

HAWAIIAN SEISMIC EVENTS DURING 1963

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Abstract.—Six hundred and seventy-three earthquakes of magnitudes 2.0 to 5.3 were recorded and located beneath the Hawaiian Ridge during 1963. The Kaoiki fault system, the Kalapana Trail region, the east rift zone of Kilauea, and a zone 30 km beneath Kilauea Caldera were regions of concentrated earthquake activity.

This report extends the coverage of "Hawaiian Seismic Events during 1962" (Koyanagi, 1964) and complements Summaries 29-32 of the Hawaiian Volcano Observatory for 1963 (Koyanagi and others, 1964a, 1964b; Krivoy and others, 1964; Okamura and others, 1964). Methods and limitations of epicenter locations were similar to those described in the report of 1962 events. To facilitate comparison of events the organization of that report has been retained. Figure 1 shows the geologic features and volcanic systems of the island of Hawaii.

The earthquakes plotted were those of magnitude 2.0 and greater which were recorded on the Hawaiian Volcano Observatory seismic net and located along the Hawaiian Ridge within the geographical coordinates lat 18°-23° N. and long 154°-161° W. The thoroughness of our interpretation depended in large part on the degree of concentration of seismic activity. Thus, the May 9-12, July 1-5, and August 3-5 seismic crises; the August 21-23 and October 5-6 Kilauea flank eruptions; and the August 26, September 21, and October 23 Kaoiki fault earthquake series were periods of such intense seismic activity that the arrival times of some earthquake phases were difficult to determine.

CHRONOLOGY OF EVENTS IN 1963

A swarm of about 150 earthquakes occurred 30 kilometers beneath the summit of Kilauea during January 8-9. The largest of these (magnitudes 4.3 and 4.2) occurred on January 8 and were felt throughout the island. Magnitudes of the others ranged down to less than 1. The largest earthquake recorded in the first

quarter of 1963 (magnitude 4.5) occurred under the south flank of Mauna Kea on March 24 (fig. 2).

The second quarter (fig. 2) was characterized by the seismic crisis of May 9-12. Thousands of small, shallow earthquakes occurred along the 10-km-long east-trending Koaie fault system immediately south of Kilauea Caldera. Although several quakes were felt in the Kilauea summit region during this episode, most of them were less than magnitude 2. Cracking of the ground was observed in the epicentral zone, and a moderate collapse of the Kilauea summit was indicated by tiltmeter readings.

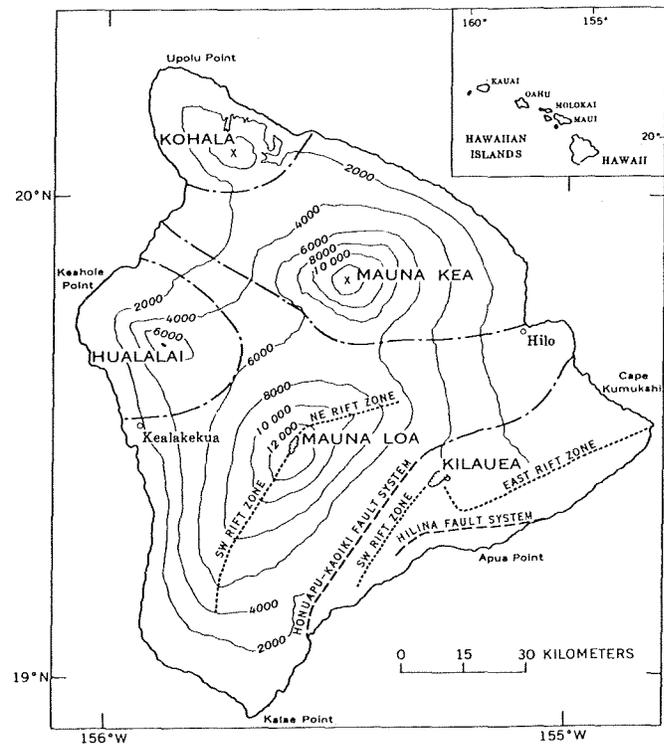


FIGURE 1.—Map of the island of Hawaii, showing geologic features. The five volcanic systems are after Macdonald (1956). Contour interval is 2,000 feet; datum is mean sea level. Dot-and-dash lines are boundaries of volcanic systems.

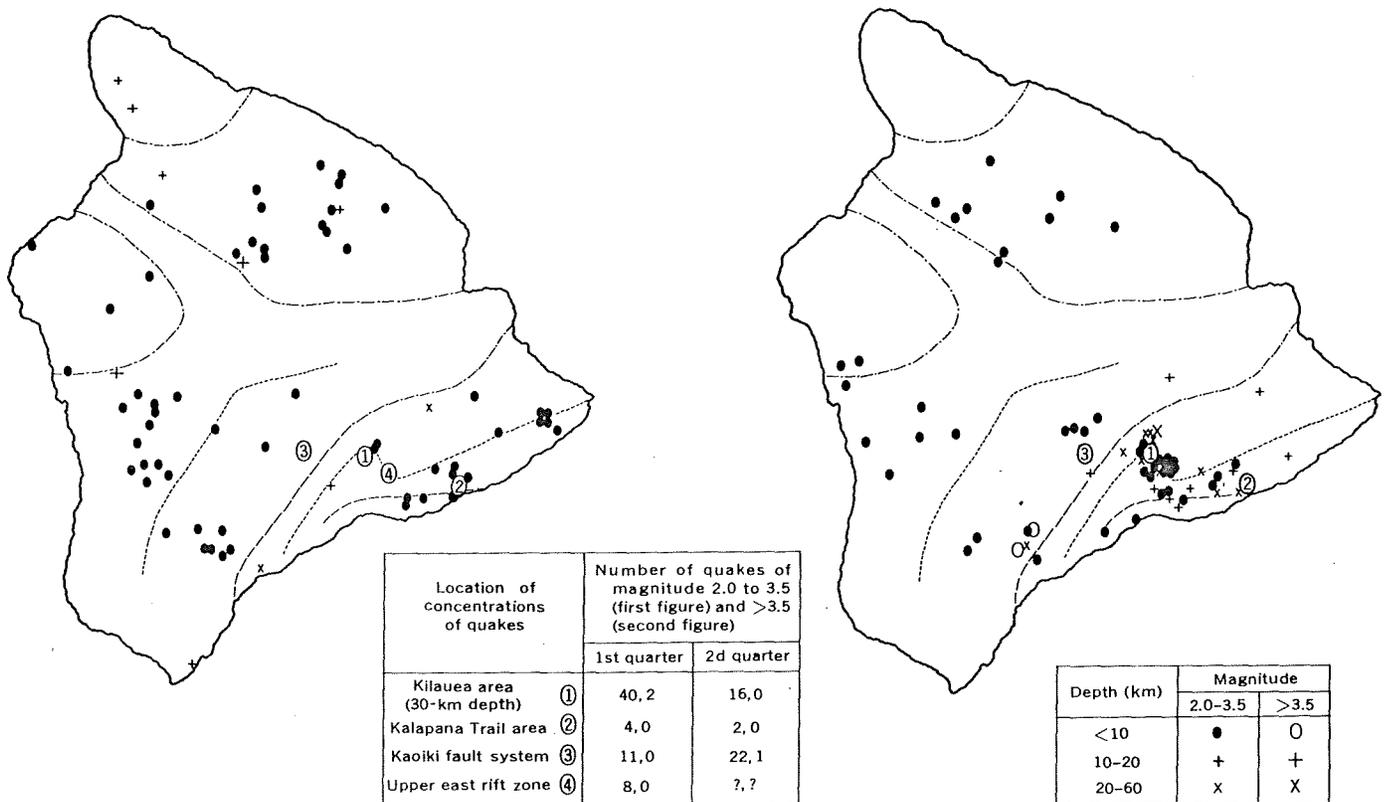


FIGURE 2.—Epicenters of earthquakes of magnitude 2.0 and greater for the first quarter (*left*) and second (*right*) of 1963. The number symbols identify concentrations of quakes that are listed in the left-hand table because they are too numerous to plot separately, and represent the following areas: (1) Kilauea, at a depth of 30 km; (2) along the Kalapana Trail, which extends south of Kilauea's east rift; (3) along the Kaoiki fault system; and (4) along the upper east rift zone of Kilauea. Geographic names are shown on figure 1. The number of earthquakes in the upper east rift and including the adjacent Koae fault system was difficult to determine accurately during the May 9-12, July 1-5, and August 3-5 seismic crises, and the August 21-23 Kilauea east rift eruption because of the complexity of the seismograms.

The cumulative activity of the following five events distinguished the third quarter (fig. 3) as the most active period of the year seismically: (1) July 1-5, Kilauea collapse; (2) August 3-5, Kilauea seismic episode; (3) August 21-23, Kilauea eruptions along the east rift; (4) August 26, Kaoiki earthquakes series; and (5) September 21, Kaoiki earthquake series.

The July 1-5 collapse of the Kilauea summit was accompanied by many small, shallow earthquakes and resulted in the cracking of the ground along the upper east rift zone of Kilauea. Collapse of the Kilauea summit was indicated by tiltmeter readings.

The August 3-5 seismic episode consisted of 2 hours of strong seismic activity along Kilauea's upper east rift zone, much like the event of July 1-5 but of shorter duration. It was followed by a flurry of Kilauea quakes at a depth of 30 km.

The August 21-23 eruption on the east rift of Kilauea was marked by small, shallow earthquakes, and har-

monic tremor was recorded throughout the eruptive period. Collapse of the Kilauea summit was indicated by tiltmeter readings.

On August 26 an earthquake of magnitude 4.9 occurred at a shallow depth along the Kaoiki fault system. It was followed by hundreds of small aftershocks in the next several days.

On September 21 there was another earthquake, of magnitude 4.8, along the Kaoiki fault system, which also was followed by hundreds of small aftershocks.

The most significant event during the fourth quarter (fig. 3) was the October 5-6 eruption on the east rift zone of Kilauea. It was characterized by small, shallow earthquakes, harmonic tremor, and collapse of the Kilauea summit. On October 23 an earthquake of magnitude 5.3 occurred at a shallow depth along the Kaoiki fault system; it was followed by several hundred small aftershocks.

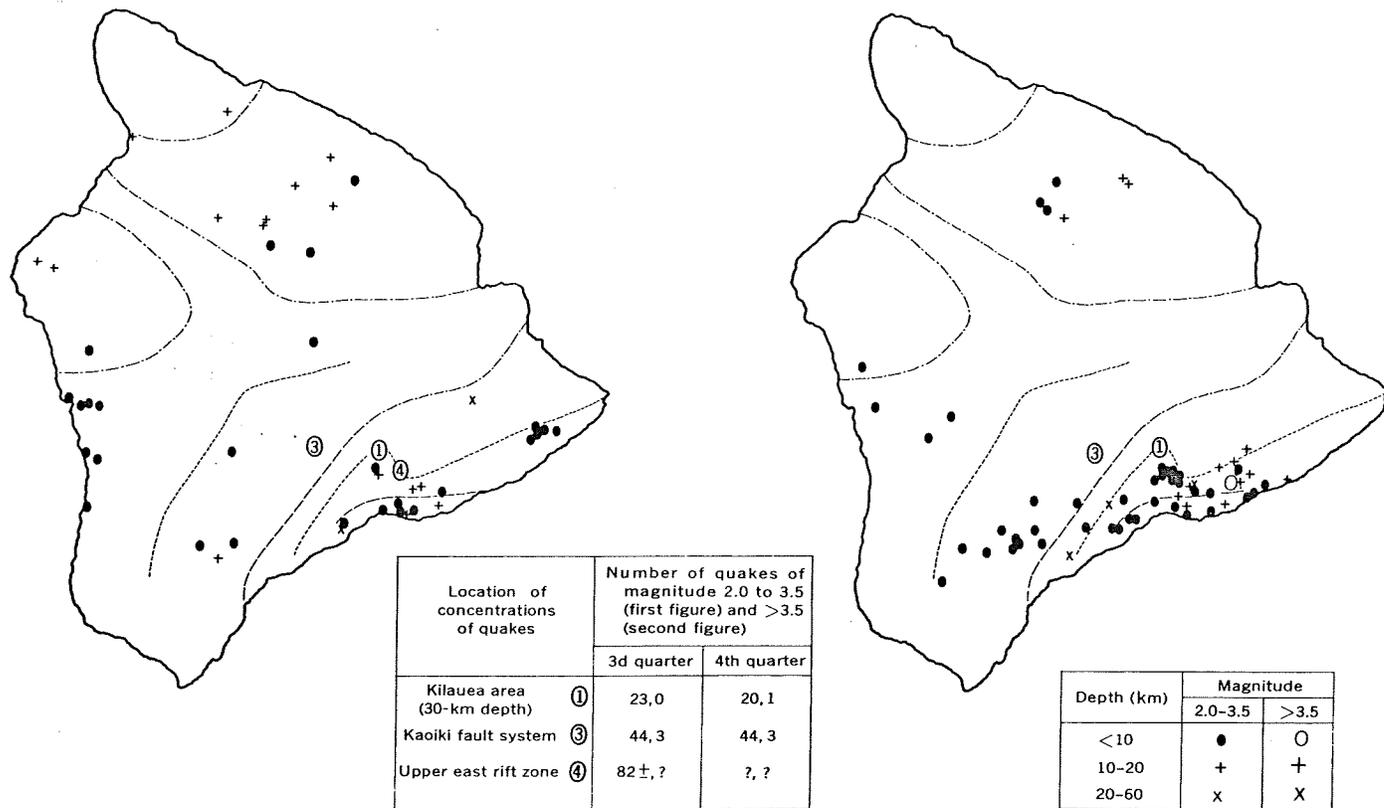


FIGURE 3.—Epicenters of earthquakes of magnitude 2.0 and greater for the third quarter (*left*) and fourth quarter (*right*) of 1963. The number symbols identify concentrations of quakes that are listed in the left-hand table because they are too numerous to plot separately, and represent the following areas: (1) Kilauea, at a depth of 30 km; (3) along the Kaoiki fault system; and (4) along the upper east rift of Kilauea. No quakes of this magnitude were reported for the Kalapana Trail area (location 2, fig. 2). Geographic names are shown on figure 1. The number of earthquakes in the upper east rift during the October eruption on the east rift of Kilauea was difficult to determine accurately because of the complexity of the seismograms.

SUMMARY

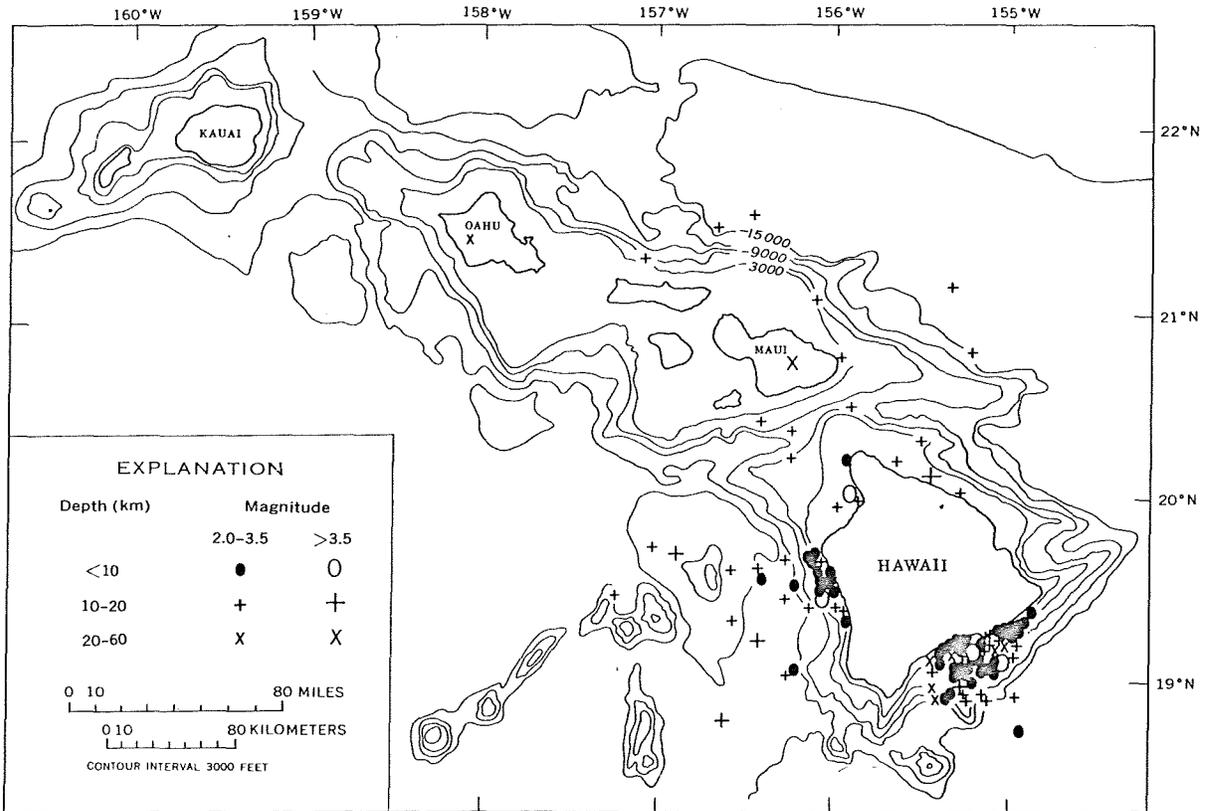
Earthquakes in Hawaii during 1963 were most numerous on the southeast end of the Hawaiian Ridge, mostly on the island of Hawaii (fig. 4). As documented for the period April 1958 to September 1959 (Eaton, 1962) and for 1962 (Koyanagi, 1964), seismic activity was greatest near and beneath the two active volcanic systems, Kilauea and Mauna Loa, and less in the dormant systems, Mauna Kea, Hualalai, and Kohala (fig. 5). Of the earthquakes of magnitude 2 and greater which were recorded and located in 1963, 47 percent were beneath Kilauea, 29 percent beneath Mauna Loa, 6 percent beneath Mauna Kea, 1 percent beneath Hualalai, 1 percent beneath Kohala, and the remaining 16 percent were offshore. Seventy-six percent of the earthquakes occurred beneath the active volcanic systems of Kilauea and Mauna Loa. Most of the recorded quakes were smaller than 2 in magnitude; of that group, most were

less than 1. Many of these took place at shallow depths beneath Kilauea Caldera, where earthquake counts of hundreds per day were not uncommon.

Both of the outbreaks on the flank of Kilauea in 1963 were characterized by several hours of shallow but intense pre-eruption seismic activity in the summit region, harmonic tremor for the duration of the eruptive period, and marked deflation of the summit.

Focal depths of earthquakes ranged from near surface to 45 kilometers. With the exception of earthquakes that occurred in the highly seismic zone 30 kilometers beneath the Kilauea Caldera region, most earthquakes had focal depths of less than 15 kilometers.

About 100 earthquakes of magnitudes 3-5 were reported felt on the island of Hawaii during 1963. Some shallow quakes of less than magnitude 3, along the east rift zone of Kilauea near the residential area of Pahoa, were reported felt by inhabitants.



Base from U.S. Navy Hydrographic Office Preliminary Sheet BC 04N

FIGURE 4.—Map of the Hawaiian Ridge showing epicenters of earthquakes during 1963 of magnitude 2.0 and greater located off the island of Hawaii.

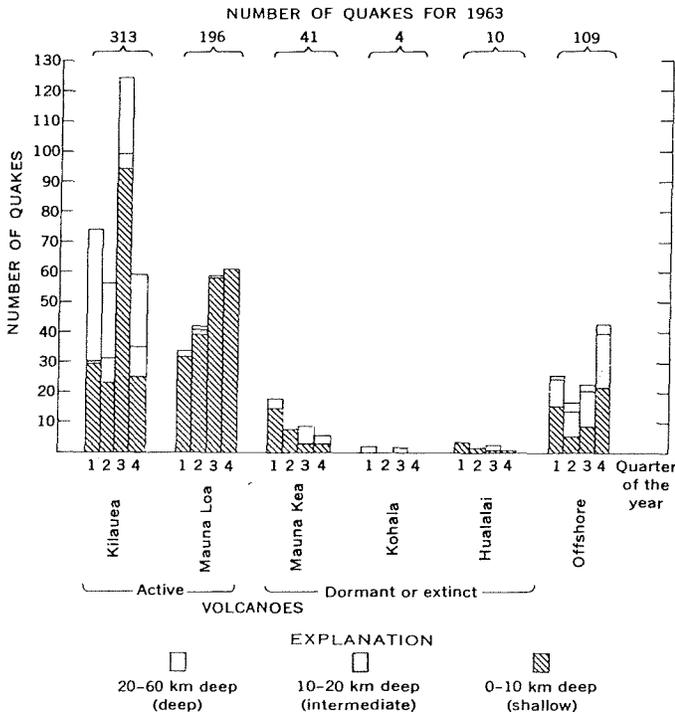


FIGURE 5.—Bar graph showing earthquakes of magnitude 2.0 and greater which occurred along the Hawaiian Ridge during 1963.

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