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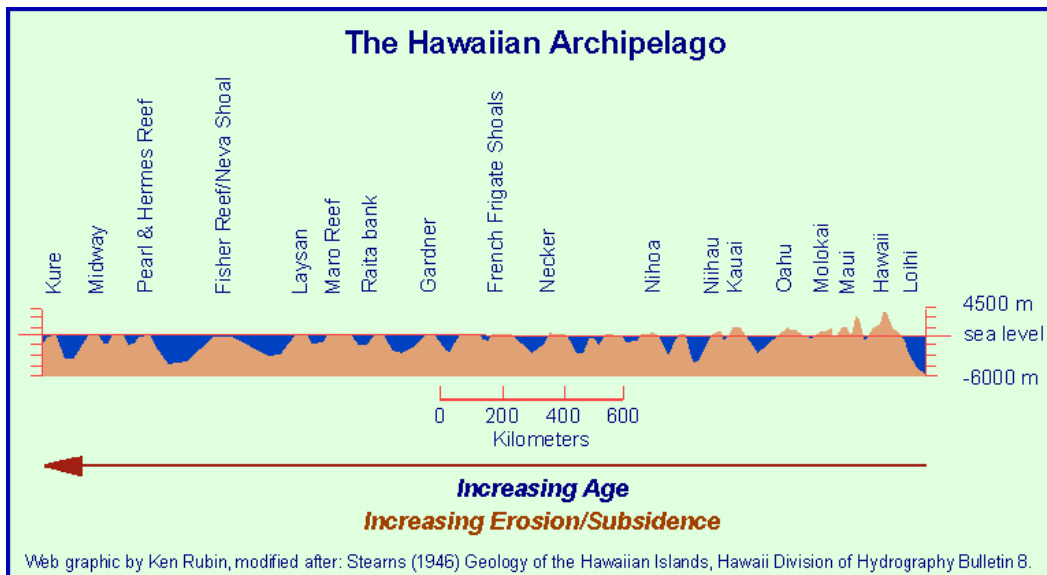
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Hot Spot Plate Tectonics

The Hawaiian-Emperor Island Chains are volcanic in origin. Each island is made up of at least one primary volcano, although many islands are composites of more than one. The Big Island, for instance, is constructed of 5 major volcanoes: Kilauea, Mauna Loa, Mauna Kea, Hualalai and Kohala. Mauna Loa is the largest active volcano on Earth. Kilauea is presently one of the most productive volcanoes on Earth (in terms of how much lava it erupts each year). The **primary volcanoes** are known as shield volcanoes, which are gently sloping mountains produced from a large number of generally very fluid lava flows.

Hawaiian volcanoes primarily erupt a type of rock known as basalt. When molten, basalt produces liquids of relatively high fluidity, compared to volcanoes that erupt more silica rich magma types such as andesite, dacite or rhyolite. The fluidity of molten basalt favors the formation of lava flows, which is why the Hawaiian volcanoes generally have gentle sloping sides. In contrast, lavas with higher silica content are more viscous and commonly produce thicker, shorter lava flows, thick blocky deposits and/or thick beds of ash that fall from the sky following explosive eruptions. These other types of volcanoes (common outside of Hawaii) are typically steeper sided.

The Hawaiian volcanoes were produced by the Hawaiian hot spot, which is presently under the Big Island of Hawaii. The image below shows the islands of the Hawaiian chain and the intervening shallows, banks and reefs along a line from southeast to northwest. In general, when you move along the island chain from southeast (Hawaii) to northwest (Kure), the volcanoes become older and older.



The age trend of the volcanoes is thought to be due to the way in which the islands are built on the moving sea floor of the North Pacific Ocean: the Pacific Ocean is mostly floored by a single tectonic plate (known as the "Pacific Plate") that is moving over the layer in the Earth known as the asthenosphere. This movement takes it to the northwest compared to the layers below it at a rate of 5 to 10 cm/yr (the rate depends on where you are on it). As the Plate moves over a fixed spot deeper in the Earth where magma (molten lava) forms, a new volcano can punch through this plate and create an island.

The Hawaiian Islands are hypothesized to be formed from one such 'hot spot'. As the plate moves away, the volcano stops erupting and a new one is formed in its place. With time, the volcanoes keep drifting westward and getting older relative to the one active volcano that is over the hot spot. As they age, the crust upon which they sit cools and subsides. This, combined with erosion of the islands once active volcanism stops, leads to a shrinking of the islands with age and their eventual submergence below the ocean surface.

1. What is a shield volcano?
2. How did the Hawaiian Islands form?
3. What do the age of the island and the hypothesized formation of the islands help show the movement of plates in the Pacific Ocean?

Procedure:

1. Using a ruler and the map provided, measure the distance between the first volcano (Kilauea) and the other island volcanoes.
2. Convert the measurements into kilometers, using the scale on the map.
3. Record the distance on the table “Age of the Hawaiian Islands and Outer Seamounts.”
4. Create a graph with distance in kilometers on the “Y” axis and age in millions of years on the “X” axis, and plot your data.
5. Draw a line to represent the best fit of your data.
6. The slope of the line will give you the speed of the plate, in kilometers per millions of years.
7. Extension: Convert the speed from km/millions of years to centimeters per year.

Volcano Name	Distance from Kilauea along trend of chain (km)	Best K-Ar age (in millions of year)	Rate of movement: (cm/yr)
Kilauea	0	0-0.4	
Kahoolawe		$> 1.03 \pm 0.18$	
Maui		1.32 ± 0.04	
Lanai		1.28 ± 0.04	
Molokai		1.76 ± 0.04	
Kauai		5.1 ± 0.20	
Nihoa		7.2 ± 0.3	
Necker		10.3 ± 0.4	
La Perouse Pinnacles		12.0 ± 0.4	
Gardner Pinnacles		12.3 ± 1.0	
Laysan		19.9 ± 0.3	
Pearl and Hermes Reef		20.6 ± 2.7	
Midway		27.7 ± 0.6	
Yuryaku		43.4 ± 1.6	
Ojin		55.2 ± 0.7	
Jingu		55.4 ± 0.9	
Nintoku		56.2 ± 0.6	
Suiko		59.6 ± 0.6	

