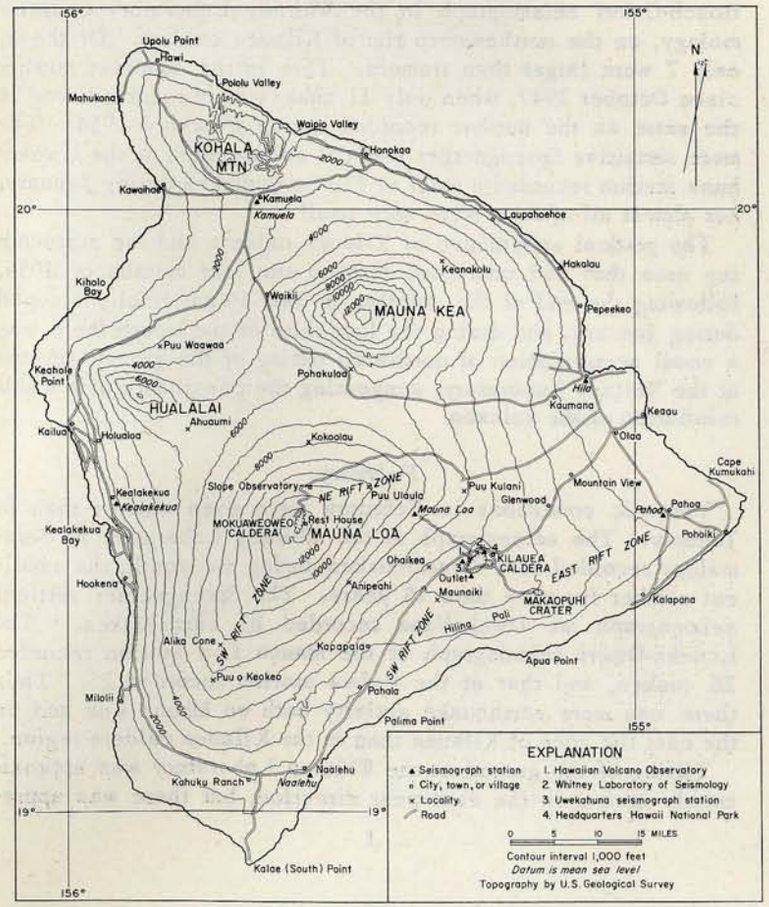
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

# HAWAIIAN VOLCANO OBSERVATORY SUMMARY I

## January-March 1956

By
G. A. Macdonald and J. P. Eaton




Map of the Island of Hawaii, showing location of the Hawaiian Volcano Observatory, seismograph stations operated by the observatory, and localities mentioned in text.

## PREFATORY NOTE

This summary of observations made at the Hawaiian Volcano Observatory is published for the use of volcanological and seismological observatories and others interested in the data at intervals more frequently than once a year. Heretofore this material was available in *The Volcano Letter*, published by the University of Hawaii, but discontinued with issues number 529 and 530, July-December, 1955. Those who wish to receive this summary should request inclusion on the mailing list from the Director, U. S. Geological Survey, Washington 25, D. C.

## 1. Summary of volcanic conditions

### *January*

The Hawaiian volcanoes were very quiet during January. Only 12 earthquakes were recorded during the month on the Bosch-Omori seismograph in the Whitney Laboratory of Seismology, on the northeastern rim of Kilauea caldera. Of these, only 7 were larger than tremors. This is the smallest number since October 1947, when only 11 quakes were recorded, and is the same as the number recorded during February 1954. The more sensitive Sprengnether vertical seismograph at the Uwekahuna station recorded a total of 114 earthquakes during January, but almost all of them were very small.

The gradual subsidence of Kilauea caldera and the surrounding area that had continued through the last months of 1955, following the end of the eruption in east Puna, finally stopped during January, and during the last third of the month there was a small accumulation of northward tilting of the ground surface at the Whitney Laboratory, suggesting the possibility of a small reinflation of the volcano.

### *February*

Volcanic conditions in February were even quieter than in January. The seismograph at the Whitney Laboratory of Seismology recorded only 9 earthquakes during the month, the smallest number for more than 15 years. The Sprengnether vertical seismograph at Uwekahuna recorded 81 earthquakes. The Loucks-Omori seismograph at the Mauna Loa station recorded 28 quakes, and that at the Pahoa station recorded 26. Thus there was more earthquake activity both on Mauna Loa and on the east rift zone of Kilauea than in the Kilauea caldera region.

Tilting of the ground at the Whitney Laboratory was approximately normal in the east-west direction, but there was appreciably less southward tilting than usual at that season of the year. This suggests a slight tumescence of the volcano, probably resulting from an increase of magmatic pressure beneath the caldera region.



### *March*

Earthquake activity at Kilauea volcano increased markedly during March, as compared to that during January and February. The seismograph in the Whitney Laboratory recorded 34 earthquakes, and the more sensitive Sprengnether seismograph at Uwekahuna recorded 197 quakes. The Mauna Loa seismograph recorded 38 quakes, and that at the Pahoa station recorded 22. Even with the increase in activity, however, the number of quakes recorded in the Kilauea caldera region was only slightly greater than that normally recorded during times of volcanic quiet.

Most of the earthquakes appear to have originated in the vicinity of Kilauea caldera, several of them at a depth of about 15 km. Some originated along the east rift zone of Mauna Loa, and others along the east rift zone of Kilauea in east Puna. A quake at $13^h\ 35^m$ on March 9, felt as a sharp short shake in the Headquarters area of Hawaii National Park, came from a focus beneath Kilauea caldera. A quake at $1^h\ 58^m$ on March 10 was felt from Glenwood to Hilo. It seems to have originated about 20 km east northeast of Hilo at a depth of about 40 km.

Many small landslides occurred during the month on the walls of Halemaumau crater. Most of them were on the southwest and northeast sides, where the rift zone intersects the crater walls.

Early on the morning of March 27 a highly sensitive vertical electromagnetic seismograph in a new station at the south edge of Kilauea caldera recorded about 3 hours of continuous tremor resembling that known to accompany the movement of liquid lava in the feeding conduits of the volcano. The tremor was so small that it is barely visible on the records from the other seismographs. It probably was caused by movement of magma deep beneath Kilauea caldera. However, because this new instrument has much higher magnification than any instrument previously operated at Kilauea, we do not know whether or not small-amplitude tremor of this sort is unusual.

As during February, southward tilting of the ground at the Whitney Laboratory was much less than usual at that season of the year, probably indicating a small increase of magmatic pressure beneath the caldera region. Westward tilting was approximately normal in amount.

2. Earthquakes recorded on the Bosch-Omori seismograph in the Whitney Laboratory of Seismology, on the northeast rim of Kilauea caldera.

| Week beginning | Minutes of tremor | Very feeble | Feeble | Slight | Moderate | Strong | Total | Local seismicity* |
|---|---|---|---|---|---|---|---|---|
| Jan. 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.5 |
| 8 | 0 | 3 | 0 | 1 | 0 | 0 | 4 | 3.5 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 1.5 |
| 29 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0.5 |
| Feb. 5 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2.0 |
| 12 | 0 | 2 | 0 | 0 | 1 | 0 | 3 | 4.0 |
| 19 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 1.5 |
| 26 | 1 | 1 | 0 | 0 | 1 | 0 | 3 | 3.75 |
| Mar. 4 | 4 | 3 | 1 | 1 | 0 | 0 | 9 | 5.5 |
| 11 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1.0 |
| 18 | 10 | 4 | 0 | 0 | 0 | 0 | 14 | 4.5 |
| 25 | 1 | 3 | 2 | 0 | 0 | 0 | 6 | 3.75 |

*Local seismicity is an arbitrary value. Each local earthquake is assigned a seismicity value according to its strength, as follows: tremor, 0.25; very feeble, 0.5; feeble, 1.0; slight, 2.0; moderate, 3.0; strong, 4.0. These values are totaled to give the weekly local seismicity. Continuous volcanic tremor is ignored in the calculation. The strength assigned to the earthquake depends on the double amplitude of the maximum oscillation it causes on the Bosch-Omori seismograph, as follows: Tremor, less than 0.5 mm; very feeble, 0.5 to 4 mm; feeble, 4 to 11 mm; slight, 11 to 25 mm; moderate, 25 to 60 mm; strong, greater than 60 mm.

3. Table of tilt at seismograph stations on the rim of Kilauea caldera.

| Week beginning | Whitney station (northeast rim) | | Uwekahuna station (west rim) | |
|---|---|---|---|---|
| | Direction | Amount (seconds of arc) | Direction | Amount (seconds of arc) |
| Jan. 1 | N 45° E | 0.7 | S | 0.3 |
| 8 | S 39° E | 2.1 | N 34° W | 1.2 |
| 15 | S 57° E | 0.4 | N 45° W | 0.4 |
| 22 | N 71° W | 0.4 | S 64° W | 0.7 |
| 29 | N | 0.1 | S 14° E | 1.3 |
| Feb. 5 | S 71° W | 0.4 | S 31° E | 1.9 |
| 12 | N 71° W | 0.4 | S | 0.3 |
| 19 | N | 0.1 | S 45° E | 0.9 |
| 26 | S 39° W | 0.8 | W | 0.6 |
| Mar. 4 | S 45° W | 0.8 | ---------- | 0.0 |
| 11 | S 34° W | 0.4 | E | 0.3 |
| 18 | W | 0.1 | S 27° E | 1.4 |
| 25 | S 79° W | 0.6 | N 26° W | 0.7 |



## LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs on the islands of Hawaii and Maui operated by the Hawaiian Volcano Observatory. Except for smaller earthquakes of special interest, only earthquakes classed as slight or larger were included in the list. The intensity ratings assigned are based on the Bosch-Omori seismograph at the Whitney Laboratory. This intensity scale has been extended empirically to permit its use with the Loucks-Omori and Sprengnether seismographs. The entries for a given earthquake are: date, time of arrival at the nearest station (Hawaiian standard time), intensity at the nearest station, name of the nearest station, epicenter, and general remarks.

*Jan. 9*, 05:02:55, slight at Uwekahuna. Near Kilauea caldera.

*Feb. 5*, 07:21:03, slight at Uwekahuna. Kaoiki fault near Halfway House. Felt at Hawaii National Park and Pahala.

*Feb. 18*, 17:02:50, moderate at Uwekahuna. Kaoiki fault west of Kilauea caldera. Felt at Hawaii National Park.

*Mar. 3*, 21:49:35, Moderate at the Whitney Laboratory. Ten km south of Kilauea caldera at a depth of about 10 km. Felt at Hawaii National Park, Olaa, and Hilo.

*Mar. 9*, 13:35:00, slight at the Whitney Laboratory. Northeast rim of Kilauea caldera. Felt at the Volcano House.

*Mar. 10*, 01:58:07, slight at Hilo. Off east coast of Hawaii about 20 km east northeast of Hilo at a depth of about 40 km. Felt at Hilo and Glenwood.

*Mar. 29*, 15:53:27, moderate at Pahoa. East rift of Kilauea south of Pahoa. Felt at Pahoa.

## DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on the seismographs at the Hawaiian Volcano Observatory (19° 25.4′ N. latitude, 155° 17.7′ W. longitude). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. Locations of epicenters, magnitudes, and depths of focus are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

*Jan. 10*, eP 09:01:46.4, 25° S., 176° W. Tonga Islands region.
eS 09:09:05.7, Depth about 200 km. Magnitude 7¾.

*Jan. 31*, iP 09:26:19.2, 4° S., 152° E. New Ireland. Depth about 400 km. Magnitude 7-7¼.

*Feb. 1*, iP 13:50:56.1, 19° N., 145½° E. Marianas Islands. Depth about 350 km. Magnitude 6¾-7.

| | | | |
|---|---|---|---|
| *Feb. 9,* | eP | 14:39:56.7, | 32° N., 116° W. Lower California. |
| | iL | 14:52:38, | Magnitude 6¾-7. |
| | eT | 15:16:27, | |
| *Feb. 12,* | iP | 12:01:31.8, | 19° N., 119½°E. Off northwest coast of Luzon, P. I. Magnitude 6¼-6½. |
| *Feb. 19,* | eL | 02:37, | 52° N., 131½° W. Queen Charlotte Islands. Magnitude 6¾. |
| *Feb. 18,* | iP | 07:43:52.2, | 30° N., 137½° E. South of Honshu, Japan. Depth about 450 km. Magnitude 7¼-7½. |
| *Mar. 3,* | iP | 00:12:58.2, | 15° S., 173½° W. Samoa Islands region. Magnitude 6½-6¾. |
| *Mar. 13,* | eP | 13:24:43.8, | 7° N., 82° W. Off south coast of Panama. |
| *Mar. 22,* | iP | 06:45:52.3, | 3½° S., 79° W. Ecuador. Depth about 100 km. Magnitude 6½-6¾. |

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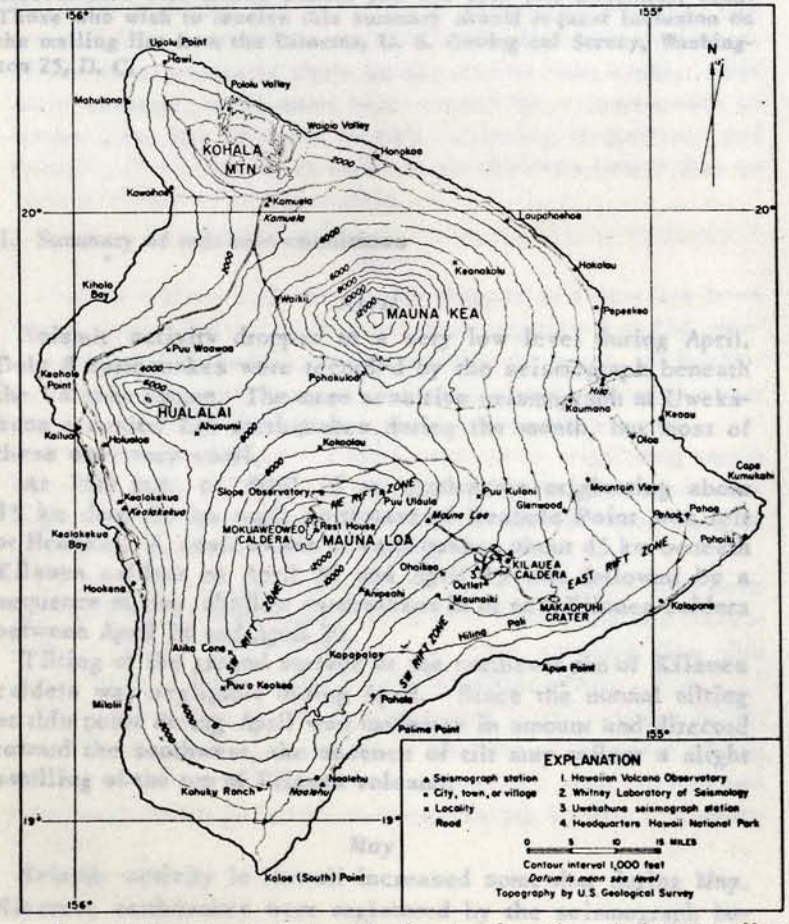
# HAWAIIAN VOLCANO OBSERVATORY SUMMARY 2

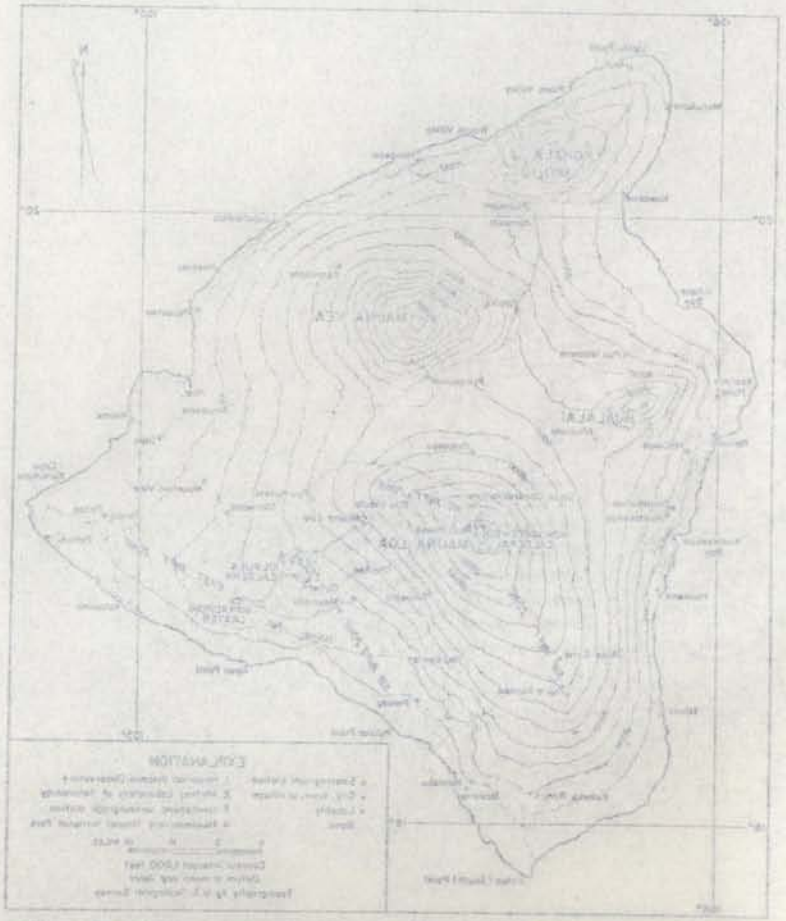
## April–June 1956

By

G. A. Macdonald and J. P. Eaton




Map of the Island of Hawaii, showing location of the Hawaiian Volcano Observatory, seismograph stations operated by the observatory, and localities mentioned in text.



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## 1. Summary of volcanic conditions

### *April*

Seismic activity dropped to a very low level during April. Only 8 earthquakes were recorded by the seismograph beneath the Volcano House. The more sensitive seismograph at Uwekahuna recorded 120 earthquakes during the month, but most of these were very small.

At 7:09 p.m. on April 15 an earthquake originating about 15 km deep 20 km north northwest of Keahole Point was felt at Honokaa. A small swarm of earthquakes about 45 km beneath Kilauea caldera on April 18 and April 19 was followed by a sequence of tiny, shallow earthquakes in or near Kilauea caldera between April 24 and April 30.

Tilting of the ground surface at the northeast rim of Kilauea caldera was negligible during April. Since the normal tilting at this point during April was moderate in amount and directed toward the southwest, the absence of tilt may reflect a slight swelling of the top of Kilauea volcano.

### *May*

Seismic activity in Hawaii increased somewhat during May. Nineteen earthquakes were registered by the seismograph be-

2. Earthquakes recorded on the Bosch-Omori seismograph in the Whitney Laboratory of Seismology, on the northeast rim of Kilauea caldera.

| Week beginning | Minutes of tremor | Very feeble | Feeble | Slight | Moderate | Strong | Total | Local seismicity * |
|---|---|---|---|---|---|---|---|---|
| April 1 | 2 | 1 | 1 | 1 | 0 | 0 | 5 | 4.00 |
| 8 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | .25 |
| 15 | 0 | 2 | 0 | 1 | 0 | 0 | 3 | 3.00 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| 29 | 2 | 5 | 0 | 0 | 0 | 0 | 7 | 3.00 |
| May 6 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | .50 |
| 13 | 1 | 2 | 0 | 1 | 0 | 0 | 4 | 3.25 |
| 20 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | .50 |
| 27 | 2 | 3 | 0 | 0 | 0 | 1 | 6 | 6.00 |
| June 3 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1.00 |
| 10 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2.00 |
| 17 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | .50 |
| 24 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1.00 |

*Local seismicity is an arbitrary value. Each local earthquake is assigned a seismicity value according to its strength, as follows: tremor, 0.25; very feeble, 0.5; feeble, 1.0; slight, 2.0; moderate, 3.0; strong, 4.0. These values are totaled to give the weekly local seismicity. Continuous volcanic tremor is ignored in the calculation. The strength assigned to the earthquake depends on the double amplitude of the maximum oscillation it causes on the Bosch-Omori seismograph, as follows: tremor, less than 0.5 mm; very feeble, 0.5 to 4 mm; feeble, 4 to 11 mm; slight, 11 to 25 mm; moderate, 25 to 60 mm; strong, greater than 60 mm.

3. Table of tilt at seismograph stations on the rim of Kilauea caldera.

| Week beginning | Whitney station (northeast rim) | | Uwekahuna station (west rim) | |
|---|---|---|---|---|
| | Direction | Amount (seconds of arc) | Direction | Amount (seconds of arc) |
| April 1 | S 63° W | 0.3 | W | 0.3 |
| 8 | N 57° W | 0.4 | S 18° E | 1.0 |
| 15 | N 72° E | 0.8 | S 63° E | 0.7 |
| 22 | S 22° W | 0.7 | N 45° W | 0.5 |
| 29 | N | 0.5 | W | 0.3 |
| May 6 | N | 0.8 | S 45° E | 0.5 |
| 13 | E | 0.5 | E | 0.3 |
| 20 | ---------- | 0 | W | 0.3 |
| 27 | N 63° E | 0.5 | N 27° W | 1.4 |
| June 3 | N 18° E | 0.4 | N 57° W | 1.2 |
| 10 | N 27° E | 0.5 | N 63° W | 0.7 |
| 17 | W | 0.2 | Record interrupted by work in vault. | |
| 24 | N 18° E | 0.4 | | |

## LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs on the islands of Hawaii and Maui operated by the Hawaiian Volcano Observatory. Except for smaller earthquakes of special interest, only earthquakes classed as slight or larger were included in the list. The intensity ratings assigned are based on the Bosch-Omori seismograph at the Whitney Laboratory. This intensity scale has been extended empirically to permit its use with the Loucks-Omori and Sprengnether seismographs. The entries for a given earthquake are: date, time of arrival at the nearest station (Hawaiian standard time), intensity at the nearest station, name of the nearest station, epicenter, and general remarks.

*Apr. 5,* 18:48:21, slight at Uwekahuna. About 10 km south of Kilauea caldera at a depth of about 15 km.

*Apr. 7,* 08:30:57, slight at Mauna Loa. Near the Mauna Loa Slope Observatory at a depth of about 10 km.

*Apr. 15,* 19:09:20, moderate at Kamuela. About 20 km north northwest of Keahole Point at a depth of about 15 km. Felt at Honokaa.

*May 13,* 21:53:36, moderate at Kamuela. 20° 17' N., 155° 17' W., about 75 km east of Hana, Maui and about 90 km north of Laupahoehoe, Hawaii. Depth probably about 20 km. Felt from Hawaii National Park on Hawaii to Honolulu on Oahu.

*May 21,* 01:06:30, slight at Kamuela. Fifteen km northwest of Kamuela at a depth of about 30 km.

*May 27,* 15:41:00, strong at Mauna Loa. Five km north of Ainapo at a depth of about 5 km. Felt from Kealakekua to Hilo, strongly at Kapapala.

*June 7,* 00:35:58, moderate at Kona. Near Kealakekua, probably at a shallow depth. Felt at Kealakekua.

*June 14,* 15:09:55, strong at Kona. Several km north of Kealakekua at a depth of about 5 km. Felt throughout Kona and as far as the Hawaiian Volcano Observatory.

*June 24,* 15:30:59, slight at Mauna Loa. About 15 km deep near the Mauna Loa seismograph station.

*June 24,* 15:31:38, slight at Mauna Loa. About 15 km deep near the Mauna Loa seismograph station.

## DISTANT EARTHQUAKES

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magnitudes, and depths of focus are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

*Apr. 18*, eP 11:07:31.2, 52° N., 178° W. Andreanof Islands, Aleutian Islands. Magnitude 6-6¾.

*Apr. 22*, eP 17:29:17.8, 54° N., 162° W. South of Alaska Peninsula. Magnitude 6.

*Apr. 23*, eP 03:41:12.5, 42½° N., 144° E. Off east coast of Hokkaido. Felt. Magnitude 6½-6¾.

*May 6*, eT 21:40:20.8, 54½° N., 162½° W. Unimak Island region, Alaska. Magnitude 5½-5¾.

*May 23*, iP 20:55:40.4, 25½° S., 179° W. Fiji Islands. Depth about iS 21:00:35.4 450 km. Magnitude 7¼.

*May 26*, eP 20:28:43.0, 19° S., 178½° W. Fiji Islands. Depth about 550 km. Magnitude 6¼-6½.

*May 28*, eP 13:35:43.3, 1° N., 121½° E. Northern Celebes. Depth about 100 km.

*May 30*, eP 15:50:03.5, 23° S., 178½° W. Tonga Islands region. Depth about 350 km.

*June 4*, eP 07:16:08.2, 52° N., 170½° W. Fox Islands, Aleutian Islands. Magnitude 6¼.

*June 13*, eP 12:19:45.1, ½° S., 124½° E. Near coast of Celebes. Depth about 200 km.

*June 28*, eS 13:10:07, 49° N., 129½° W. Off coast of Vancouver eL 13:14:42 Island, British Columbia. Magnitude 6¼-6½.

UNITED STATES
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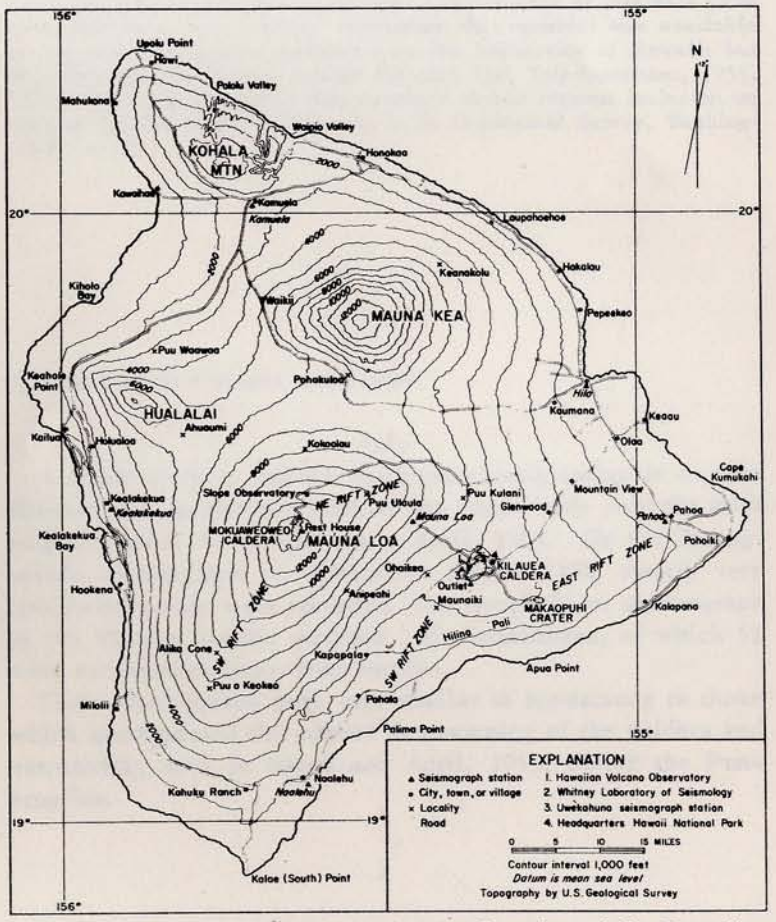
# HAWAIIAN VOLCANO OBSERVATORY SUMMARY 3

## July–September 1956

By

J. P. Eaton and George D. Fraser

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## 1. Summary of volcanic conditions

*July*

A flurry of tiny, shallow earthquakes originating in or near Kilauea caldera the last week of the month made July the most seismic month for Hawaii since April, 1955. On the Sprengnether seismograph at Uwekahuna almost 1400, mostly very small earthquakes were recorded. The Bosch-Omori seismograph in the Whitney station recorded 206 disturbances, of which 51 were earthquakes larger than tremors.

These earthquakes were very similar in appearance to those which accompanied the marked downwarping of the caldera and surrounding area in March and April, 1955, during the Puna eruption.

An earthquake originating about five km southeast of Puu o Keokeo on the southwest rift of Mauna Loa at 1:41 a.m. on July 26 was felt in central Kona.

The rate of eastward tilting of the earth's surface at the Whitney station was somewhat less than normal during July. Northward tilting, however, proceeded at about twice the rate normal for the month.

*August*

Seismic activity on Hawaii remained at a moderate level during August. Twenty-eight earthquakes registered on the Bosch-Omori seismograph in the Whitney station. Almost all of the more than 400 earthquakes recorded by the Sprengnether seismograph at Uwekahuna originated in or near Kilauea caldera and were very small.

The largest earthquake of the month occurred at 3:36 p.m. on August 3. It originated about 30 km deep under Kilauea Iki Crater just east of Kilauea caldera and was reported felt by no one.

A small earthquake at 11:21 p.m. on August 23 was felt by a few residents of Kona.

At the Whitney station the northward component of tilting of the ground surface was normal for August, but the eastward component was only one third of the normal amount.

*September*

Frequent, tiny earthquakes in and near Kilauea caldera marked the month of September at Hawaii's volcanoes. Twenty earthquakes were recorded at the Whitney station. The Sprengnether seismograph at Uwekahuna registered 344 earthquakes. Almost all of these were very small and originated in Kilauea caldera.

A shallow earthquake near Kalalua Crater on the east rift of Kilauea was felt in the Volcano area at 7:09 p.m. on September 12. A slightly larger earthquake originating southwest of Kalapana at a depth of about 10 km at 12:44 a.m. on September 26 was felt in Hilo.

Northeastward tilting of the earth's surface at the Whitney station proceeded at about half the rate normal for September.



**2. Earthquakes recorded on the Bosch-Omori seismograph in the Whitney Laboratory of Seismology, on the northeast rim of Kilauea caldera.**

| Week beginning | Minutes of tremor | Very feeble | Feeble | Slight | Moderate | Strong | Total | Local seismicity * |
|---|---|---|---|---|---|---|---|---|
| July 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0.75 |
| 8 | 8 | 2 | 0 | 0 | 0 | 0 | 10 | 3.00 |
| 15 | 30 | 2 | 0 | 0 | 0 | 0 | 32 | 8.50 |
| 22 | 22 | 12 | 1 | 0 | 0 | 0 | 35 | 12.50 |
| 29 | 102 | 34 | 2 | 0 | 0 | 0 | 138 | 44.50 |
| Aug. 5 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | .25 |
| 12 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | .50 |
| 19 | 2 | 10 | 0 | 0 | 0 | 0 | 12 | 5.50 |
| 26 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 1.50 |
| Sept. 2 | 1 | 3 | 1 | 0 | 0 | 0 | 5 | 2.75 |
| 9 | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 2.50 |
| 16 | 4 | 4 | 0 | 0 | 0 | 0 | 8 | 3.00 |
| 23 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 2.25 |

*Local seismicity is an arbitrary value. Each local earthquake is assigned a seismicity value according to its strength, as follows: tremor, 0.25; very feeble, 0.5; feeble, 1.0; slight, 2.0; moderate, 3.0; strong, 4.0. These values are totaled to give the weekly local seismicity. Continuous volcanic tremor is ignored in the calculation. The strength assigned to the earthquake depends on the double amplitude of the maximum oscillation it causes on the Bosch-Omori seismograph, as follows: Tremor, less than 0.5 mm; very feeble, 0.5 to 4 mm; feeble, 4 to 11 mm; slight, 11 to 25 mm; moderate, 25 to 60 mm; strong, greater than 60 mm.

**3. Table of tilt at seismograph stations on the rim of Kilauea caldera.**

| Week beginning | Whitney station (northeast rim) | | Uwekahuna station (west rim) | |
|---|---|---|---|---|
| | Direction | Amount (seconds of arc) | Direction | Amount (seconds of arc) |
| July 1 | N 22° E | 0.7 | Record interrupted by work in vault. | |
| 8 | N 23° W | .9 | | |
| 15 | N 37° E | .6 | | |
| 22 | N 22° E | .7 | W 33° S | 0.5 |
| 29 | N 37° E | .6 | S | .5 |
| Aug. 5 | N 14° E | .5 | W | .3 |
| 12 | N 11° W | .6 | N | .2 |
| 19 | N 27° E | .3 | N 31° W | .9 |
| 26 | N 33° W | .4 | W 37° N | 1.5 |
| Sept. 2 | E 33° N | .4 | W 6° S | 1.5 |
| 9 | N 45° E | .5 | N 33° W | 1.1 |
| 16 | N | .1 | S 45° W | 1.1 |
| 23 | E | .2 | W 8° N | 1.1 |

## LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs on the islands of Hawaii and Maui operated by the Hawaiian Volcano Observatory. Except for smaller earthquakes of special interest, only earthquakes classed as slight or larger were included in the list. The intensity ratings assigned are based on the Bosch-Omori seismograph at the Whitney Laboratory. This intensity scale has been extended empirically to permit its use with the Loucks-Omori and Sprengnether seismographs. The entries for a given earthquake are: date, time of arrival at the nearest station (Hawaiian standard time), intensity at the nearest station, name of the nearest station, epicenter, and general remarks.

July 26, 01:40:45, moderate at Naalehu. About five km southeast of Puu o Keokeo on the southwest rift of Mauna Loa. Felt in central Kona.

Aug. 1, 23:22:14, slight at Naalehu. Ten km north of Naalehu at a depth of about five km.

3, 15:36:28, slight at Uwekahuna. Thirty km deep under Kilauea Iki.

Sept. 5, 22:36:35, slight at Naalehu. About 10 km northnorthwest of Naalehu at a depth of about five km.

7, 08:15:06, slight at Uwekahuna. Kaoiki fault near Halfway House at a depth of about 30 km.

26, 00:43:37, slight at the Whitney Laboratory. Fifteen km west southwest of Kalapana along the south shore of Kilauea at a depth of about 10 km. Felt in Hilo.

## DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on the seismographs at the Hawaiian Volcano Observatory (19° 25.4' N. latitude, 155° 17.7' W. longitude). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. Locations of epicenters, magnitudes, and depths of focus are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

July 4, eP 00:47:23.7, 18° S., 178½° W. Fiji Islands. Depth about 450 km.

9, eP 03:30:43.6, 37° N., 26° E. Aegean Sea. 42 killed and many injured. Several towns destroyed on Thira and Ios Islands. Magnitude 7¼-8.



July 9, eP 10:08:00.7, 20° N., 73° W. Near coast at Haiti. Moderate property damage of Port de Paix. Depth about 100 km. Magnitude 6½-6¾.

17, iP 07:45:43.4, 7° S., 126½° E. Banda Sea. Depth about 450 km. Magnitude 6¾.

18, iP 06:30:55.1, 5° S., 130° E. Banda Sea. Magnitude 7-7½.

23, eP 19:36:10.7, 24° S., 102° W. Easter Island region. Magnitude 6¼-6¾.
eS 19:44:34
eL 19:51:26

Aug. 9, iP 23:07:59.6, 15° S., 176° W. Samoa Islands region. Depth about 200 km. Magnitude 6¾.
iS 13:13:46
eL 13:16:57

12, eP 17:09:46.7, 34° N., 138° E. Near south coast of Honshu, Japan. Magnitude 6½-6¾.
eS 17:18:07

14, eL 03:59:46, Prince Edward Islands region, South Indian Ocean.

15, iP 11:03:31.9, ½° S., 123° E. Northern Celebes. Depth about 150 km.
iS 11:13:44
eL 11:25:19

15, eS 13:28:41, 46° N., 151° E. Kurile Islands. Magnitude 6¼.
eL 13:35:39

24, eP 04:35:21.2, 53° N., 172½° E. Near Islands, Aleutian Islands. Magnitude 6½.
eS 04:41:40
eL 04:46:24

30, eP 04:31:15.1, 54° N., 164° W. Unimak Island, Aleutian Islands. Magnitude 6.
eS 04:40:27
eL 04:41:53

30, eP 05:31:26, 41° N., 126½° W. Off coast of northern California. Magnitude 5½.
eS 05:38:25
eT 06:04:42

Sept. 11, eL 02:52:50, 16½° S., 178° E. Fiji Islands. Magnitude 6-6¼.

11, eP 21:12:41.7, 40½° N., 155° E. Northern Kurile Islands. Magnitude 6-6¼.
eS 21:19:51
eL 21:26:03

16, eL 09:28:25, 34° N., 69½° E. Magnitude 6¼-6½.

20, eP 22:00:38.4, 51½° N., 159½° E. Near south coast of Kamchatka. Magnitude 6¼.
eS 22:07:37

24, eP 06:12:06.8, 15½° S., 173½° W. Samoa Islands. Magnitude 6.
eL 06:22:10

24, eP 07:11:16.0, 22° S., 175° E. Fiji Islands region.
eL 07:23:05

29, iP 22:34:36.7, 3° N., 128° E. Off north coast of Halmahera. Depth about 60 km.

29, eP 23:30:48.9, 35½° N., 140° E. Central Honshu, Japan. One killed, several injured and minor property damage in Tokyo. Depth about 60 km. Magnitude 6¾-7.

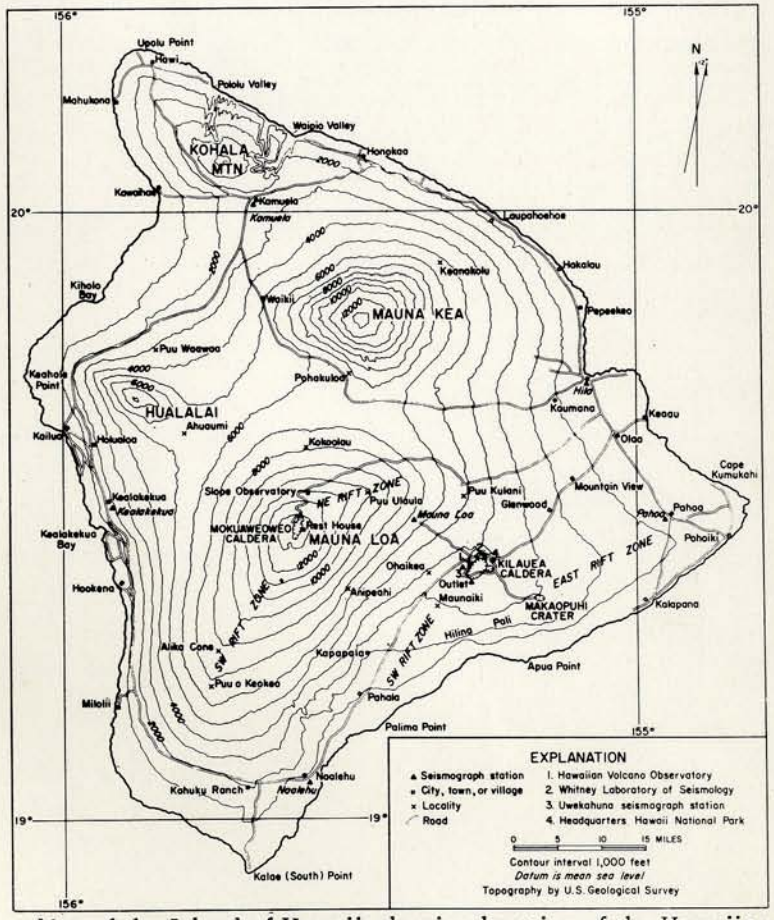
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

# HAWAIIAN VOLCANO OBSERVATORY SUMMARY 4

## October–December 1956

By

J. P. Eaton and George D. Fraser




Map of the Island of Hawaii, showing location of the Hawaiian Volcano Observatory, seismograph stations operated by the observatory, and localities mentioned in text.

## PREFATORY NOTE

This summary of observations made at the Hawaiian Volcano Observatory is published for the use of volcanological and seismological observatories and others interested in the data at intervals more frequently than once a year. Heretofore this material was available in *The Volcano Letter,* published by the University of Hawaii, but discontinued with issues number 529 and 530, July-December, 1955. Those who wish to receive this summary should request inclusion on the mailing list from the Director, U. S. Geological Survey, Washington 25, D. C.

## 1. Summary of volcanic conditions.

*October*

The swarm of tiny earthquakes from the region of Kilauea caldera that began near the end of July continued through October. At Uwekahuna the Sprengnether seismograph recorded 702 quakes. As in past months these earthquakes predominantly were very small and originated in or near Kilauea caldera at shallow depths.

At 12:45 a.m. on October 16, a strong earthquake from an epicenter at sea about 45 km west of Kailua, Kona, was felt over the entire island of Hawaii and as far north as Honolulu on Oahu.

At the Whitney station on the northeast rim of Kilauea caldera, northeastward tilting of the earth's surface continued at a rate slightly less than normal for October.

*November*

During November the swarm of small earthquakes from Kilauea caldera declined slightly. The Sprengnether seismograph at Uwekahuna registered 562 quakes, most of which originated within a few km of the station.

Only one earthquake was reported felt during November. It occurred at 12:26 a.m. on the 13th on the Kaoiki fault near Kilauea caldera and was felt along the north rim of the caldera.

At the Whitney station normal eastward tilting continued through the month, but tilting toward the north reversed sharply in mid-November. This reversal from northward to southward tilting occurred about one month earlier than usual.

*December*

Seismic activity declined slightly during December. Almost all of the 439 disturbances recorded by the Sprengnether seismograph at Uwekahuna originated at Kilauea caldera and were very small.

The only earthquake reported felt during the month shook central Kona at 7:13 p.m. on December 14.

At the Whitney station on the northeast rim of Kilauea caldera, southward tilting of the ground surface was slightly in excess of the amount normal for December.

2. Earthquakes recorded on the Bosch-Omori seismograph in the Whitney Laboratory of Seismology, on the northeast rim of Kilauea caldera.

| Week beginning | Minutes of tremor | Very feeble | Feeble | Slight | Moderate | Strong | Total | Local seismicity * |
|---|---|---|---|---|---|---|---|---|
| Sept. 30 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 1.00 |
| Oct. 7 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0.75 |
| 14 | 0 | 1 | 2 | 0 | 0 | 1 | 4 | 6.50 |
| 21 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 1.00 |
| 28 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 1.00 |
| Nov. 4 | 4 | 1 | 0 | 0 | 0 | 0 | 5 | 1.50 |
| 11 | 2 | 4 | 1 | 0 | 0 | 0 | 7 | 3.50 |
| 18 | 16 | 5 | 0 | 0 | 0 | 0 | 21 | 6.50 |
| 25 | 23 | 14 | 0 | 0 | 0 | 0 | 37 | 12.75 |
| Dec. 2 | 13 | 8 | 0 | 0 | 0 | 0 | 21 | 7.25 |
| 9 | 6 | 2 | 0 | 0 | 0 | 0 | 8 | 2.50 |
| 16 | 7 | 2 | 0 | 0 | 0 | 0 | 9 | 2.75 |
| 23 | 11 | 5 | 0 | 0 | 0 | 0 | 16 | 5.25 |

* Local seismicity is an arbitrary value. Each local earthquake is assigned a seismicity value according to its strength, as follows: tremor, 0.25; very feeble, 0.5; feeble, 1.0; slight, 2.0; moderate, 3.0; strong, 4.0. These values are totaled to give the weekly local seismicity. Continuous volcanic tremor is ignored in the calculation. The strength assigned to the earthquake depends on the double amplitude of the maximum oscillation it causes on the Bosch-Omori seismograph, as follows: tremor, less than 0.5 mm; very feeble, 0.5 to 4 mm; feeble, 4 to 11 mm; slight, 11 to 25 mm; moderate, 25 to 60 mm; strong, greater than 60 mm.



3. Table of tilt at seismograph stations on the rim of Kilauea caldera.

| Week beginning | Whitney station (northeast rim) | | Uwekahuna station (west rim) | |
|---|---|---|---|---|
| | Direction | Amount (seconds of arc) | Direction | Amount (seconds of arc) |
| Sept. 30 | E 18° N | 0.8 | W 18° N | 0.5 |
| Oct. 7 | N 45° E | 0.2 | W | 0.5 |
| 14 | E 34° N | 0.9 | W 18° S | 1.0 |
| 21 | E 27° S | 0.3 | W | 0.2 |
| 28 | N 45° E | 1.0 | W 34° N | 0.5 |
| Nov. 4 | E 11° N | 0.6 | N 27° W | 0.3 |
| 11 | S | 0.1 | W 18° S | 0.5 |
| 18 | E | 0.7 | W 27° N | 0.3 |
| 25 | S 18° E | 0.8 | S 14° E | 0.6 |
| Dec. 2 | S 30° W | 1.0 | E 22° N | 0.8 |
| 9 | S 45° W | 0.2 | W 11° S | 0.8 |
| 16 | | 0 | W 18° N | 0.5 |
| 23 | E 18° N | 0.4 | S | 0.5 |

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Oct. 11, 12:53:34, slight at Kamuela. About 20 km northwest of Kamuela at a depth of about 15 km. Felt in Kamuela.

Oct. 16, 00:44:55, strong at Kona. At sea about 45 km west of Kailua, Kona, at a shallow depth. Felt over the entire island of Hawaii and as far as Honolulu on Oahu.

Oct. 16, 17:31:24, slight at Kona. Aftershock of previous earthquake. Felt in Kona.

Oct. 20, 20:23:04, very feeble at Pahoa. Near the south shore of Kilauea 10 km southwest of Kalapana at a depth of about 5 km. Felt in Hilo.

Oct. 20, 22:05:14, feeble at Pahoa. Near the south shore of Kilauea 10 km southwest of Kalapana at a depth of about 5 km. Felt in Hilo.

Oct. 25, 07:05:14, slight at Uwekahuna. Near Kilauea caldera at a depth of 30 km.

Nov. 3, 08:05:12, slight at Uwekahuna. Near Kilauea caldera at a depth of about 10 km.

Nov. 13, 00:11:25, slight at Uwekahuna. On the Kaoiki fault near Kilauea caldera at a depth of about 10 km. Felt at the north rim of Kilauea caldera.

Nov. 15, 17:43:46, slight at Mauna Loa. Near the Mauna Loa seismograph station at a depth of about 10 km.

Dec. 14, 19:13:21, feeble at Kona. Near the Kona seismograph station. Felt in Kona.

## DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on the seismographs at the Hawaiian Volcano Observatory (19° 25.4' N. latitude, 155° 17.7' W. longitude). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. Locations of epicenters, magnitudes, and depths of focus are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

Oct. 11, eP 02:33:33.1, eS 02:40:46, iL 02:47:57 — 46° N., 150½° E. Kurile Islands. Felt: Hokkaido, Japan. Depth about 100 km. Magnitude 7¼-7½.

Oct. 11, eP 16:55:24.4, eS 17:00:41, iL 17:02:07, eT 17:28:32 — 40½° N., 126½° W. Off Cape Mendocino, Calif. Felt: Coastal area of northern California. Magnitude 6.

Oct. 19, eL 14-42, — 56½° S., 122° W. South Pacific Ocean. Magnitude 6½.

Oct. 19, eP 20:55:03.5, eS 21:01:08, eL 21:05:16 — 52° N., 177° E. Rat Islands, Aleutian Islands. Magnitude 6¾.

Oct. 23, eP 08:53:28.0, — 13½° N., 120½° E. Mindoro Island, Philippine Islands. Depth about 100 km.

Oct. 24, eP 14:53:06.3, iS 15:01:58, iL 15:09:37 — 12° N., 87° W. Near coast of Nicaragua. Minor damage at Managua. Felt: Southern El Salvador. Magnitude 7-7¼.

Oct. 25, eP 05:32:43, — 12° N., 87° W. Nicaragua aftershock. Felt: El Salvador and Nicaragua. Magnitude 6-6½.



Oct. 26, eS 23:06:29, eL 23:13:11 — 14° S., 167° E. New Hebrides Islands. Magnitude 6½.

Oct. 28, iP 03:38:27.4, iS 03:46:23, eL 03:54:23 — 32° S., 179° W. Kermades Islands. Magnitude 6½.

Nov. 4, eP 07:14:04.9, — 20½° S., 176½° W. Tonga Islands. Depth about 100 km. Magnitude 6½-6¾.

Nov. 9, iP 13:15:53.9, eS 13:23:44 — 17° N., 94° W. Southern Mexico. Slight damage in Oaxaca Province. Depth about 150 km. Magnitude 6.

Nov. 17, eP 20:35:03.8, eL 20:43:29, eT 21:14:43 — 54½° N., 134° W. Queen Charlotte Islands region. Felt: Ketchikan, Alaska. Magnitude 6¼-6½.

Nov. 28, eP 19:36:01, eL 19:50:40 — 49½ N., 155° E. Northern Kurile Islands. Magnitude 6¾-7.

Nov. 29, eP 09:25:03.3, — 27° N., 141° E. Bonin Islands. Magnitude 7.

Dec. 8, eP 16:17:53, iS 16:23:23, iL 16:27:21 — 51° N., 179½° W. Andreanof Islands, Aleutian Islands. Magnitude 6½.

Dec. 18, eP 02:44:39.3, eS 02:56:49, iL 03:14:11, eT 04:27:54 — 25½° S., 68½° W. Chile-Argentina border. Felt: Antofagasta and Copiapo. Magnitude 6¾-7¼.

Dec. 21, iS 09:12:04, eL 09:14:20, eT 09:44:58 — 51° N., 131° W. Queen Charlotte Islands. Magnitude 6½-6¾.

Dec. 23, eP 08:47:03, — 22° N., 144½° E. Marianas Islands region. Depth about 100 km. Magnitude 6½.

Dec. 27, iP 00:22:27.0, iS 00:29:08, eL 00:33:13 — 24° S., 177° W. Tonga Islands region. Depth about 300 km. Magnitude 7-7¼.

Dec. 28, eP 14:34:56.1, eS 14:45:42, eL 14:55:03 — 38° S., 167½° E. Near coast of North Island, New Zealand. Depth about 150 km. Magnitude 6¼-6¾.