

SEISMICITY OF THE LOWER EAST RIFT ZONE OF KILAUEA VOLCANO, HAWAII, JANUARY 1962-MARCH 1963

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Abstract.—Eight-hundred and forty small, shallow earthquakes from the lower eastern part of the Kilauea east rift zone were recorded at Pahoa between January 1962 and March 1963. Ninety-four percent of these earthquakes, including some that were felt, were smaller than magnitude 2. The largest was of magnitude 4.0. Instability of the flank of Kilauea south of the east rift zone is indicated by the concentration of foci south of the surface trace of the rift zone.

Following the brief eruption of Kilauea along the central part of its east rift zone in September 1961 (Moore and Richter, 1962), frequent earthquakes emanated from the lower part of the rift zone and adjacent southeast flank of the volcano for many months. Earthquakes from this region, lat 19°21' N. to 19°33' N. and long 154°46' W. to 155°06' W. (fig. 1), that occurred from January 1962 through March 1963 were studied to determine what light they might shed on the structure of this portion of the volcano.

The seismograph at Pahoa recorded 840 earthquakes ranging in magnitude from 0.5 to 4.0 on the Richter scale during this period. At Pahoa these earthquakes were characterized by strong, sharp first motion, high frequency (5 to 10 cycles per second), and short total duration (1/2 to 2 minutes). Almost all the quakes produced compressional first motion at Pahoa.

Earthquakes of magnitude 2 or greater were generally well recorded on the Kilauea seismic network and at Hilo, as well as at Pahoa (fig. 1) (see also Krivoy and others, 1963; Koyanagi and others, 1963; Okamura and others, 1963; Okamura and others, 1964; and Krivoy and others, 1964, for a description of stations and instruments of the seismic network). Foci were determined from P arrival times interpreted on the basis of traveltimes curves obtained from the March 7, 1955, earthquake in southeast Hawaii (Eaton, 1962, fig. 2, model B). The very large number of smaller quakes that originated within 15 to 20 kilometers of Pahoa

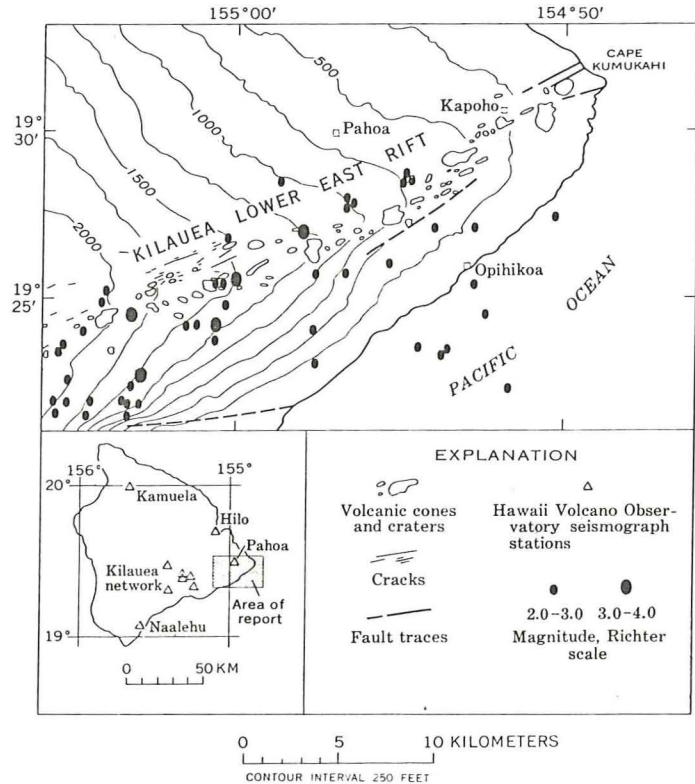


FIGURE 1.—Plot of earthquake epicenters (elongated dots) along the lower east rift zone of Kilauea, during January 1962-March 1963. Cones, craters, cracks, and fault traces after Stearns and Macdonald (1946).

were poorly recorded at other stations, where their first arrivals were often indistinct.

Epicenters of quakes of magnitude 2.0 and greater are plotted on figure 1. Most of these quakes came from depths of 3 to 8 km. The two deepest quakes of the group had magnitudes of 2.5 and 2.8 and originated at a depth of about 12.5 km at lat 19°22' N., long 155°03' W. Several deeper earthquakes (about 45 km) occurred a few kilometers southwest of the region considered here (Koyanagi, 1964).

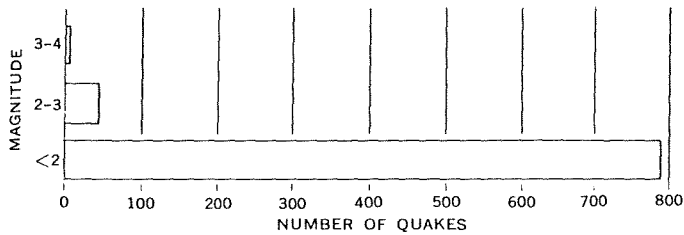


FIGURE 2.—Magnitudes of quakes along the Kilauea lower east rift recorded at Pahoa during January 1962–March 1963. The smallest earthquakes from this region that could be discerned on the Pahoa seismograms had magnitudes of about 0.5.

Of the 840 quakes recorded at Pahoa, 790 (94.0 percent) were smaller than magnitude 2.0 (fig. 2). Forty-five (5.4 percent) had magnitudes of 2.0 to 3.0; and five (0.6 percent) had magnitudes of 3.0 or greater.

The largest earthquake of the group was of magnitude 4.0. It took place 14 km southwest of Pahoa at a depth of about 5 km on January 7, 1962. It was felt throughout the island, but no damage was reported. Several earthquakes smaller than magnitude 2.0, presumably from the immediate vicinity of Pahoa or Kapoho, were felt as sharp vibrations lasting only 1 or 2 seconds by residents of these communities.

The number of quakes recorded at Pahoa per week (fig. 3) ranged from 0 to 58. Periods of increased seismic activity alternating with relatively quiet periods occurred at intervals of 3 to 7 weeks. The most striking feature of the curve is the 2 months of very low seismic activity on the lower east rift zone after the brief eruption of Kilauea in and near Aloi Crater on the upper

east rift zone during December 7–10, 1962. This period of inactivity was terminated at the end of February 1963 by 2 weeks of frequent earthquakes; 48 quakes were recorded during the week that ended on March 11.

When considered in the context of events at Kilauea following the 1960 flank eruption near Kapoho (Richter and Eaton, 1960), the high level of seismic activity along the lower east rift zone from January 1962 through March 1963 appears to be closely related to the rapid refilling of the shallow reservoir beneath the Kilauea summit (Eaton, 1962) that began in the autumn of 1960. Also, the drop in reservoir pressure caused by the small eruption in December 1962 seems temporarily to have relieved stresses usually applied through the fluid core of the rift zone to the lower (eastern) part of the rift zone.

The preponderance of shallow earthquakes and the absence of foci deeper than about 12 km indicate that the lower part of the rift zone is confined largely to the pile of volcanic rocks on the ocean floor and that it does not penetrate the mantle. Lateral transmission of magma demonstrated in recent flank eruptions (Eaton, 1962) also supports the idea of a shallow rift zone.

The asymmetry in the distribution of earthquakes, with the rift zone itself being the northern limit of concentrated epicenters, shows the instability of Kilauea's southeast flank, which is broken by numerous normal faults that approximately parallel the rift zone and have downward displacement on the seaward blocks.

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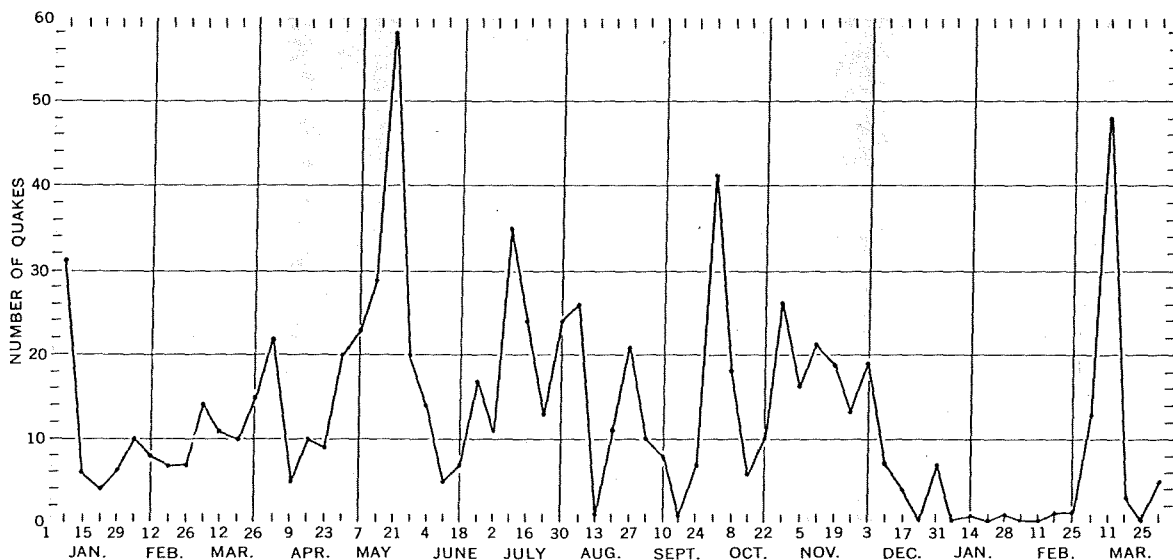


FIGURE 3.—Weekly frequency of earthquakes along the lower east rift zone recorded at Pahoa, January 1962–March 1963.

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