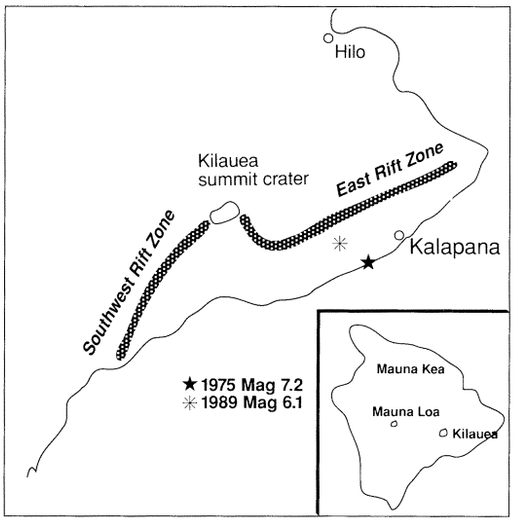
Where Have All the Earthquakes Gone?

Seismologists wonder why part of Hawaii's Kilauea volcano has gone quiet

By RICHARD MONASTERSKY



***All's quiet:** The number of small jolts around Kalapana has averaged below normal in recent years, causing seismologists to wonder whether the region is preparing for a big quake or relaxing after previous ones.*

The sky turns a seasick shade of green, signaling the impending arrival of a torrential downpour, complete with lightning galore and howling winds. But moments before the first fat raindrops hit the ground, the gale ceases abruptly in a pregnant pause—the calm before the storm.

Seismologists have their own version of that phenomenon. Called seismic quiescence, the term describes how a particular patch of ground will sometimes stop producing its normal quotient of minor earthquakes just before a big one hits.

That's why geophysicists James H. Dieterich and Paul Okubo grew interested when they noticed a lull in tremors on one side of Hawaii's Kilauea volcano during the last few years. The quiescent area sits on Kilauea's eastern flank, just south of the volcanically active east rift zone, according to Dieterich, a researcher at the U.S. Geological Survey in Menlo Park, Calif. Okubo works at the USGS' Hawaiian Volcano Observatory.

On its own, a simple observation of quiescence might not capture much attention among seismologists. Because faults behave irregularly from one year to the next, some regions may take a rest for a short spell without ever generating a big quake. Quiescence does not always precede something important. But the Kilauea case stands out because Dieterich and Okubo have discovered that the currently inactive region has a history of going silent before large quakes.

The quiescent zone is an irregularly shaped block of crust measuring about 18 kilometers on its longest side and extending to a depth of 10 kilometers. Researchers believe that a major fault cuts through the bottom of that block, forming a nearly horizontal break that separates the upper crust from deeper regions. Riding on that fault, the top layer is slipping toward the ocean with unusual haste. Surveys using Global Positioning System satellites show the southeastern part of the volcano moving seaward at the geologically exceptional rate of 10 centimeters per year. Calculations suggest that at the depth of the fault, the top layer is slipping even faster — at 25 centimeters per year, the fastest creep ever detected along a fault (SN: 6/12/93, p.382).

In 1975, this same fault generated a magnitude 7.2 quake near the town of Kalapana that caused part of the south coast of the island of Hawaii to drop by 3.5 meters, spawning a wall of water—a tsunami — more than 14 meters high. In the late 1970s, while studying seismic records of Kilauea, seismologist Max Wyss and his colleagues noticed that the region involved in the Kalapana shock had grown quiet for four years prior to the quake.

The quiescent region that Dieterich and Okubo have found coincides with the one Wyss identified before that 1975 temblor. That correlation caused the two USGS researchers to take a closer look at a magnitude 6.1 quake that struck the Kalapana region in 1989. Sure enough, this shock also followed three years of reduced seismic activity in the same region. While seismologists have noted many cases of prequake quiescence, the Kilauea example marks the first known case of quiescence repeating itself in the same region before successive quakes, Dieterich says.

The big question, of course, is whether the pattern will hold up. Will the current calm lead to another major Kalapana quake?

At present, Dieterich and Okubo say they don't know what to make of the quiescence. But they are certain of one thing: They do not want their observations to be misconstrued as an earthquake forecast.

"We're not predicting an earthquake. We think there are many questions that need to be addressed related to the seismic quiescence before any such steps could be taken," says Dieterich, who presented the pair's findings last month to the National Earthquake Prediction and Evaluation Council, of which he is a member. Aside from assessing actual predictions, the council also reviews current research at seismologically active sites in the United States.

One interpretation of the quiescence is that it represents a finale to past quakes rather than a prelude to future ones, notes Dieterich. The current quiet may be just an abrupt end to the aftershocks that followed the Kalapana earthquakes of 1975 and 1989.

Wyss, another member of the council, favors this idea. "I would not interpret this as a precursor. I would interpret it as meaning that the story is now over. The energy has been depleted and it will be quiet for a number of years," says Wyss, now at the University of Alaska in Fairbanks.

Dieterich says the previous large earthquakes and quiescence periods at Kalapana complicate the seismic story at Kilauea. Each of the previous events drastically altered the frequency of small earthquakes, making it difficult to determine the region's baseline level of activity, a reference needed to interpret the current quiescence.

Despite the questions, Dieterich and Okubo think the drop in seismic activity may well turn out to be important. "I have a healthy dose of skepticism about the quiescence, but the observations are too interesting to ignore," Dieterich says.

Geophysicist Paul Segall, with the USGS in Menlo Park, has reached the same conclusion based on his study of Kilauea's seaward slip. Says Segall, "We've got a chunk of Earth that we know is moving at a pretty astronomical rate, and we know it has generated large earthquakes and tsunamis in the past. We clearly have to take a closer look at this area." □