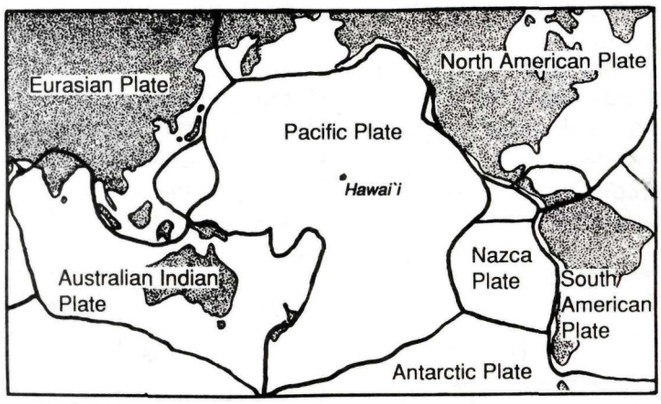
Haleakalā

Haleakalā National Park
National Park Service
U.S. Department of the Interior

Origin of Hawaiian Volcanoes

Plate Tectonic Theory

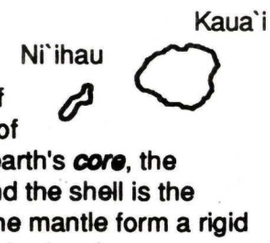
The earth is composed of a series of layers. Imagine an egg as a model of the earth. The yolk represents the earth's ***core***, the white represents the ***mantle*** layer and the shell is the earth's ***crust***. The crust and top of the mantle form a rigid layer called the ***lithosphere***, which is broken into a number of pieces called ***plates***. Beneath the lithosphere the mantle rock is hot and under pressure, making it soft and pliable. As the soft mantle circulates, the overlying plates are moved.



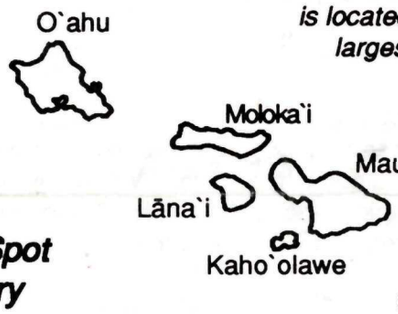
Plates surrounding the Pacific

About 95% of earth's volcanoes and earthquakes occur at plate edges, known as ***plate boundaries***. At ***parallel*** boundaries, the plates slide by each other causing earthquakes. At ***divergent*** boundaries, where plates move apart, magma fills the cracks making both plates grow. At ***convergent*** boundaries, where plates collide, dense oceanic plates sink under continental plates and melting results. Volcanoes along the Pacific "Ring of Fire" such as Mt. St. Helens in Washington State and Mt. Fuji in Japan are created at convergent boundaries.

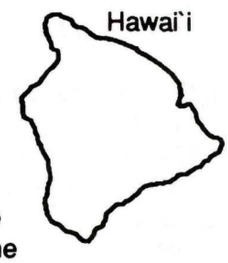
Because Hawaiian volcanoes are formed in the middle of the Pacific Plate and not on the edge, the plate tectonic theory by itself doesn't explain their origin.



The Hawaiian Islands are the tops of volcanoes that grew from the ocean floor. Haleakalā National Park is located on one of the largest volcanoes in the world.



Hot Spot Theory

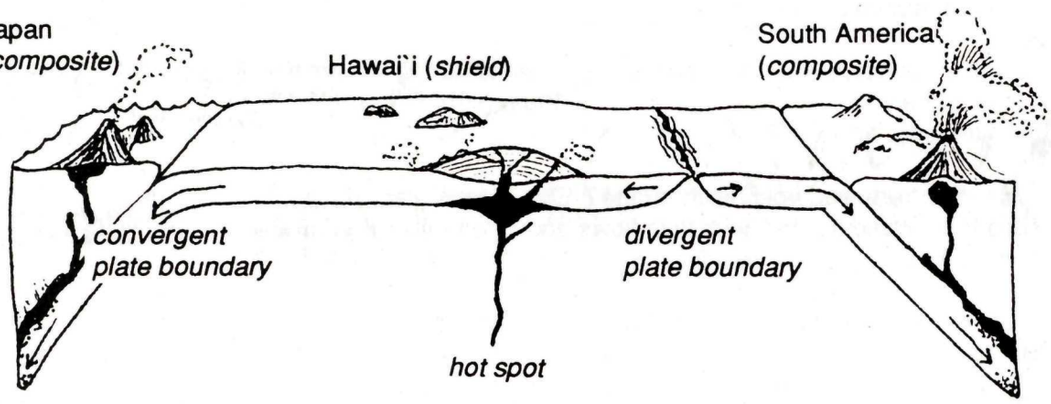


Hawaiian volcanoes are produced by a ***hot spot*** in the mantle. The hot spot is a rising current where the upper mantle melts, producing ***magma***. Magma is less dense than the surrounding rock, and rises to the surface. A volcano forms on top of the plate, so as the plate moves the volcano moves with it, as if on a conveyor belt. The volcano becomes ***dormant*** as it moves away from the hot spot and frequent eruptions cease. A new volcano forms in its place.

The Pacific plate moves toward the northwest at a rate of about 4 in (10 cm) per year, so the oldest Hawaiian volcanoes are located to the northwest. The youngest and largest island, Hawai`i, has three ***active*** volcanoes which have erupted during recorded history. An undersea volcano named Lō`ihi, located about 20 mi (32 km) southeast of Hawai`i, may form a new island some day.

Although you may think of the 8 major islands as Hawai`i, there are really 132 islands in the chain. These islands will eventually be submerged by erosion from rain, wind, waves and landslides, becoming underwater mountains called ***seamounts***. A chain of seamounts extends from Midway Is. to the western Aleutian Islands. According to radiometric dating of seamount rocks, the Hawaiian hot spot has been creating volcanoes for at least 81 million years.

Tectonic setting determines the type of volcano produced, as shown in this cross section.



All volcanoes are NOT alike

Hawaiian volcanoes are called ***shield*** volcanoes. Since they are produced by a mantle hot spot they have very fluid magmas. Fluid magmas often cause relatively gentle eruptions, create a broad shield shaped volcano, and make dark colored rocks. In contrast, volcanoes like Mt. Fuji or Mt. St. Helens are called ***composite*** or ***strato*** volcanoes. Composite volcanoes, produced by melting at a convergent plate boundary, have very thick and pasty or ***viscous*** magmas. Viscous magmas often cause violent explosions, build steep-sided cones and domes, and make light colored rocks.

Life Stages of Hawaiian Volcanoes

1. Submarine Stage
On the ocean floor, gentle eruptions of fluid lava pile layer upon layer building a shield shaped volcano. This stage may last for about 500,000 years. (*for example Lō`ihi: 20 mi, 32 km, south of the Island of Hawai`i)*

2. Emergent Stage
As the volcano nears sea level, a cone is built by steam explosions. When debris piles high enough to keep ocean water out, steam explosions stop and new eruptions can take place on dry land. (*no modern example*)

3. Shield Building Stage
Frequent eruptions at the summit and along ***rift zones***, ridges along the sides of the volcano where eruptions are concentrated, rapidly add to the shield. A summit ***caldera***, a large crater created by collapse, may form, then fill with lava and collapse again repeatedly as the volcano grows. (*Kīlauea and Mauna Loa, Island of Hawai`i)*

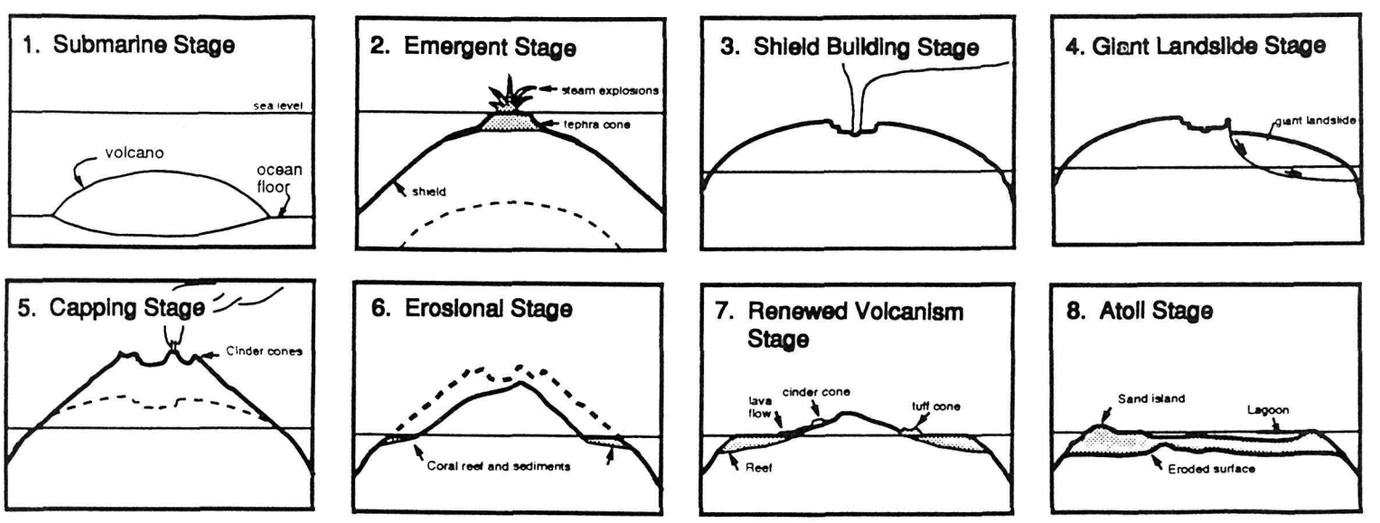
4. Giant Landslide Stage
As a volcano grows, it is unstable. Recent discoveries of landslide debris on the ocean floor around Hawai`i suggest that up to one third of the above sea level portion of a Hawaiian volcano may suddenly collapse into the sea as the volcano grows. (*possibly Kīlauea, Island of Hawai`i)*

5. Capping Stage
A steep-sided cap of viscous lava covers the volcano. Capping stage lavas have a different chemical composition and may cause more explosive eruptions than the shield lavas. Time between eruptions increases until they eventually stop. (*Mauna Kea, Island of Hawai`i)*

6. Erosional Stage
Streams carve valleys and canyons. Ocean waves pound the shoreline producing sea cliffs. This erosion reduces the height of the volcano. Coral reefs are built by tiny marine animals. Broken down coral and shells form white sand beaches. *(Kohala, Island of Hawai`i)*

7. Renewed Volcanism Stage
After a quiet period several hundred thousand to several million years long, eruptions may begin again. Activity may be sporadic and explosive, and does not necessarily follow the old rift zones. (*Haleakalā, Maui)*

8. Atoll Stage
Erosion wears the remaining land down to sea level. Coral reefs grow around the old volcano forming an atoll, a low island with a lagoon in the middle. Eventually the reef dies as plate motion carries it into colder water. (*Kure Atoll: 1500 mi, 2400 km, northwest of Maui)*



Did you know that Haleakalā...

...had an ancient summit which may have towered about 15,000 feet (4500 m) above sea level?

..."crater" is actually a valley carved by streams during the erosional stage of the volcano? The "crater" is 3,000 ft (900 m) deep, 7 1/2 mi (12 km) long, and 2 1/2 mi (4 km) wide.

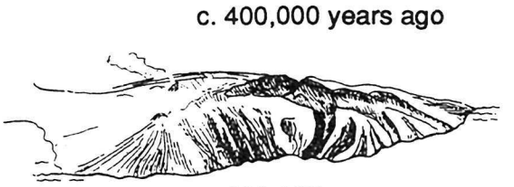
...is in the "renewed volcanism" stage? The renewed activity partially filled the eroded "crater" with lava flows and small hills called cinder cones. Each cone is a vent from a separate eruption.

...is classified by scientists as an ***active*** volcano, although it is not currently erupting? It has erupted at least 10 times in the last 1,000 years, most recently in about 1790 near Mākena.

...summit is 10,023 feet (3055 m) above sea level, but the volcano is actually about 28,000 feet (8500 m) high measuring from the ocean floor? Only about 5% of the volume of the volcano is above the sea.

...is mostly made of a lava rock called ***basalt***, which contains about 61% silicon and aluminum oxides, and 21% iron and magnesium oxides? This composition results in the dark and red colors of the rocks.

c. 400,000 years ago



c. 100,000 years ago

< 1,000 years ago

Haleakalā through time viewed from the south.

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