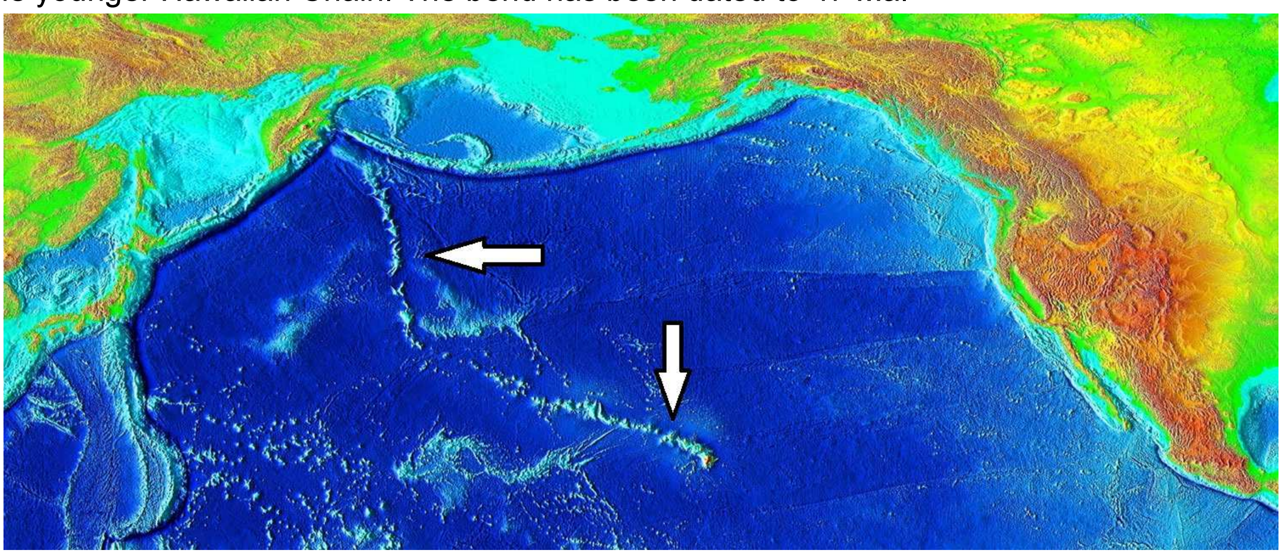
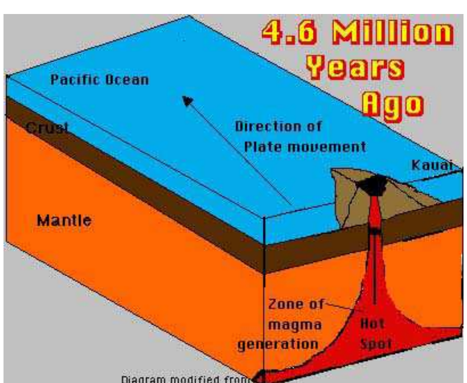
Hot Spots

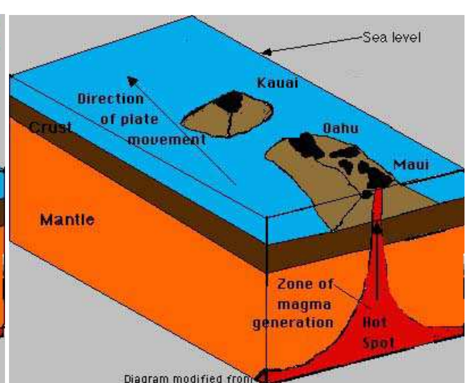
In geology, the places known as hotspots or hot spots are volcanic regions thought to be fed by underlying mantle that is anomalously hot compared with the surrounding mantle. A hotspot track results if such a region is moving relative to the mantle. A hotspot's position on the Earth's surface is independent of tectonic plate boundaries. There are two hypotheses that attempt to explain their origins. One suggests that hotspots are due to mantle plumes that rise from the core–mantle boundary. The other hypothesis is that lithospheric extension permits the passive rising of melt from shallow depths. This hypothesis considers the term "hotspot" to be a misnomer, asserting that the mantle source beneath them is, in fact, not anomalously hot at all. Well-known examples include the Hawaii, Iceland and Yellowstone hotspots.

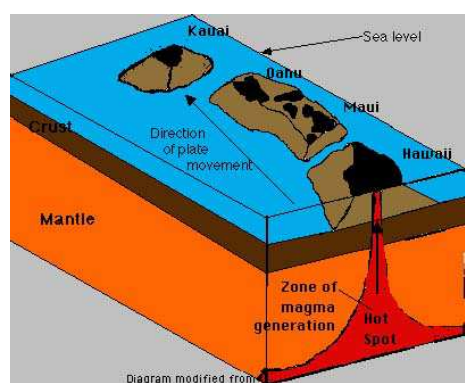
Hotspot Tracks

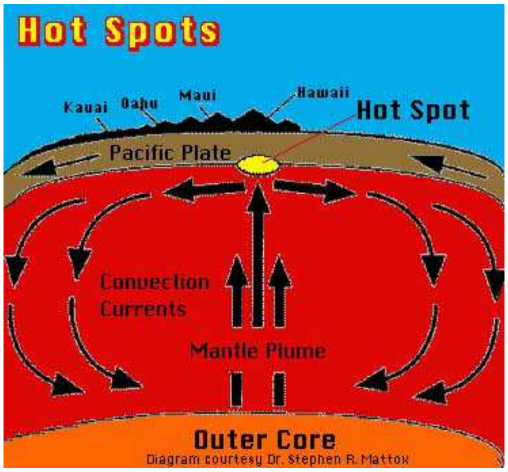
Many volcanic ocean islands are created by columnar shaped hot upwellings called mantle plumes that originate near the 3000 km deep base of Earth's mantle. Mantle plumes are not much influenced by surface motions of the tectonic plates that slowly move over them. Hence, long linear chains of plume-sourced volcanoes that get older and older with increasing distance from active hotspots can be tracked for hundreds to thousands of kilometers. In the Hawaiian hotspot trail, the Hawaii islands are the youngest in the chain that stretches nearly 6,000 km to Detroit seamount in the northwest Pacific, where volcanism occurred about 80 million years ago. An unprecedented 60 degrees bend characterizes the **Hawaiian-Emperor Chain**, dividing it into the older Emperor Chain and the younger Hawaiian Chain. The bend has been dated to 47 Ma.



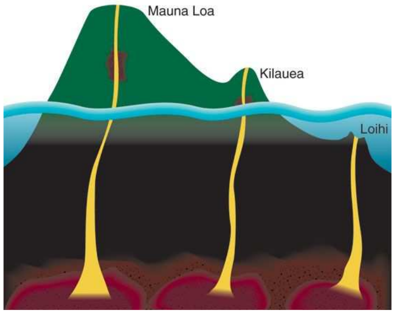




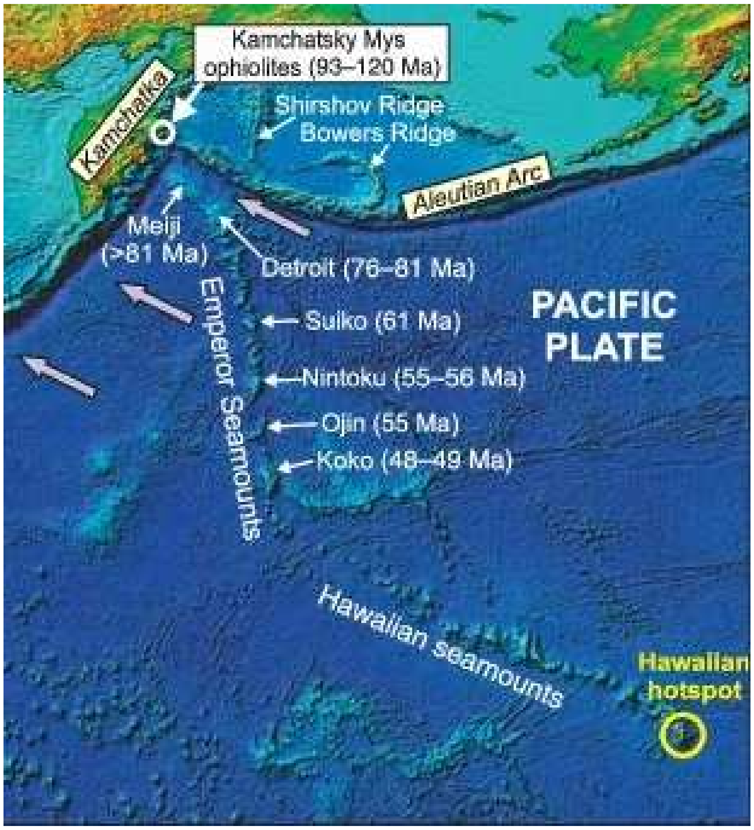




The hot spot or mantle plume is stationary. The plate moves over it.



Loihi Seamount will be the next Hawaiian Island. Undersea pillow lava on Loihi summit.



The older Emperor Chain is shown here with the seamounts dated by their rocks from 43-80 Ma. Note the increasing age of the seamounts which were once islands, themselves.

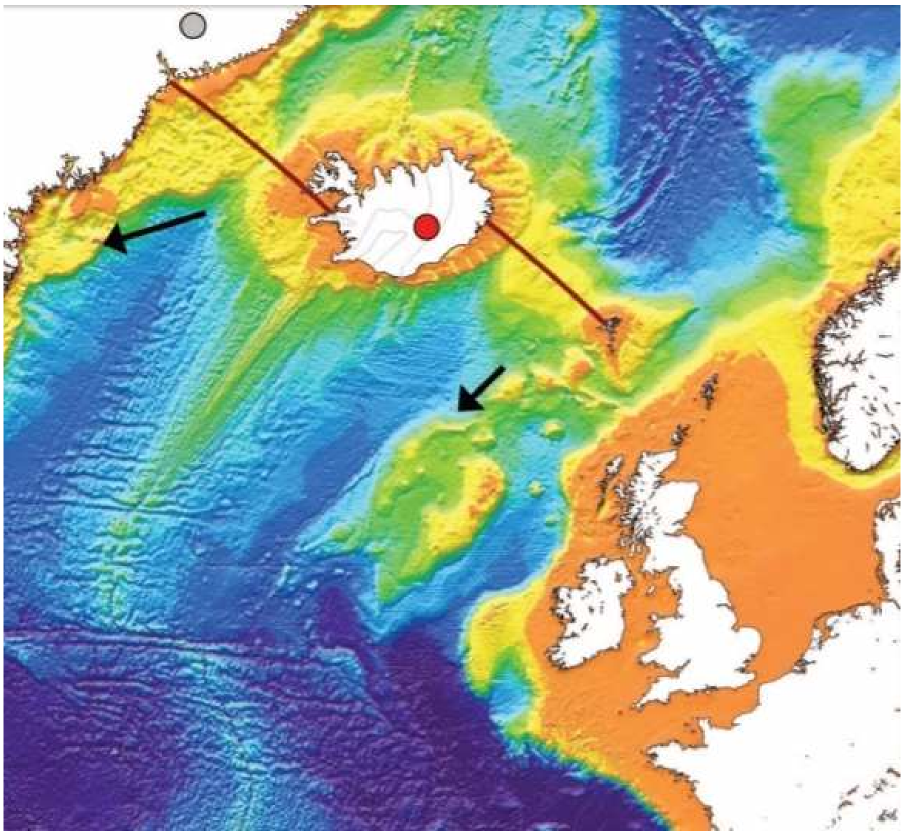
The seamount chain, containing over 80 identified undersea volcanoes, stretches about 3,900 mi from the Aleutian Trench in the far northwest Pacific to the Lo‘ihi seamount, the youngest volcano in the chain, which lies about 22 mi southeast of the Island of Hawai‘i.

The Hawaiian-Emperor Chain is a huge undersea mountain range extending upward from the ocean floor. The 60 degree 'bend' might indicate a shift in the direction of the pacific plate occurred some 43 Ma. Another theory suggests a movement of the normally stationary mantle plume may also be involved.

Iceland Hotspot *Located on the Mid-Atlantic Ridge (spreading zone) complicates the analysis...

The Iceland hotspot is a hotspot which is partly responsible for the high volcanic activity which has formed the Iceland Plateau and the island of Iceland. Iceland is one of the most active volcanic regions in the world, with eruptions occurring on average roughly every three years (in the 20th century there were 39 volcanic eruptions on and around Iceland). About a third of the basaltic lavas erupted in recorded history have been produced by Icelandic eruptions. Notable eruptions have included that of Eldgjá, a fissure of Katla, in 934 (the world's largest basaltic eruption ever witnessed), Laki in 1783 (the world's second largest), and several eruptions beneath ice caps, which have generated devastating glacial bursts, most recently in 2010 after the eruption of Eyjafjallajökull.

Iceland's location astride the Mid-Atlantic Ridge, where the Eurasian and North American Plates are moving apart, is partly responsible for this intense volcanic activity, but an additional cause is necessary to explain why Iceland is a substantial island while the rest of the ridge mostly consists of seamounts, with peaks below sea level.



The Iceland Hotspot is not usual in all respects: It has an active MId-Atlantic spreading-ridge passing right through it. Due to this location the I-hotspot sits in the middle of its hotspot trail rather than at the end of its trail. The trail extends across the North Atlantic Ocean, from Iceland to the Faeroe Islands, the Faeroe-Iceland ridge (FIR) on the Eurasian plate, and from Iceland to East Greenland, the Greenland-Iceland ridge (GIR) on the North American plate. This interpretation makes the I-hotspot at least as old as the opening of the North Atlantic Ocean in this area, at least 56 Ma based on oceanic magnetic anomalies.

Red circle above shows the center of the hotspot source today, and grey circle its position at 40 Ma according to Lawver and Müller (1994). The aseismic ridges between Greenland and Iceland (GIR) and the Faeroes and Iceland (FIR) are possibly hotspot tracks (red lines). Absolute plate motions of the North American and Eurasian plates are shown with arrows with velocities 26 mm/yr and 15 mm/yr.

Yellowstone Hotspot

The Yellowstone hotspot is a volcanic hotspot in the United States responsible for large scale volcanism in Idaho, Montana, Nevada, Oregon, and Wyoming as the North American tectonic plate moved over it. It formed the eastern Snake River Plain through a succession of caldera-forming eruptions. The resulting calderas include the Island Park Caldera, the Henry's Fork Caldera, and the Bruneau-Jarbidge caldera. The hotspot currently lies under the Yellowstone Caldera. The hotspot's most recent caldera-forming supereruption, known as the Lava Creek eruption, took place 640,000 years ago and created the Lava Creek Tuff, and the most recent Yellowstone Caldera. The Yellowstone hotspot is one of a few volcanic hotspots underlying the North American tectonic plate; others include the Anahim and Raton hotspots.

Hayden Valley with Yellowstone Caldera rim in the background.