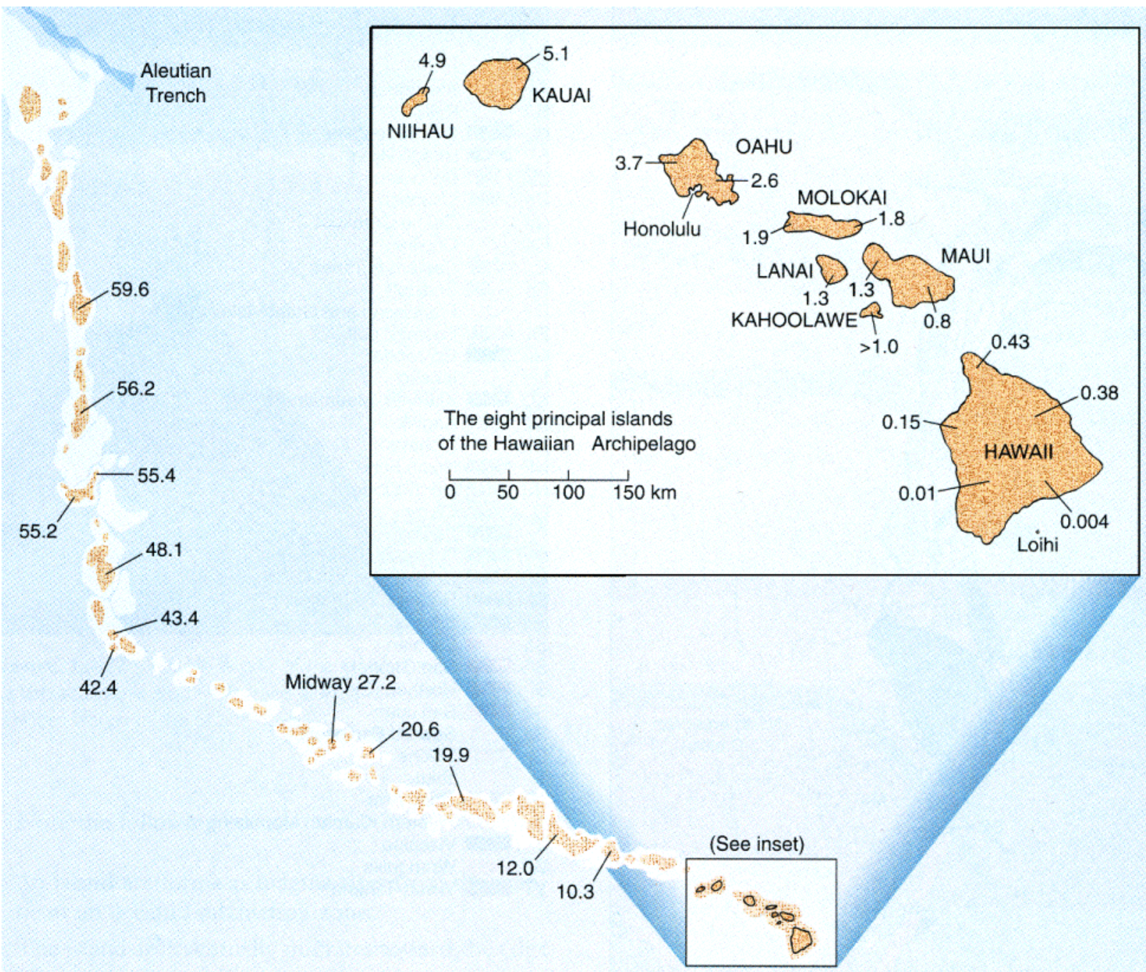
Calculating the Rate of Plate Motion
Pacific Plate
Geology and Art, Fall 2004

Hot spots are plumes of molten material that sit beneath tectonic plates. They are generated by upwelling in the Earth's mantle. As lithospheric plates move by, magma periodically breaks through the crust to create a chain of volcanic mountains. The Hawaii-Emperor seamount chain is approximately 5,800 kilometers long, created from what was thought to be a fixed hot spot in the Pacific Ocean

> The prevailing theory among geophysicists is that the Hawaii-Emperor Seamounts formed as the Pacific Plate moved over a fixed hot spot that today is located beneath the island of Hawaii and is responsible for the world's most active volcano, Kilauea. The segment known as the Hawaiian Ridge, which includes the main Hawaiian Islands and a chain of islands, atolls, and seamounts known collectively as the Northwestern Hawaiian Islands, extends some 1,800 miles (3,000 kilometers) northwest across the Pacific. At the end of the Northwestern Hawaiian Islands, the chain turns sharply northward and becomes the Emperor Seamounts, which stretch to their intersection with the Aleutian Trench at the Kamchatka Peninsula in Siberia. According to most researchers, this sharp bend represents a rapid change in direction of the Pacific Plate as it passed over the fixed hot spot 47 million years ago. The research by Tarduno and colleagues proves this notion wrong by showing that the bend is at least partly the result of the movement of the hot spot plume within the mantle itself.
> http://news.nationalgeographic.com/news/2003/08/0814_030814_hotspot.html#main



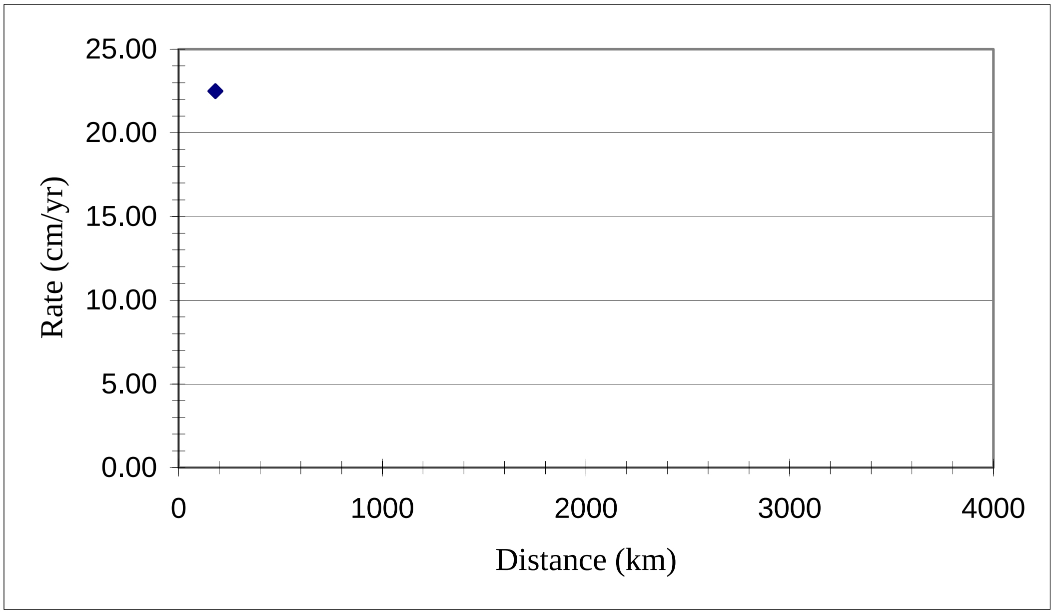
Note: the scale of the inset box is one-fifth the larger map (50 kms on the inset = 250 kms)

In this exercise you will determine the rate that the Pacific plate was moving when the Northwestern Hawaiian Islands were created over the past 47 million years.

1. Draw a straight line through the Northwestern Hawaiian Island chain (both the Hawaiian Islands in the box, and the entire chain). Start your line at the 0.004 million year mark.
2. Measure the distance from the 0.004 my mark to each of the ages in the table below. Define the distance using a perpendicular line for each age that bisects the line drawn in part 1.
3. Fill in the following table down to 5.2 million years:

Interval	Age (my)	Distance (kms)	Rate (cm/yr)
1	0.8	180	22.50
2	1.3		
3	1.8		
4	2.6		
5	3.7		
6	5.1		
7	10.3		
8	12		
9	18.9		
10	20.6		
11	27.2		
12	42.4		

4. Plot the distance against the average rate of plate movement on the following chart:



5. What is your average rate?

6. Explain why there is such a difference in rates over the past 42 million years.

Homework: complete the table and chart to 42.4 million years.