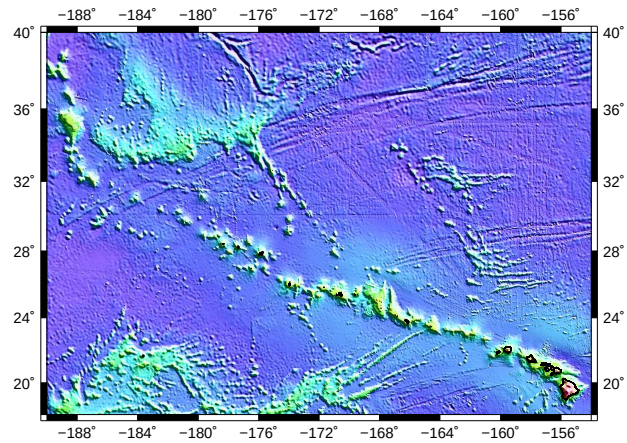
GEOL 595 - Mathematical Tools in Geology
Lab Assignment # 1 - August 28, 2008

Name:

Hawaii-Emperor seamount chain

STEP A

The figure to the right shows the Hawaiian-Emperor seamount chain. Rock samples from some of the islands have been collected and age dated indicating that the ages get progressively older from east (Big Island) to west. As you know, volcanoes are quite active on this ocean island chain especially on the Big Island (e.g. Kileaua). What hypothesis can you make to explain these observations and unique progression of volcanic ages ?



Would you call this a *qualitative* hypothesis or *quantitative* hypothesis ? (Please explain)

A Quantitative Measurement: Use any information, physical properties, or notation on the map to determine the velocity of the Pacific plate between eruptions 1.) on the island of Oahu and 2.) the NW corner of the Big Island (see red circles). Assume the distance between Oahu and the Big Island is 250 km, the radiometric age of the Big Island is 0.43 Ma, and the age of Oahu is 2.6 Ma.

1. What information might you already know about velocity in general ? What 3 physical properties do you need to determine the velocity of an object ?

2. Which of these properties do you know, which are unknown ?

· Which properties are *directly proportional* to velocity (i.e. velocity increases when they increase)? (Write the variables, and explain this in words)

· Which properties are *inversely proportional* to velocity (i.e. velocity decreases when they increase)? (Write the variables, and explain this in words)

3. Based on your assessment of the important variables for this problem and understanding of their relationships try to write these properties in a simple equation.

4. Now use this equation to calculate the velocity of the Pacific Plate between the eruptions on Oahu and the Big Island. Plate velocity is usually discussed in units of cm/yr. Please give your answer in these units. To do this, go back to the original physical quantities and covert distance (250 km) to centimeters. Also convert your time units to years. (Recall that *kilo* means 1000, and *centi* means one one-hundredth, 0.01). Then put these values into your equation and calculate your velocity. Does your plate velocity make sense in the scheme of plate speeds known on the Earth?

STEP B

Now, with your mathematical equation in hand, let's make a testable prediction of your hypothesis. You are given an all expenses payed trip to collect rock samples from a shield volcano at Midway. You will send your samples to a laboratory for radiometric age-dating. Now use your calculated plate velocity to predict the age you would expect for the island of Midway based on your model hypothesis. To predict the age of Midway, revisit your equation above.

5. For this problem, what physical properties do you know, and what are unknown ?

6. This time you must determine the distance between Midway and the Big Island. Can you use any information on the map to obtain this information ? Can the latitude or longitude values help you ? If so, which is preferable and why (hint: you can assume $1^o = 111$ km) ?

7. Now determine the predicted age of the Midway volcano (give your final answer in Ma).

8. The laboratory finally returns the radiometric dating of your samples. The results yield an average age of 27.2 Ma. How does this value compare with your prediction ? Does this validate or invalidate your hypothesis? List some factors that may explain the difference between your predicted age and the experimentally determined age. Can you use this new knowledge to adjust your hypothesis ?