Virtually Hawaii

http://satftp.soest.hawaii.edu/space/hawaii/

Virtually Hawaii can be found by anybody around the world who has computer access to the Internet. ***Virtually Hawaii*** is designed for a number of audiences, including tourists planning trips to Hawai'i, people interested in the geology of the islands, and individuals who want to see the uses of satellite data to study the land, oceans, and the atmosphere. Here we show just one aspect of the on-line computer presentation, focusing on the way that our "Virtual Field trips" for the islands can be used to study the evolution of Hawaiian volcanoes.

Virtually Hawaii is run by NASA's Hawai'i Space Grant Consortium, which has its own home page at: http://www.spacegrant.hawaii.edu

HAWAIIAN VOLCANOES

Virtually Hawaii's "Virtual Field Trips" provide an excellent opportunity for Internet users to see places that enable the geologic history of the Islands to be studied in detail. From the current eruptions of Kilauea Volcano on the Big Island to Waimea Canyon on Kaua'i there are thick layers of lava flows almost 5 million years old, we can see that Hawai'i has a very dynamic geology. This poster describes some of the best features of each island that show this history, and which island(s) to find these examples.

Each Hawaii island has a different age (see the ages given on this poster). Notice how all of these islands get older as we go from southeast to northwest – this is due to plate tectonics moving the ocean floor towards the northwest. Each island started its life growing over a hot spot, growing as a submarine volcano at the place where Kilauea is now forming. An interesting puzzle you can solve is to use the ages of the Hawaiian volcanoes to see how fast the ocean floor is moving. First measure the distance of each volcano from Kilauea. Then, on graph paper, plot this distance against the age of the volcano. Draw a straight line through these points to find the average rate of movement of the ocean crust (give your answer in either centimeters per year or kilometers per million years.

To see many more images of each part of Hawai'i, you can take each electronic Virtual Field Trip by typing the specific web address for each island.

We use Landsat satellite images to show the eight Hawaiian Islands as imaged between 1999 to 2001. These data have a spatial resolution of 30 meters. Many different images have been used to create "cloud-free mosaics" of each island by looking between the clouds. The surrounding ocean has been artificially colored black to ease the viewing.

Kaua'i

5.1 to 3.6 million years old

http://satftp.soest.hawaii.edu/space/hawaii/vfts/kauai/kauai2.vft.html

The original volcano on Kaua'i was the Wai'alea'ale volcano, which once was a much bigger volcano than it is today. A giant avalanche has eroded away the eastern ~3/4 of the volcano; the wall of Waimea Canyon (1) is the headwall of the avalanche scarp. Following this event, either the Wai'ale'ale volcano continued to erupt, or a different volcano developed. Either way eruptions occurred within the old avalanche scar and built lavas back to almost re-fill the depression. Lavas that flowed west ponded against the old scarp and thus are thick and flat-lying. the old caldera of this "second" volcano is the Lihu'e basin (2). It is likely that this "second volcano also suffered from avalanching to the east. In both these views, the lava flows that filled the old summit caldera now form dense, thick layers of rock that are more resistant to erosion than the flanks, and now form the flat summit area of Kaua'i.

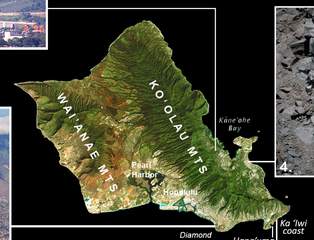
O'ahu

Wai'anae 3.8 to 3.1 million years old
Ko'olau 2.7 to 1.8 million years old

http://satftp.soest.hawaii.edu/space/hawaii/vfts/oahu/oahu.vft.html

We see another fine example of how a Hawaiian volcano can be modified by giant landslides during the **erosional stage**. The pali on the eastern side of the Ko'olau volcano on East O'ahu (3) is a line of steep cliffs that rise over 300 meters above the coastal plain. This erosion also lets us view inside the old Ko'olau volcano and the probable cause of the landslides; at the H-3 quarry (4), hundreds of dikes a meter or so wide were intruded into the interior of the volcano, forcing this side of the mountain towards the east. Eventually, this horizontal motion resulted in the over-steepening of the land, and its subsequent collapse onto the ocean floor.

Other landscapes on O'ahu also shows how Hawaii Islands can be modified during the erosional stage. Pearl Harbor is a drowned river valley, and shows that O'ahu (like other Hawaiian Islands) has been sinking sometime in the past. **Rejuvenation stage** eruptions have also added new land, such as Diamond Head (5) and the Ka'lwi coastline of Southeast O'ahu (6). Called the "Honolulu Series," these eruptions are quite young (0.8 to 0.03 million years old) and formed now-popular tourist attractions such as Hana'uma Bay and Koko Crater.



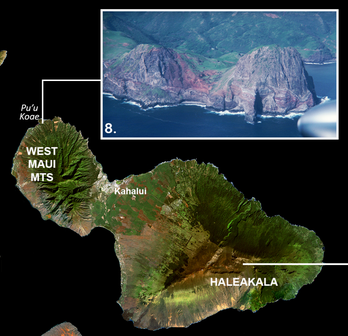
Moloka'i

1.8 to 1.5 million years old

http://satftp.soest.hawaii.edu/space/hawaii/vfts/molokai/molokai.vft.html

Like many Hawaiian volcanoes, East Molokai'i volcano is under-going extensive stream erosion on its flanks, and deep valleys have been carved into the old shield. We can also see similar erosion on parts of Maui and the older volcanoes on the Big Island. The well developed fringing reef around East Moloka'i (7) indicates that the volcano is in the reef growth stage of its evolution.

Lana'i

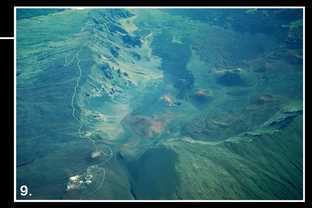


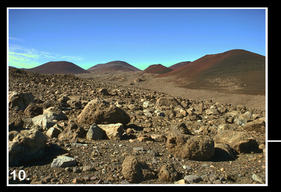
Maui

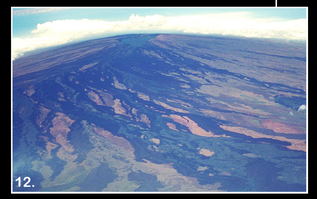
West Maui 1.8 to 1.5 million years old
East Maui 0.8 to 0.7 million years old

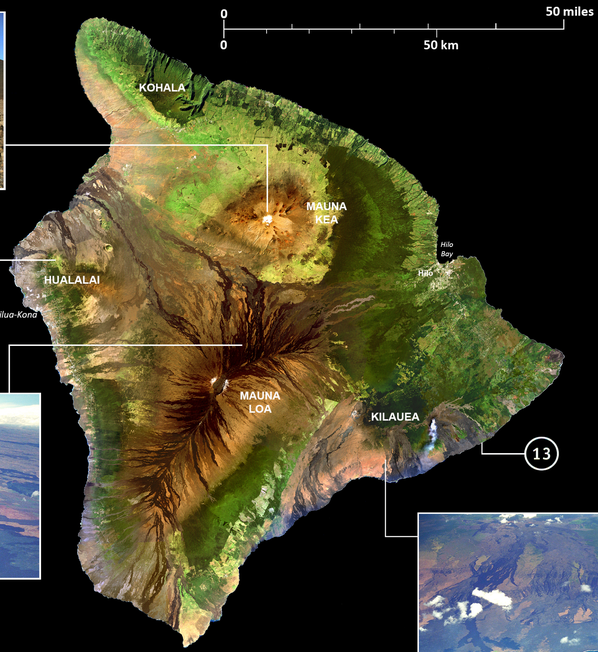
http://satftp.soest.hawaii.edu/space/hawaii/vfts/maui/maui.vft.html

Signs of deep erosion can be found on both West and East Maui, indicating that these volcanoes have reached their **erosional stage**. At a place called Pu'u Koa'e, there are two large rock peaks that are made of a volcanic rock called trachyte (8), which once formed domes inside volcanic cones that have now been eroded away. Haleakala Crater lies at the summit of East Maui volcano (9) and is interpreted to be a deep erosional depression rather than a true volcanic crater. Notice also the small cinder cones and relatively young lava flows on the crater floor, indicating recent **rejuvenation stage** eruptions.







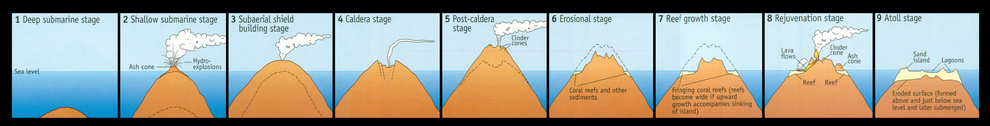


Big Island

0.5 million years old to present

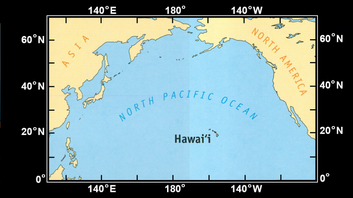
http://satftp.soest.hawaii.edu/space/hawaii/all.bi.vfts.html

Kohala volcano (0.5 to 0.3 myrs) is no longer active and glacial deposits (10) can be found at the summit of Mauna Kea (0.38 to <0.01 myrs), which is in the **post-caldera stage** of its life cycle. Notice the many cinder cones on Mauna Kea, which were formed by eruptions with high lava fountains. Hualalai has some rocks 130,000 years old and last erupted in 1801. In 1800 it produced a large volume of very fluid lava that left thousands of olivine nodules lying around the vent area (11). Kilauea Volcano (12) is the youngest of the five Big Island volcanoes (0.1 myrs to present) and is in the **shield building stage**. Built onto the side of Mauna Loa, most of the eruptions of Kilauea (13) are located along lines of weakness called "rift zones". Rift zones are common features of Hawaiian volcanoes, and we can also find them on Mauna Loa (14) and other volcanoes on most islands. Mauna Loa (0.54 million years to present) has a large summit crater called Moku'aweoweo Crater, indicating that it is in the **caldera forming stage.**

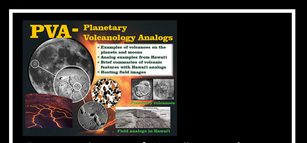


EVOLUTION OF HAWAIIAN ISLANDS

These diagrams show the life cycle of a Hawaiian island, from its formation as a submarine volcano to its final stage as an atoll. As we Look at the satellite images of the island on this poster, we can see several of these stages. The Big Island has volcanoes in the subaerial shield building stage (Mauna Loa and Kilauea), the post-caldera stage (Hualalai and Mauna Kea), and the erosional stage (Kohala). East Molokai has rejuvenation stage volcanism (Kalaupapa). There is also a submarine volcano called Lo'ihi off the SE coast of the Big Island which is in Stage 1 of this sequence. Can you think of other parts of Hawai'i (including the Leeward islands, to the west of Ni'ihau) that show other stages in this evolutionary sequence?



Topographic profiles across the Hawaiian Islands clearly show how the islands sink beneath the ocean as they get older. This is partly due to erosion, but more significantly is the weight of the island that depresses the underlying ocean crust and causes the land to subside. Once each Island moves off of the hot spot (currently located beneath SE Big Island) that created each volcano, there is no new lava to continue building the volcano and so the summit elevation decreases over time. An interesting exercise is to measure the height of each volcano using the profiles above, and to use graph paper to plot these heights against the distance of each volcano from Kilauea volcano (which is close to the current location of the hot spot). What do you think this series of point shows?



For more images of Hawaii as a planetary volcanology analog, visit our other web site:
http://www.higp.hawaii.edu/prpdc/pva/index.html