

Second hand Hawaiian volcanoes

Like widgets on an assembly line, Hawaiian volcanoes are automatically manufactured as they move along a row, geologists believe. The force driving the assembly line is the northwestward movement of the Pacific plate. And the blowtorch that builds the volcanoes is the "hot spot" deep in the earth under the island chain. As finished volcanoes move past the hot spot, they stop erupting and gradually erode.

But then something happens that long has puzzled scientists. After a volcano has moved about 190 kilometers away from where it was formed, and four or five more volcanoes have grown and died behind it, it erupts a second time, though more mildly than the first time.

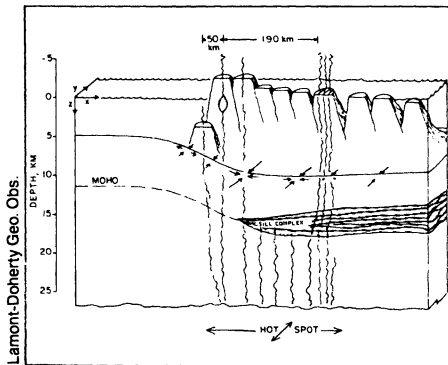
Now, geophysicist Uri S. ten Brink of the Lamont-Doherty Geological Observatory in Palisades, N.Y. offers an explanation for the secondary eruption, which he described recently at a meeting of the American Geophysical Union in Baltimore. He suggests it has to do with how the Hawaiian volcanoes bear down upon the plate beneath them.

When a volcano first erupts, ten Brink says, it grows large very quickly. Its weight is absorbed over a wide area of the plate below, and eventually the pressure on the plate becomes so great and widespread that it stops-up the hot spot, as a person might use his thumb to cut off water from a garden hose. The magma's upward progress is blocked, so the volcano dies and begins to erode.

Later, however, as new volcanoes build up in the chain behind it, the volcano becomes part of a line of pressure — the mountain chain — and no longer exerts its own widespread pressure on the plate, according to ten Brink. Instead, the weight is distributed in a line, so magma can rise again on either side of the line, ten Brink says. It erupts through new, smaller cones that form "like pimples" on the sides of the volcano perpendicular to the mountain chain, ten Brink says. Examples of such secondary cones are Diamond Head, Koko Head and the Punchbowl, all of which were built during the secondary eruptions of Koolau, an old volcano on the Hawaiian Island of Oahu, according to ten Brink.

Ten Brink notes that secondary eruptions occur at a constant distance from the primary eruptions but not at a constant time. A volcano must move a certain distance — about 190 km — before it lets up enough pressure to allow a second eruption, he explains, but the speed of that movement can vary, depending on the speed of the plate.

The most recent large secondary eruptions occurred in 1790 in the Haleakala volcano on Maui, southeast of Oahu, and



During its first eruption, a Hawaiian volcano grows heavy enough to stop-up the hot spot. Magma no longer can escape through the volcano, so it spills underground, forming a sill complex. The mountain erupts again after it has moved 190 km away from where it was formed — to the point where it relieves pressure on the hot spot.

to this day, Haleakala continues to vent some steam. Its primary eruptions occurred about 750,000 years ago.

The next volcano in line to undergo secondary eruptions is Kohala, the northernmost of four volcanoes on the island of Hawaii. Kohala had its primary eruptions about 400,000 to 450,000 years ago, ten Brink says, but he could not predict when next eruptions might occur.

Next in line after Kohala are Hualalai and Mauna Kea, both of which are dead but likely to have secondary eruptions later on, according to ten Brink. Following them is Mauna Loa, which is in the late stages of its primary eruptions. And the southernmost volcano on Hawaii is Kilauea, which is in the midst of its primary eruptions, ten Brink says. Farther south but still underwater is Loihi, the beginning of a new volcano.

Ten Brink's theory is based on seismic studies performed in 1982 near Oahu, which suggested the existence of a lense-shaped body lying horizontally between the crust and the mantle under the islands. Ten Brink and other Lamont-Doherty scientists reported in the May 9, 1985 *NATURE* that this huge "sill body" — estimated to be about 4 km thick at the center and about 200 km wide — is a mass of cooled, dry magma that was trapped in its ascent from a deeper source.

"This is a very large volume of material," ten Brink says, "almost as large as the volume of the island [of Oahu] itself. This suggests that there is much more magma generated down deep in the mantle than scientists have figured until now."

Ten Brink's theory also suggests that the hot spot under Hawaii may be larger than previously believed. Whereas it once was considered just big enough to act as a blowtorch for one volcano, the new theory indicates it is large enough to feed a second volcano 190 km away. Ten Brink estimates the hot spot is 300 km long and about 200 km wide. — *M. Murray*

High court hits key part of budget law

The U.S. Supreme Court this week handed down its ruling on a challenge to the Balanced Budget and Emergency Deficit Control Act, better known for the names of its Senate authors — Gramm, Rudman and Hollings. Writing for the majority in this 7-to-2 opinion, retiring Chief Justice Warren Burger ruled that one of the law's key provisions for executing automatic budget cuts "violates the doctrine of separation of powers," and thus is unconstitutional.

In response, Sen. Warren Rudman (R-N.H.) termed the Supreme Court decision "a very minor setback," and added that he still believes "the [Gramm-Rudman-Hollings law] is alive and well."

Because the court's decision did not invalidate the entire Gramm-Rudman-Hollings (GRH) law, it leaves in limbo the status of the \$11.7 billion curtailment in federal spending — including some \$2.5 billion from research and development programs — that occurred on March 1, the day the first phase of the law went into effect (SN: 3/1/86, p. 135).

What the Supreme Court did strike down was the task the law assigned to the Comptroller General, who heads the General Accounting Office. The comptroller was supposed to determine for the President how mandatory budget cuts would be distributed if federal spending for a given fiscal year would otherwise have exceeded limits specified in the GRH law. Since only Congress can remove the Comptroller General from office, Burger says it is clear that this officer is primarily answerable to the Congress, and therefore an officer of the Congress. And since "the Constitution does not permit Congress to execute the laws," Burger says, "it follows that Con-

Rickover dead at 86

Admiral Hyman George Rickover, the "father of the U.S. nuclear navy," died Tuesday at his home in Arlington, Va. He had been ailing from a stroke.

The U.S. Naval Academy graduate was born in Makow, Russia on the 27th day of this century. Though he saw sea duty, it was for his role in the development of nuclear power — first with the Manhattan Project, later for the Navy — that the feisty perfectionist gained renown. Said Navy Secretary John F. Lehman Jr., "In his 63 years of service, Admiral Rickover took the concept of nuclear power from an idea to the present reality of more than 150 U.S. naval ships under nuclear power, with a record of 3,000 ship years of accident-free operation." □