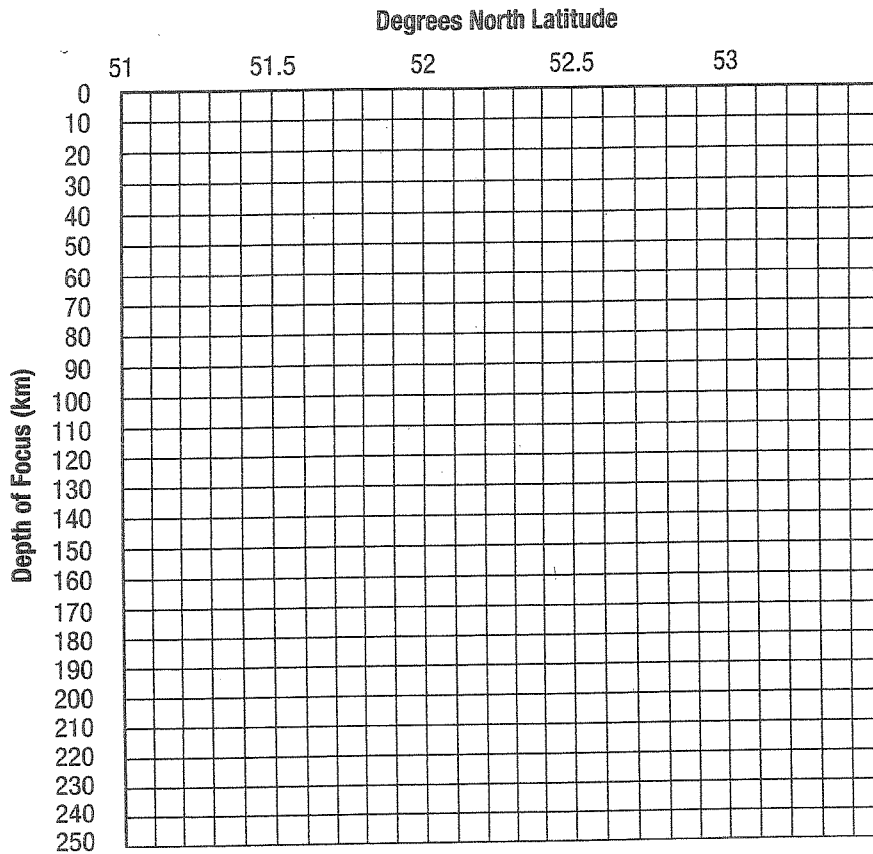
3. The Data Table below shows the depths of foci and latitudes of earthquakes in the Aleutian Islands. All of the earthquakes in the table occurred near 180°W longitude. Examine the table of earthquake data and record any patterns you observe.

DATA TABLE

Earthquake	Year	Latitude of Epicenter (°N)	Depth of Focus (km)
1	1982	51.39	51
2	1983	51.97	116
3	1984	51.13	15
4	1985	52.36	213
5	1985	52.62	233
6	1986	51.70	67
7	1986	52.31	170
8	1987	51.29	22
9	1987	51.93	94
10	1990	52.30	143
11	1991	51.96	108
12	1992	52.01	99
13	1992	52.13	130
14	1992	52.48	211
15	1995	51.19	29
16	1997	51.28	33
17	1998	51.59	43
18	1999	51.87	72
19	2000	51.60	71
20	2001	51.32	55
21	2001	51.77	79
22	2003	51.15	11
23	2003	52.13	180

- Use the information in the Data Table to construct a graph showing the location and depth of the earthquakes. Use the following grid and plot the latitude on the horizontal axis and the depth of the focus on the vertical axis. Number the vertical axis with zero at the top and maximum depth at the bottom. Give your graph an appropriate title.
- After plotting the data, draw a straight line that comes as close as possible to each of the data points.

Title: _____



Analysis and Conclusions

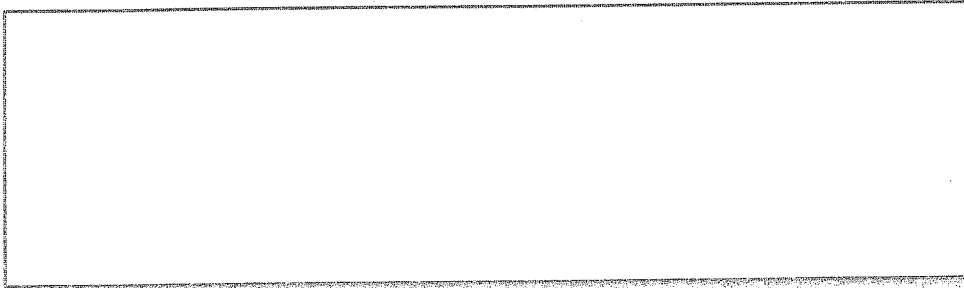
1. **Using Graphs** What relationship exists between the depths of the earthquake foci and the latitude?

2. **Analyzing Data** How does the graph illustrate that the boundary between the Pacific plate and the North American plate is a convergent boundary?

3. **Applying Concepts** The Aleutian trench is located where the two plates meet at the surface of the lithosphere. Use the graph to determine the approximate latitude of the Aleutian trench at 180°W longitude. Explain your answer.

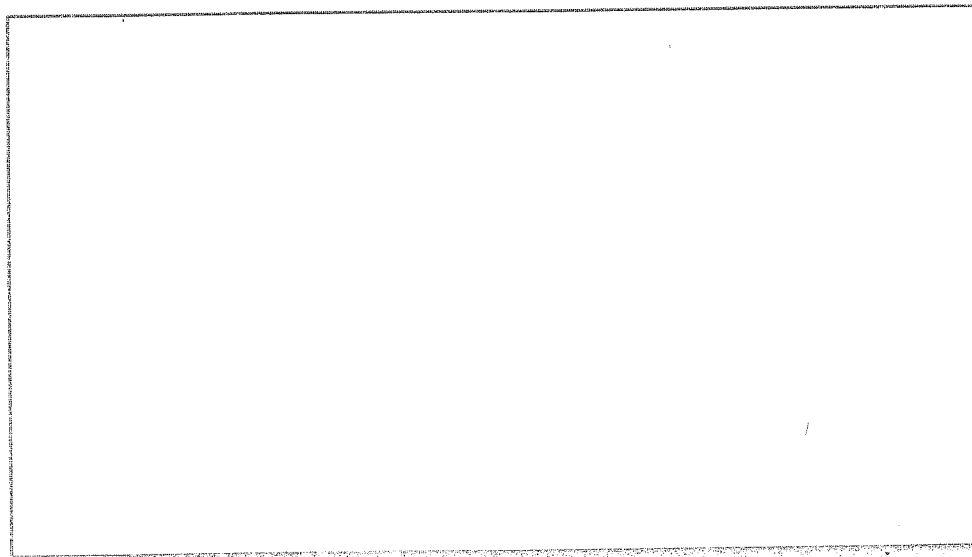
4. **Using Graphs** Use the slope of the graph to determine how quickly the convergent boundary descends as latitude increases.

5. **Calculating** A change in latitude of one degree corresponds to a distance of approximately 111 km along a north-south line. Using this information and your answer to Question 4, determine how far the convergent boundary descends as it moves 1 km northward. Show your work.



Use your results from Question 5 to help you answer Questions 6 and 7.

6. **Using Models** Draw a triangle that shows a side view of the convergent boundary with the correct scale relationship between horizontal distance and depth. Measure the angle at which the subducted plate descends beneath the upper plate. This is called the subduction angle.



7. **Calculating** Imagine there is a volcanic island arc on the surface of the lithosphere above the area where the descending plate reaches a depth of 100 km. Approximately how far north of the trench are the islands located? Show your work.

8. **Evaluating and Revising** Are all of the data points you plotted on the graph close to the straight line you drew to best fit the data? Provide possible explanations for your answer.

9. **Applying Concepts** Is the year in which an earthquake occurred an important variable in this investigation? Explain.

Go Further

The United States Geological Survey provides earthquake data from locations around the world. Obtain earthquake data near a divergent boundary such as an oceanic ridge or a transform fault boundary such as the San Andreas Fault. Graph some data points to see whether the depths of the foci of the earthquakes change as the distance from the boundary increases. Compare your findings to the results from this investigation. Explain any differences.



2.1.4 Lab: Modeling a Plate Boundary

Dry Lab

Earth Science Core Sem 2 (S843275)

Name: _____

Points possible: 50

Date: _____

If you do not have access to a laboratory, use this dry lab data to complete the lab activity. Make sure you understand the lab procedure so you can interpret the data provided.

This dry lab accompanies the "Modeling a Plate Boundary Lab" on page 79 of your Prentice Hall *Earth Science Lab Manual*.

Pre-Lab Discussion (pp. 79-80)

Answer questions 1 – 5.

Procedure (pp. 80-82)

1. Look at the map on Resource 3 in the DataBank. Examine the convergence of the Pacific tectonic plate and the North American tectonic plate, south of the Aleutian Arc of volcanic islands in the northern Pacific Ocean.
2. Look at the diagram on page 80 to help you understand how the edges of the Pacific plate and the North American plate converge.
3. Look at the Data Table on page 81. This Data Table shows the Depths of Foci and Latitudes of earthquakes occurring in the Aleutian Islands. These earthquakes all occurred near the 180° W longitude. Examine the table. Do you see any patterns in the data?

Analysis and Conclusions (pp. 82-84)

Figure 1

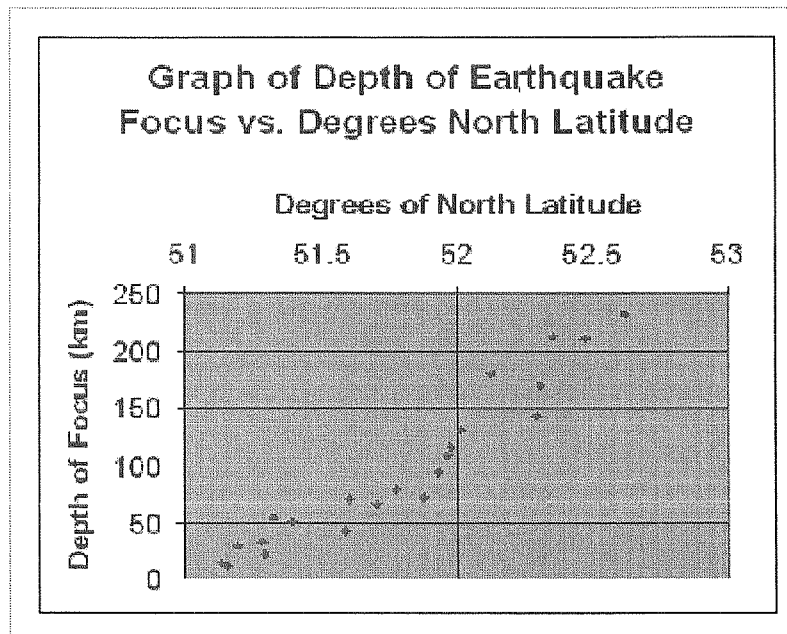


Figure 1 shows a graph of location and depth of earthquakes, based upon the information in the Data Table on page 81. The line is a line of best fit that comes as close as possible to each of the data points. Use Figure 1 to answer the following questions.

1. Using Graphs

What is the relationship between the depths of earthquake foci and latitude?

2. Analyzing Data

How does the graph show that the boundary between the Pacific plate and the North American plate is a convergent boundary?

3. Applying Concepts

The Aleutian trench is located where the two tectonic plates meet at the surface of the lithosphere. Use the graph above to determine the approximate latitude of the Aleutian trench at 180° W longitude. Explain your answer.

4. Using Graphs

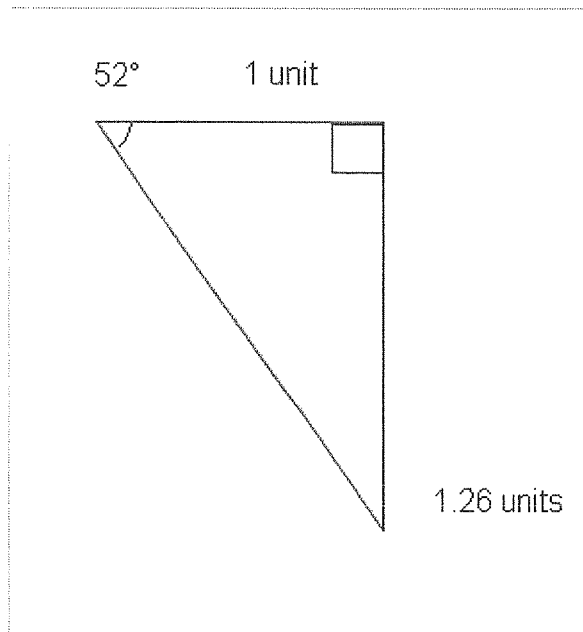
Calculate the slope of the graph to figure out how quickly the convergent boundary descends as latitude increases.

5. Calculating

A change in latitude of 1 degree corresponds to an approximate 111 km distance along a north-south line. Use this information along with your answer to question 4 to determine how far the convergent boundary descends as it moves 1 km northward. Show all calculations.

6. Using Models

The triangle below shows a side view of the convergent boundary with the correct scale relationship between the depth and the horizontal distance. The angle at which the subducted plate descends beneath the upper plate is 52° and is known as the *subduction angle*.



7. Calculating

Imagine there is a volcanic island arc on the surface of the lithosphere above the area where the descending plate has a depth of 100 km. Approximately how far north of this trench are the islands located? Show all calculations.

8. Evaluating and Revising

Are all of the data points plotted on the graph close to the line of best fit? Provide explanations for why they are or are not.

9. Applying Concepts

Is the year in which an earthquake occurred an important variable in this investigation? Why or why not?

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