MiSP Plate Tectonics Worksheet #2 L2

Name ________________________________ Date______________

THE HAWAIIAN ISLANDS – TECTONIC PLATE MOVEMENT

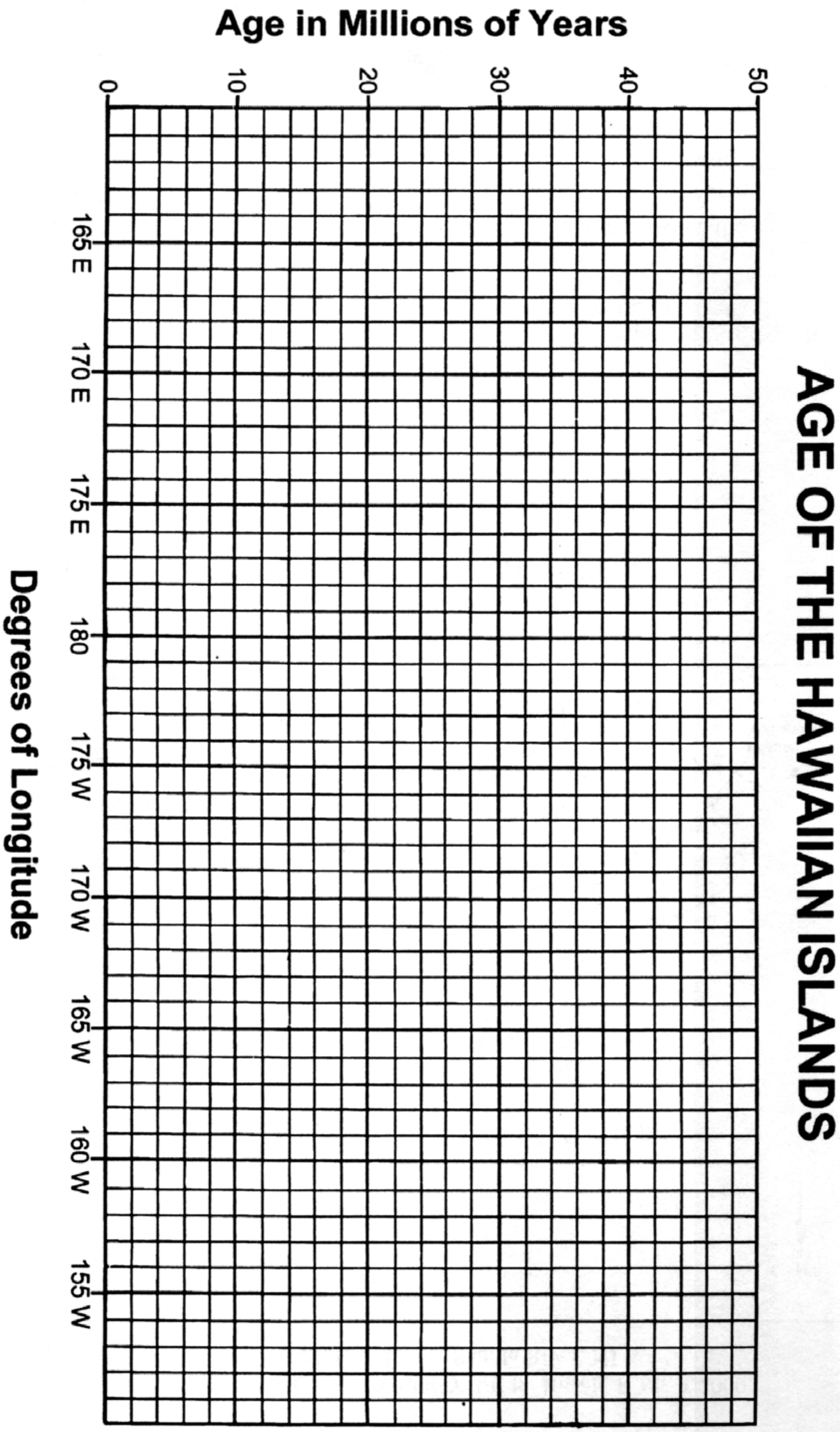
Introduction: (excerpts from Wikipedia and http://pubs.usgs.gov/publications/text/Hawaiian.html)
The Hawaiian Islands represent the last and youngest part of a long chain of volcanoes extending some 6000 km across the Pacific Ocean and ending in the Aleutian Trench off the coast of Alaska. This volcanic chain consists of the small section Hawaiian archipelago (Windward Isles, and the U.S. State of Hawaii), the much longer Northwestern Hawaiian Islands (Leeward Isles), and finally the long Emperor Seamounts. The Leeward Isles consist mostly of atolls, atoll islands and extinct islands, while the Emperor Seamounts are extinct volcanoes that have been eroded well beneath sea level. This long volcanic chain was created over some 70 million years by a *hot spot* that supplied magma, formed deep in the earth's interior (*mantle*), that pushed its way through the earth's surface and ocean cover forming volcanic islands. As the Pacific Plate was moved by *tectonic forces* within the Earth, the hot spot continually formed new volcanoes on the Pacific Plate, producing the volcanic chain.

The direction and rate of movement for the Pacific Plate will be determined with the help of the approximate age of some of the Hawaiian volcanoes and distances between them.

Procedure 1:
1. Using the data provided in ***Table 1***, plot a graph on the next page that compares the age of the Hawaiian Islands and reefs to their longitude.
2. Label the island (reef) name next to each plotted point. Then, connect the points with a smooth line.

Table 1

ISLAND OR REEF	APPROXIMATE AGE (MILLIONS OF YEARS)	LONGITUDE (DEGREES AND MINUTES)
Hawaii	0.5	155° 30′ W
Kanum	39.0	170° 0′ E
Kauai	4.7	158° 30′ W
Maui	1.1	156° 15′W
Midway	18.0	177° 30′W
Molokai	1.6	157° 0′W
Necker	10.1	164° 30′W
Nihoa	???	162° 0′W
Oahu	2.5	158° 0′W
Pearl	20.1	176° 0′W
Yuruaku	42.3	168° 30′E


AGE OF THE HAWAIIAN ISLANDS
Age in Millions of Years
0
10
20
30
40
50
Degrees of Longitude
165 E
170 E
175 E
180
175 W
170 W
165 W
160 W
155 W

Discussion L1, 2, 3

1. Draw a best-fit line on your graph. Which island or reef deviates most from the best-fit line? Based on Plate Tectonics, why does it deviate?

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2. Using your graph, determine an approximate age for the extinct island, Nihoa.

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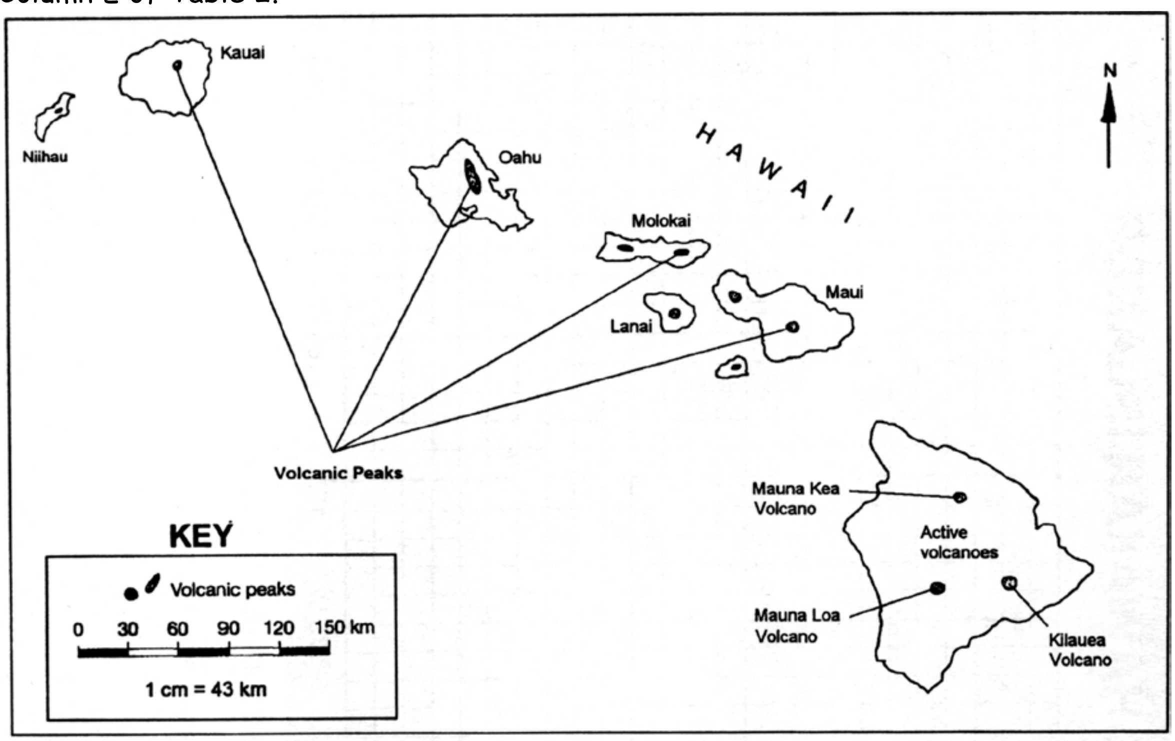
Procedure 2:

l. Using the data from Table 1, place the age next to each of the following volcanoes on the Hawaii Map: Kauai, Oahu, Molokai, Maui and Hawaii ***(Kilauea Volcano)***. Also write the age in Column E of Table 2.



Map of the Hawaiian Islands, showing volcanic peaks. Absolute ages were determined from basalts that form the islands.

2. Measure the distance ***(to the nearest 0.1 cm)*** from the center of each island's volcanic peak to the center of Kilauea Volcano on the big island of Hawaii. Enter in Column B on Chart 2.

3. Using the map scale, determine the actual distance ***(to the nearest 0.1 Km)***. Record in Table 2, Column C. **Actual distance = Measured Distance/column B(cm) x 43 km/cm**
3. Convert the actual distance in **kilometers** from each island volcanic peak to the Kilauea peak to **centimeters** and record in Column D on Table 2. Distance (cm) = Distance/column C x 100,000 cm/km
4. Complete Column F by multiplying the age/column E(millions of years) x 1,000,000
5. Calculate the average rate of movement for each island in centimeters per year. Use the following formula to determine the rate. Put the rates in Column G on Table 2

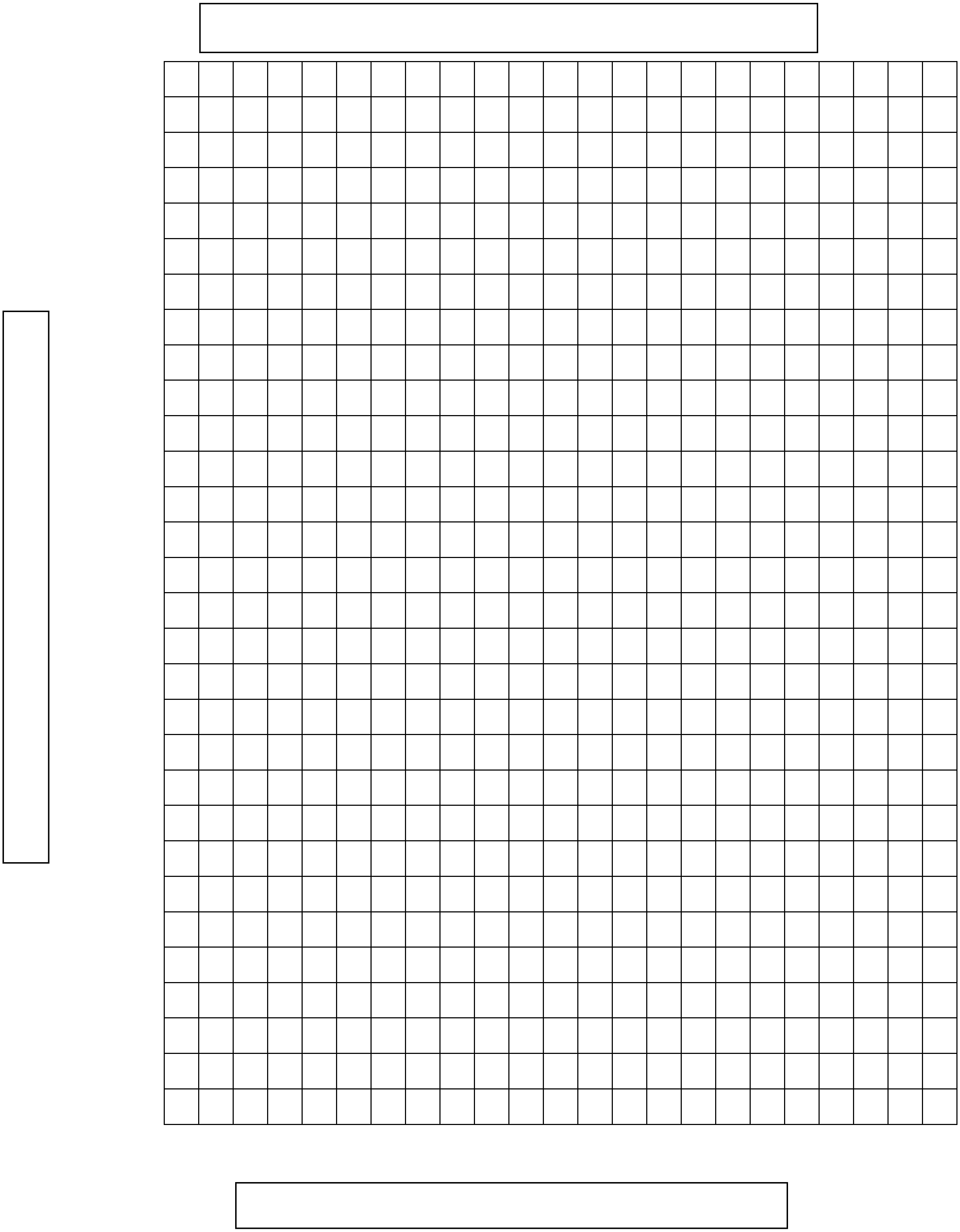
$$\text{Average Rate of Movement} = \frac{\text{Actual Distance (cm)}}{\text{Age (years)}} = \frac{\text{Column D}}{\text{Column F}}$$

Table 2

A Hawaiian Island	B Measured Distance to Kilauea Peak on Hawaii (cm)	C Actual Distance (km) B x 43 km/cm	D Actual Distance (cm) C x 100,000	E Age (millions of years) *from Table 1*	F Age (years) Number in E x 1,000,000	G Average Rate of Movement D/F (cm/year)
Hawaii	0	0	0	.5	500,000	0
Maui						
Molokai						
Oahu						
Kauai						

Graph data from Table 2 to show the relationship between age (millions of years) [column E] and the distance (km) [column C].

- Label the X axis with age (millions of years).
- Label the Y axis with distance (km).
- Plot the data points and label each with the date
- Connect the data points
- *Draw a best fit line that passes through (0, 0)*



Discussion #2 – Refer to the second graph
L1-3
1. Loihi is a submarine active volcano approximately 0.4 million years old and located about 35 km southeast of Hawaii. Its longitude is 155° 15' W. Locate Loihi's location on the Hawaii map with a large **X,** and plot a point for it on your graph completed in **Procedure 1**. Scientists predict that this volcano may be the next Hawaiian island. Explain this prediction.

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2. Based on the rate of movement calculations, describe the change of rate of the Hawaii Islands' on the Pacific Plate during the past 4.7 million years ***(increasing/decreasing, steady or accelerating,)***

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3. In what direction is the Pacific Tectonic Plate moving?

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4. What is the general trend in sizes of the Hawaiian Islands from Kilauea westward to Hawaii? What caused that trend?

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5. If there was a small area of volcanic activity under the ocean between Oahu and Kauai, 450 km from Kilauea, how old would the rocks be in that spot? Use the second graph.

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L2-3

6. Look at the second graph. Notice that, as time passed, new islands were formed as the older ones moved away from the place where the island of Hawaii is currently located. Examine the distance that the islands moved over time by calculating the unit rate of change (slope). Use the best fit line. *(When using the best fit line, the ordered pairs to determine slope must be from the best fit line, not from your data chart.)*

$$\text{Unit Rate of Change} = \frac{\Delta \text{ Distance (km)}}{\Delta \text{ Age (millions of years)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Distance (km) Δ y	Δ Age (millions of years) Δ x	**Unit Rate of Change (slope)** Δ y/Δ x

7. The units of the unit rate of change are kilometers per millions of years. Convert that number to centimeters per year – units that are more understandable (remember that there are 100,000 cm per meter):

- ✓ multiply the numerator by 100,000
- ✓ add 6 zeros to the denominator to change to years
- ✓ divide

Unit rate of change (slope) in cm/year = ______________________________

8. Compare the unit rate of change from #7 for the best fit line with the rates of movement that you calculated in Table 2. Why is the calculated unit rate of change (slope)

of the best fit line different than the calculated rates for each island? Refer to the second graph.

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