VOLCANOES

"I don't know where I'm-a-gonna go. . ."

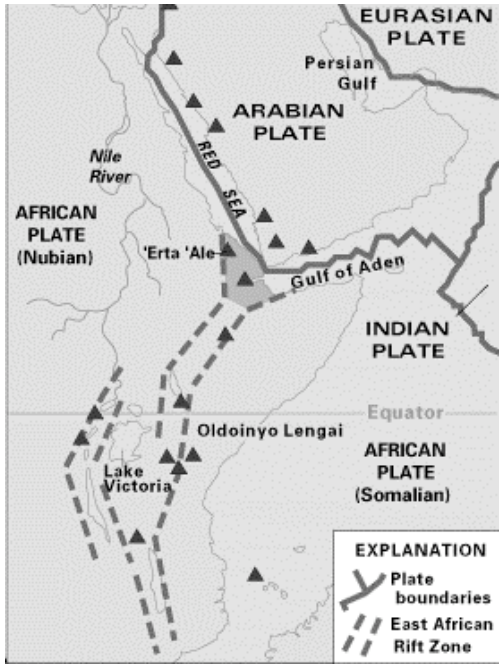
But first, we need to finish up a few things concerning. . .

Plate Tectonics

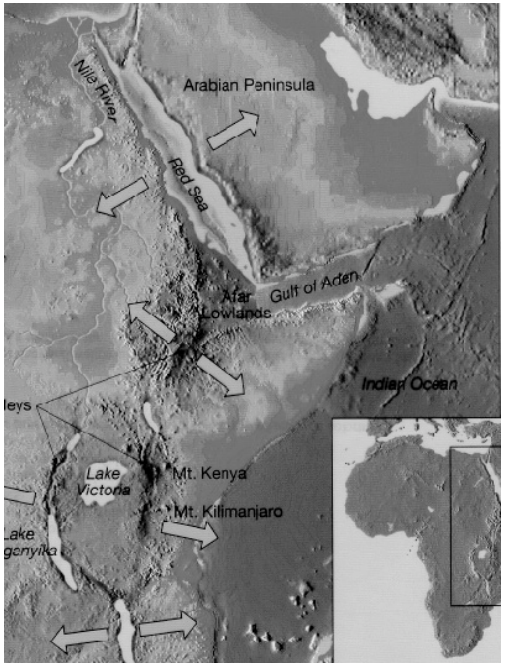
Triple Junctions

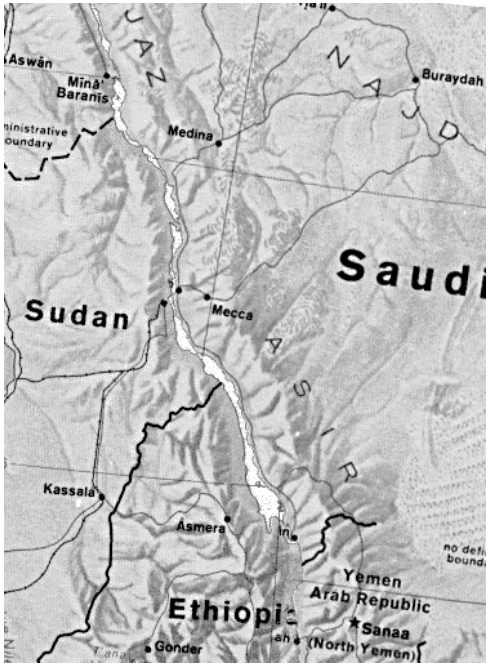
- When you break a dinner plate, the cracks do not simply split the plate in two; you get "side cracks" as well.
- This ultimately derives from physics: when you put stress on something flat and brittle, it cracks along three stress lines, not two.
- Same applies to tectonic plates—when a plate rifts, it starts out at a *triple junction*.

The best-known triple junction connects three rifts: one in the Red Sea, one in the Gulf of Aden, and one forming a crack called the *East African Rift Valley* that is slowly splitting East Africa away from the rest of the continent.



You can see the rift zones in the Red Sea and Gulf of Aden more clearly on this topographic map.



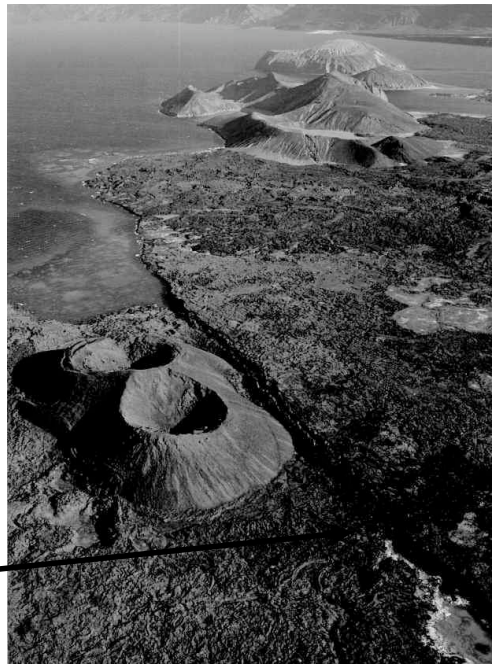


The Red Sea formed along one arm of this triple junction. Its coastlines match up very precisely, allowing for some later deformation down around Yemen.

Before. . .

. . . and after.

As you might expect, this causes volcanoes and basalt flows to form along the rift, as seen here in Somalia.



"Hot Spots"

- Some points in the asthenosphere are hotter than others.
- As a continent moves over a hot spot, a chain of volcanoes is formed. . .
- . . . but this time the chain is *parallel* to the direction the continent is moving, not perpendicular like a true island arc.
- At any given time, the newest volcanoes are right over the hot spot, with older ones progressively farther away.

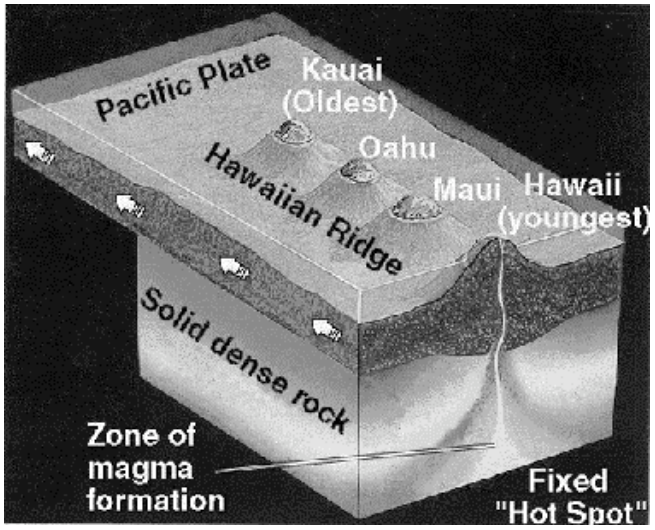
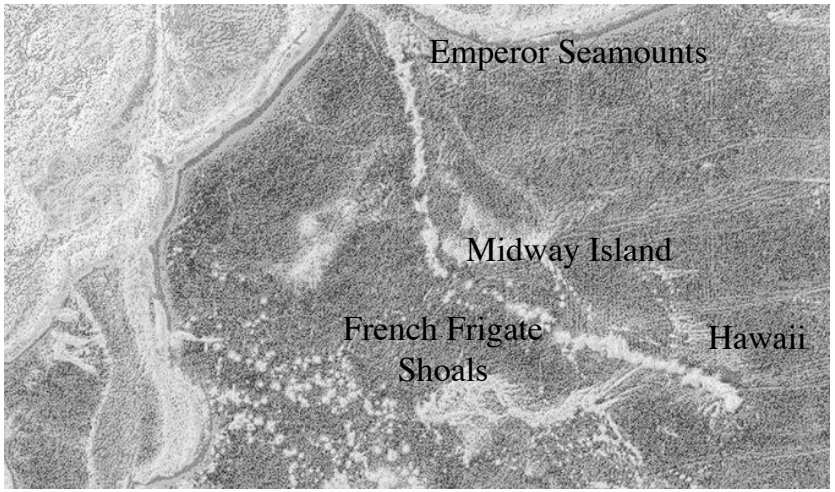
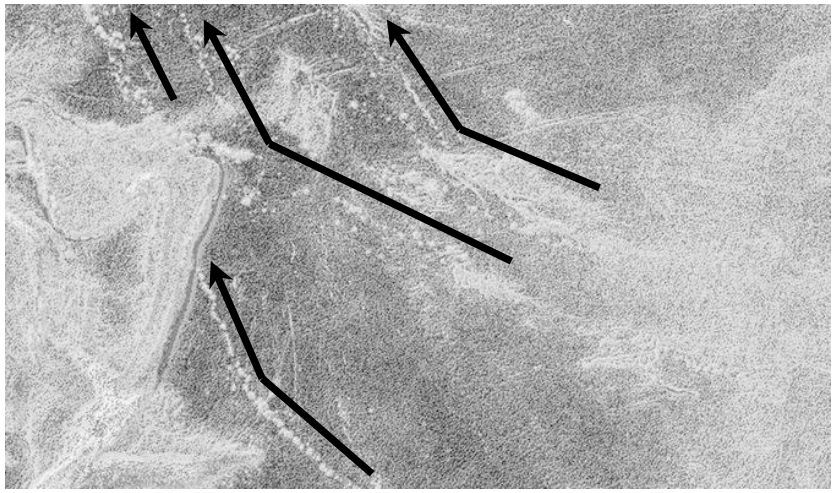


Diagram of Hawaii, a classic "hot spot" volcanic chain

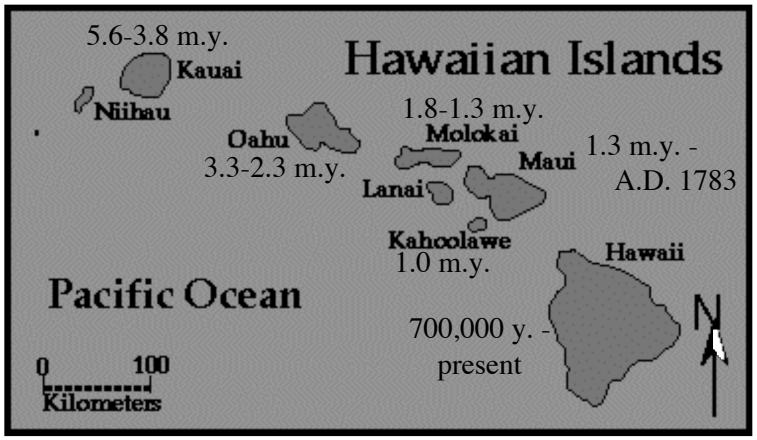


The Hawaiian chain is much longer than the islands in the State of Hawaii. Its "dogleg" results from the Pacific Plate changing direction as it moved over the hot spot.

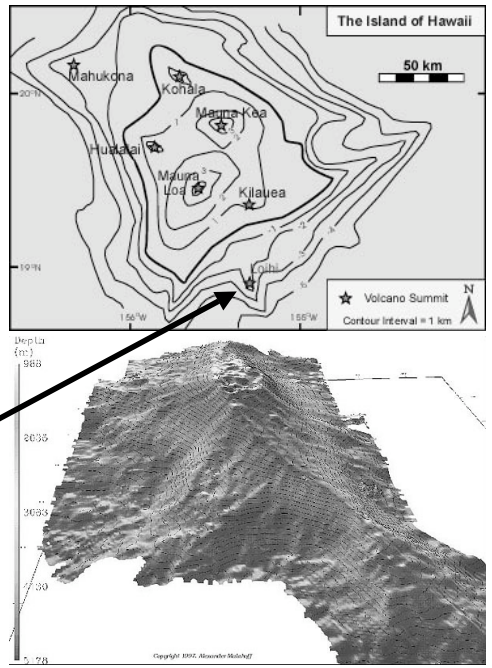
Because there are several hot spots in the Pacific, there are several island chains that are all parallel. . .



The youngest Hawaiian Islands are over the hot spot. The older ones are farther away.



The newest Hawaiian volcano, Loihi, is erupting under the ocean and hasn't broken the surface yet. . . but it's off the southeast coast of the Big Island, right where you'd expect it to be. (Top: location of Loihi. Bottom: 3-D image of Loihi based on sonar scans)



What comes out of volcanoes?

- Volcanoes put out *lava*
  - Mafic (rich in Fe and Mg; about 50% Si)
    - Mafic lavas are less *viscous* and flow more easily
  - Felsic (richer in Si, up to 80%)
    - Felsic lavas are more viscous
    - Felsic lavas are also more prone to trapping gases, causing explosive eruptions

What comes out of volcanoes?

- Volcanoes put out gas (CO_2, SO_2, H_2O, etc.)
  - Gas pressure is what forces material out of a volcano
- Volcanoes also put out *tephra*
  - Tephra = any airborne solid matter put out by a volcano. Types of tephra include
    - ash
    - lapilli
    - cinders
    - bombs
    - blocks

Smoothly flowing basaltic lava is known by the Hawaiian name *pahoehoe*. . .

Pahoehoe lava cools into typical smooth, "ropy" shapes

Basaltic lava with a jagged, rough surface is known as *a'a* or *aa* (another Hawaiian word, pronounced "ah-ah")

Close-up of an aa flow. (There's no chemical difference between pahoehoe and aa lavas; the difference has to do with flow speed relative to temperature and viscosity.)

Congealed magma in the central vent of an extinct volcano may form a *volcanic neck* when the surrounding rock weathers away. Shiprock, New Mexico is a fine example. . .

Lake Nyos, Cameroon, sits in a volcanic crater that still gives off carbon dioxide gas. On August 21, 1986, Nyos released a large burst of CO_2 that suffocated 1700 people.

Volcanoes, like Mount Pinatubo (shown here erupting in 1991), may also extrude *pyroclastic material*, or *tephra* (airborne solid particles).

The ash from Mount Pinatubo blanketed the surrounding area and darkened the sky. . .

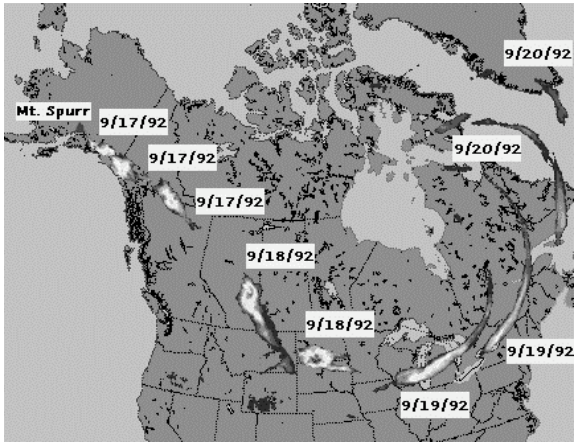
It really didn't help matters that a typhoon hit the Philippines at the same time that Pinatubo erupted. This created volcanic ash mudslides (*lahars*).

Imagine a river of cement hitting your house at up to 35 miles per hour. . . that's how bad the lahars from Mt. Pinatubo were.

Volcanoes and Climate

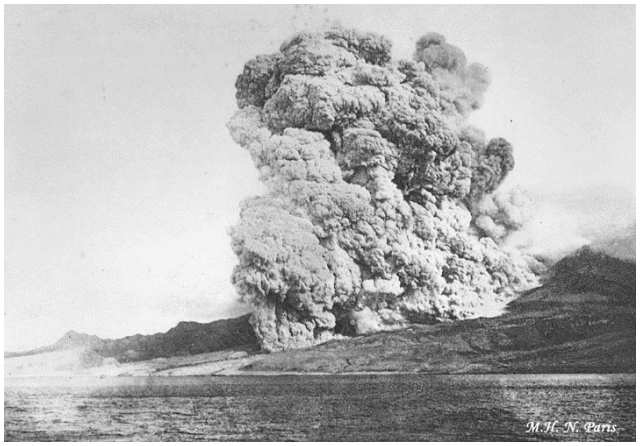
- Volcanoes may also shoot vast amounts of ash into the atmosphere.
  - Ash from Krakatau, in 1883, may have gone 30 miles into the atmosphere
  - Ash from Krakatau was blown all round the world (creating visual effects such as blue moons and incredible sunsets) and took several years to settle out

Fine ash clouds in the upper atmosphere may travel extremely long distances. This map tracks ash from Mount Spurr, Alaska, over four days in 1992



Volcanoes and Climate

- Large eruptions affect global climate
  - Tambora erupted in 1815, largest eruption in recorded history—led to global cool temperatures, crop failures and famines. In the US, 1816 became known as "the year without a summer."
  - Krakatau (1883) produced ash cloud that dropped mean global temperatures by an average of 0.25 degrees C
  - Mt. Pinatubo in 1991 shot ash and gas 21 miles into the atmosphere—led to global mean temperature dropping about 0.5 degrees C in 1992



A mixture of superheated gases and ash is a *nuee ardente* or *pyroclastic flow*. This one was emitted by Mont Pelée in 1902, on the Caribbean island of Martinique; it destroyed the entire town of St. Pierre and killed 28,000 people.

Particles larger than ash include *lapilli* and *cinders*. . .

Lava blobs that solidify in mid-air are *volcanic bombs*, usually with a teardrop-like shape.

Volcanic blocks, on the other hand, are solid when they're ejected (i.e. they don't solidify in midair). These blocks were ejected by Mont Pelée in 1902.

Volcanic eruptions may become extra violent if magma comes into contact with water, causing an explosive release of steam known as a *phreatic eruption*. Ubehebe Crater in Death Valley, CA was formed when underground magma contacted groundwater.

Santorini, off the coast of Greece, is a volcanic crater (about 10 miles across) that erupted around 1625 BC. The walls of the crater cracked, and ocean water rushed in, creating a *phreatic* explosion that blew out the west wall of the crater (which reaches up to 1000 feet above the surface of the ocean).