

EAS 100
Homework Assignment #2
Plate Motions from Hotspot Tracks
(The Hawaiian Island – Emperor Seamount Chain)

Name: _____

Objective:

Observation of the age of volcanic rocks in the Hawaiian Island-Emperor Seamount Chain provides data to estimate the direction and velocity of plate motion of the Pacific plate over a fixed mantle hotspot. This assignment produces an actual (and reasonably accurate) measurement of plate motion and provides experience with map and graph analysis.

Procedure:

1. Reading in Text: Evidence: Hot Spots, pages 139-140, Figure 5.19. Hawaiian volcanism and the volcanic structure of the islands are illustrated in Figures 7.5, 7.6, 7.8, 7.9, 7.10 and 7.27B.
2. Examine the attached figure which is similar to the map shown in Figure 5.19. The Loihi volcano (seamount) is actively growing by undersea volcanic eruption just to the southeast of the island of Hawaii (see inset on attached map). It will become, in several tens of thousands to hundreds of thousands of years, the next Hawaiian island. **Measure the distances** (you can use the scale shown on the attached page) of each of the Hawaiian Islands from Loihi. Use the approximate center of each island as a location to measure the distances from Loihi. **Estimate the age of each island** (in millions of years) from the radiometric age dates for volcanic rocks given in the attached figure. If multiple ages are given for one island, use an average. Complete the Table below (the data for the island of Lanai are already entered to provide an example):

Table 1: Age and Distance Data for Hawaiian Islands

<u>Island</u>	<u>Symbol</u>	<u>Age (millions of years, m.y.)</u>	<u>Distance from Loihi (km)</u>
Hawaii	H		
Maui	Ma		
Kahoolawe	Ke		
Lanai	L	1.3	255
Molokai	Mo		
Oahu	O		
Kauai	Ki		
Nihau	N		

3. **Plot the data from Table 1 on the attached graph.** Use a large dot (●) positioned at the appropriate age and distance location for each data point. **Write the letter code (symbol) for each island next to the data point.** The data and plotted point are shown for the island of Lanai as an example.

Analysis:

1. Notice that the points define a nearly straight line relationship. Because the island of Hawaii and Loihi are still active, the ages for these volcanoes may not line up with the others causing some curvature of the age-distance relation. Therefore, **draw an approximate "best-fit" straight line through the data points** for islands older than 0.5 million years. **Use a single straight line to approximately represent the data points. Measure the slope (dy/dx or "rise over run") of this line.** What are the units (dimensions) of the slope of this line? **Fill in the Table below:**

Table 2. Pacific Plate Velocity Estimates from Slope of Age-Distance Graph for the Hawaiian Islands

Velocity in km/million years _____

Velocity in cm/year _____ (convert from km/million years)

What do these data and analysis tell us about the lithospheric plate motion relative to a (presumably fixed) hotspot beneath Hawaii? _____

2. Examine map on the attached Figure and Figure 5.19 of Lutgens and Tarbuck. Note the trend of the Hawaiian Island chain and the continuation – the Emperor Seamounts. The top of the map is to the North. From the alignment of islands with increasing ages (from 0 to 42.4 million years), **what direction has the plate moved over the hotspot?** (Notice that the apparent direction of plate motion was considerably different prior to 43 million years ago.) **Circle the closest direction** (just circle the letters corresponding to the correct direction) from the list of directions given below. (The compass directions are abbreviated, for example, NNE = North-Northeast, or half way between North and Northeast or an azimuth of 22.5°. You should be able to just estimate the correct direction from the trend of the islands shown on the map, but you may find a protractor useful if you're not familiar with directional information.)

Compass direction: N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
Equivalent Azimuth: 0° 45° 90° 135° 180° 225° 270° 315°

3. **Describe the relationship (in words) between the distance from Loihi and the age of the volcanism for the Hawaiian islands that is shown on your graph.**
4. **Write an equation that represents the line that you have drawn.** (Hint: try the equation of a straight line:

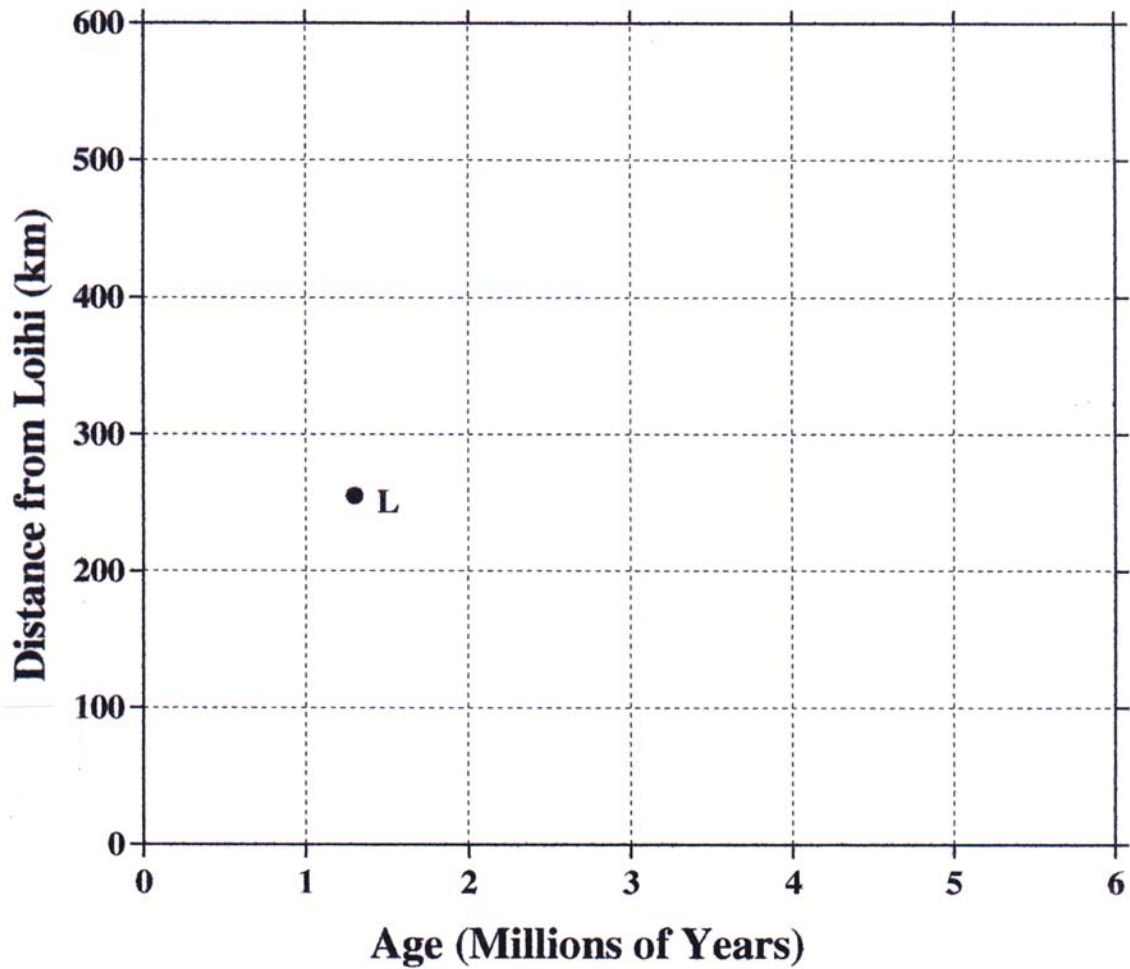
$$\text{Distance} = \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \text{ times Age}$$

put numbers in the blanks in this equation).

If your equation is correct, age-distance point on your line will satisfy the equation (substituting the age value and the corresponding distance value into the equation will result in an equality).

NAME _____ ID# _____

EAS 100 Homework 2
Age -- Distance Graph for the Hawaiian
Islands to Determine Plate Velocity



*Fold paper on this line
to use scale*



