

HAWAIIAN SEISMIC EVENTS DURING 1968

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Abstract.—In Hawaii, 699 earthquakes having a magnitude of from 2.0 to 4.7 were recorded in 1968. Seismic activity continued beneath southeastern Hawaii during the year with prolonged volcanic eruptions and associated structural adjustments.

This is the seventh of a series of reports showing earthquake locations and other data compiled by the staff of the Hawaiian Volcano Observatory, U.S. Geological Survey (Koyanagi, 1964; Koyanagi and Endo, 1965; Koyanagi and Okamura, 1966; Koyanagi, 1968; Koyanagi 1969a, 1969b).

The locations of earthquakes having a magnitude of 2.0 and greater¹ occurring beneath the five volcanos on the island of Hawaii (fig. 1) and offshore along the Hawaiian Ridge from lat 18° to 23° N. and long 154° to 161° W. are shown in figures 2 and 3. The earthquakes are plotted in three depth groups (<10, 10–20, and 20–60 km) (fig. 4) and two magnitude groups (2.0–3.5, and >3.5).

The methods and limitations of locating earthquakes are consistent with the earlier reports. Hawaiian seismic-wave travelttime curves are applied to P-wave arrivals, and S-P values read to 1/10-second accuracy. Earthquakes beneath the island of Hawaii, having a magnitude of 2.5 or greater, are generally located within a 5-kilometer sphere of error; errors as great as 10 km may be expected from earthquakes located offshore considerable distances away from stations.

DESCRIPTION OF 1968 SEISMIC EVENTS

Seismic activity for the year was climaxed by three eruptions of Kilauea Volcano, a long summit phase (Kinoshita and others, 1969) followed by two shorter flank phases. The long summit eruption at Halemau-mau Crater started on November 5, 1967, and continued spasmodically until early July 1968. Periods

¹A modification of the Richter scale is used for magnitude determination (Koyanagi and others, 1966).

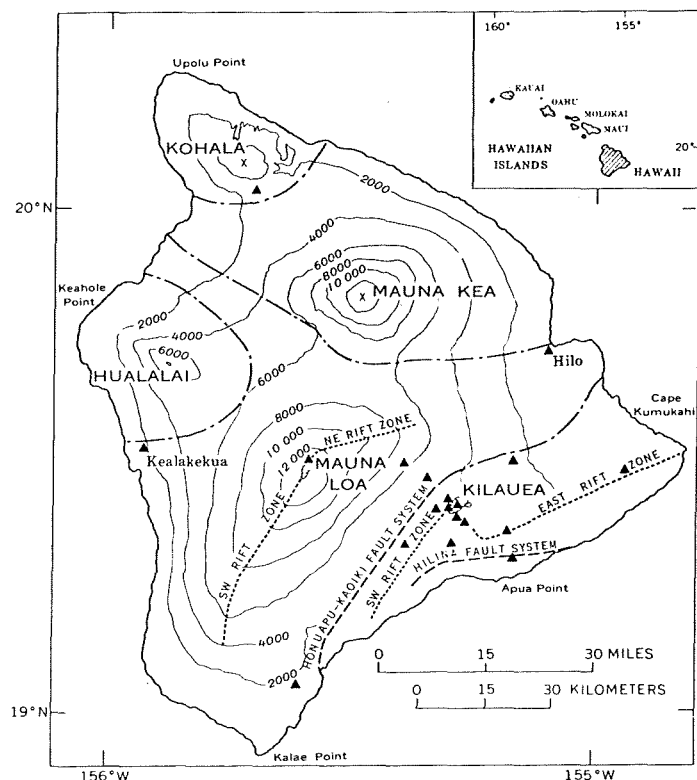


FIGURE 1.—Map of the island of Hawaii, showing the five volcanos and their principal structural features. Dot-and-dash lines are boundaries of volcanic systems. Location of seismograph stations is indicated by closed triangles. Contour interval is 2,000 feet, and datum is mean sea level.

of lava fountaining with continuous tremor lasting several hours to many days alternated with periods of degassing activity and relative volcanic quiescence. Tremor amplitudes generally diminished from one period of fountaining activity to the next. Between periods, during degassing at the lava lake, the seismic records showed numerous shallow shocks of low magnitude (about 0.1 or less). The end of the summit eruption in early July was followed by a pause of 6 weeks, after which Kilauea erupted again on August

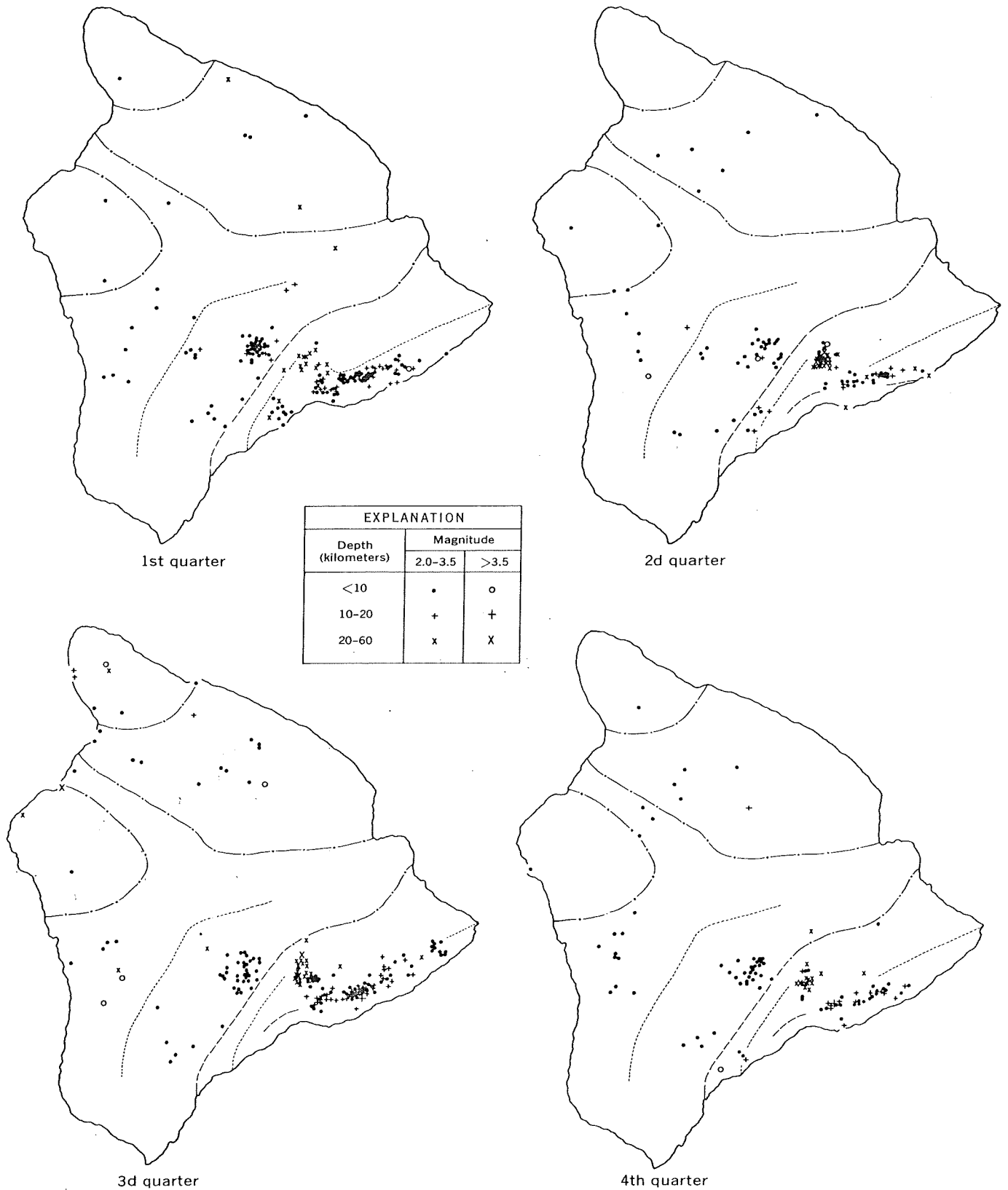
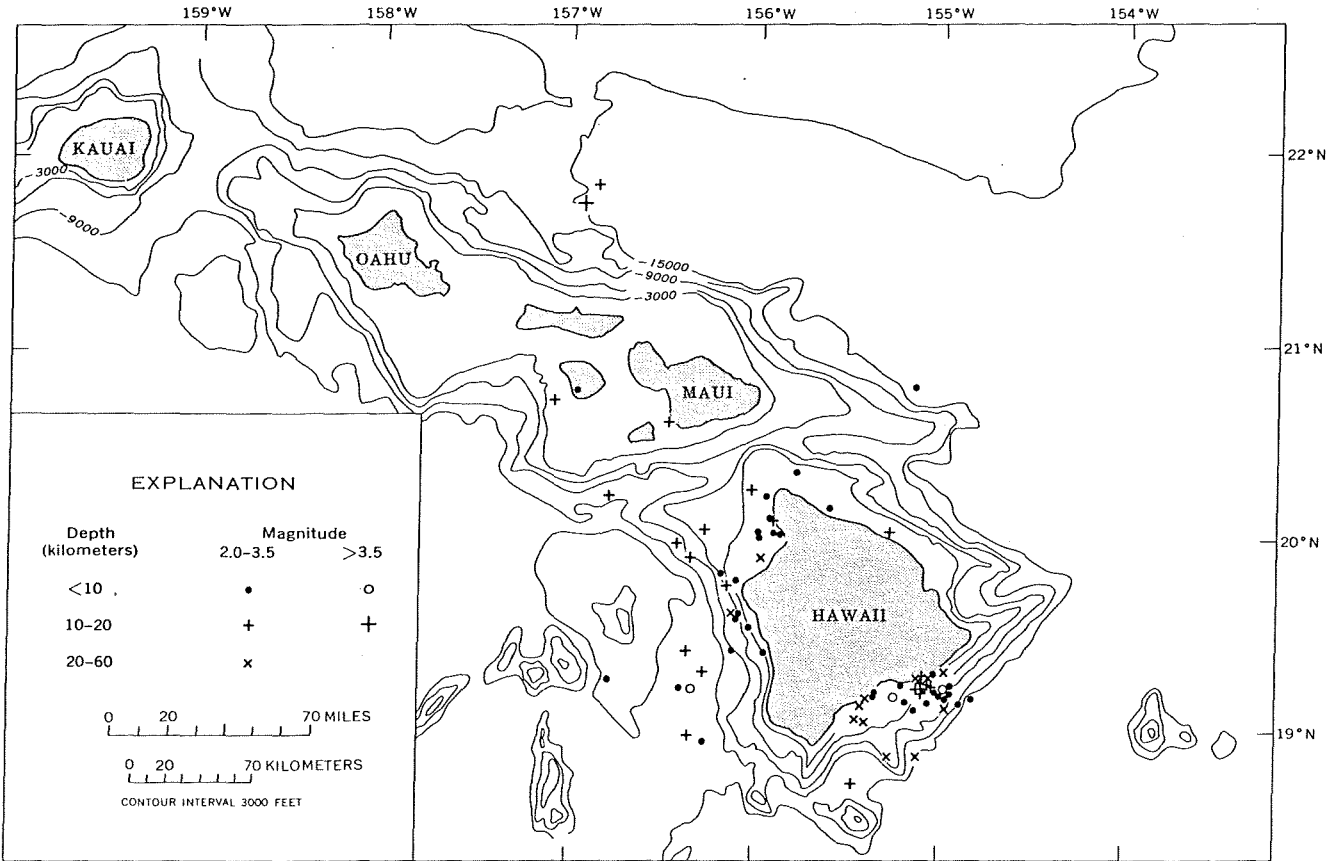


FIGURE 2.—Plot of epicenters of earthquakes having a magnitude of 2.0 or greater beneath the island of Hawaii during each quarter of 1968. Dot-and-dash lines are boundaries of volcanic systems, long-dashed lines are fault systems, and short-dashed lines are rift zones. Geographic names are shown in figure 1.



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

FIGURE 3.—Map of the Hawaiian Islands, showing epicenters of earthquakes having a magnitude of 2.0 or greater that occurred off the island of Hawaii during 1968.

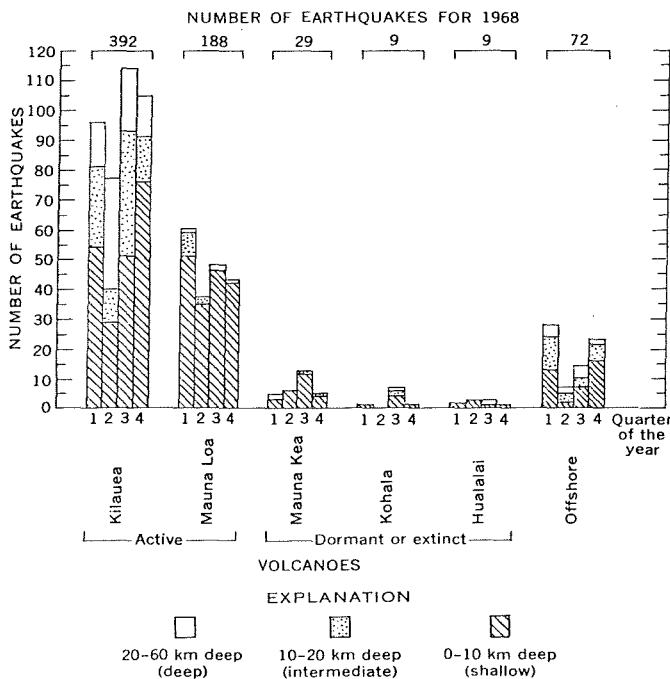


FIGURE 4.—Geographic location and distribution, with depth, of earthquakes having a magnitude of 2.0 or greater which occurred in the Hawaiian Islands during 1968.

22-26. This time the eruption took place 5 km south-east of the summit at Hiiaka Crater on the east rift. After another brief period of volcanic quiescence, the final outbreak of the year took place from October 7 to November 19, several kilometers downrift from the August event. In addition to sharp deflation of the summit, hundreds of shallow earthquakes and periods of harmonic tremor were characteristic of both flank eruptions.

During some periods of intense volcanic tremor in 1968, normal earthquake recording in the Kilauea summit area was somewhat disturbed, but probably only a few of the large earthquakes (magnitude of 2.0 or greater) were undetected. Tremor was localized and occurred at low intensities for long periods of eruption, so that normal monitoring of Kilauean earthquakes was undisturbed. During the first half of the year, the number of earthquakes originating beneath the flanks of Kilauea and from a source about 30 km beneath the summit of the volcano remained at moderate levels. On January 7-9, a swarm of more than 600 earthquakes occurred at a depth of about 10 km beneath the south-east flank; 12 of the larger shocks were registered at a

magnitude of from 2.0 to 2.8. In late April, when only weak tremor from the waning summit eruption was being recorded, a 4.5-magnitude earthquake originated 30 km beneath the southern part of the summit of Kilauea. This earthquake was felt islandwide at 04^h09^m, April 28, and in the five following days about 200 aftershocks were recorded.² During the 2d quarter, 33 earthquakes having a magnitude of 2.0 or greater originated at this deep source, and 3 of these had a magnitude greater than 3.5.

From early June, nearly a month prior to the end of the summit eruption, earthquake activity along Kilauea's flanks started to increase. Southwest-flank activity showed fluctuating highs in June, July, November, and December. However, the greatest increase was noted beneath the southeast flank. From June until the August east-rift eruption, southeast-flank earthquakes often numbered more than 50 per day. After the August eruption, the count dropped to about 30 per day, but it increased somewhat a few days prior to the final volcanic outbreak in October. During the October eruption, several hundred earthquakes outlined the eruptive area; 48 shallow earthquakes had magnitudes of from 2.0 to 2.7, but owing to difficulty in plotting, these were omitted from figure 2, 4th quarter.

Although the volcano remained quiet for the rest of the year, the frequency of southeast Kilauea earthquakes increased to new high levels in mid-December. At 16^h33^m, December 16, the largest earthquake of the year, with a magnitude of 4.7, occurred near the eastern end of the Hilina fault system. More than 150 aftershocks associated with this event occurred during the initial 14 hours of activity.

On December 19, an earthquake having a magnitude of 3.5 occurred about 10 km farther east and was followed by about 50 aftershocks within a few hours.

SUMMARY

In 1968, most of the earthquakes occurred beneath the southeast part of the Hawaiian Ridge. More than three-fourths of the earthquakes with a magnitude between 2.0 and 4.7 occurred near the two active volcanoes, Kilauea and Mauna Loa, and scattered epicenters extended off the west coast of the island of Hawaii. The earthquakes were related to the five volcanoes of the island of Hawaii as follows: 57 percent

occurred beneath Kilauea, 27 percent beneath Mauna Loa, 4 percent beneath Mauna Kea, 1 percent beneath Kohala, and 1 percent occurred beneath Hualalai. The remaining 10 percent of the earthquakes occurred offshore; most were concentrated off the southeast coast, but some scattered earthquakes occurred off the west coast. Focal depth of 66 percent of the earthquakes was less than 10 km; 19 percent were 10 to 20 km deep, and 15 percent were 20 to 60 km deep.

During the year, 80 earthquakes were felt by Hawaii residents, and 5 of these, having magnitudes between 3.7 and 4.7, were felt islandwide. Of the 699 recorded earthquakes having a magnitude of from 2.0 to 4.7, 97 percent had a magnitude of from 2.0 to 3.5, and 3 percent had a magnitude exceeding 3.5. The following table shows the number of earthquakes according to magnitude and focal depth:

Magnitude	Depth (km)		
	<10	10-20	20-60
2.0-2.5	341	104	69
2.6-3.0	83	16	19
3.1-3.5	24	7	13
3.6-4.0	7	2	6
4.1-4.5	5	1	1
4.7	0	1	0

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² Times are given in hours and minutes, Hawaiian standard time.

