

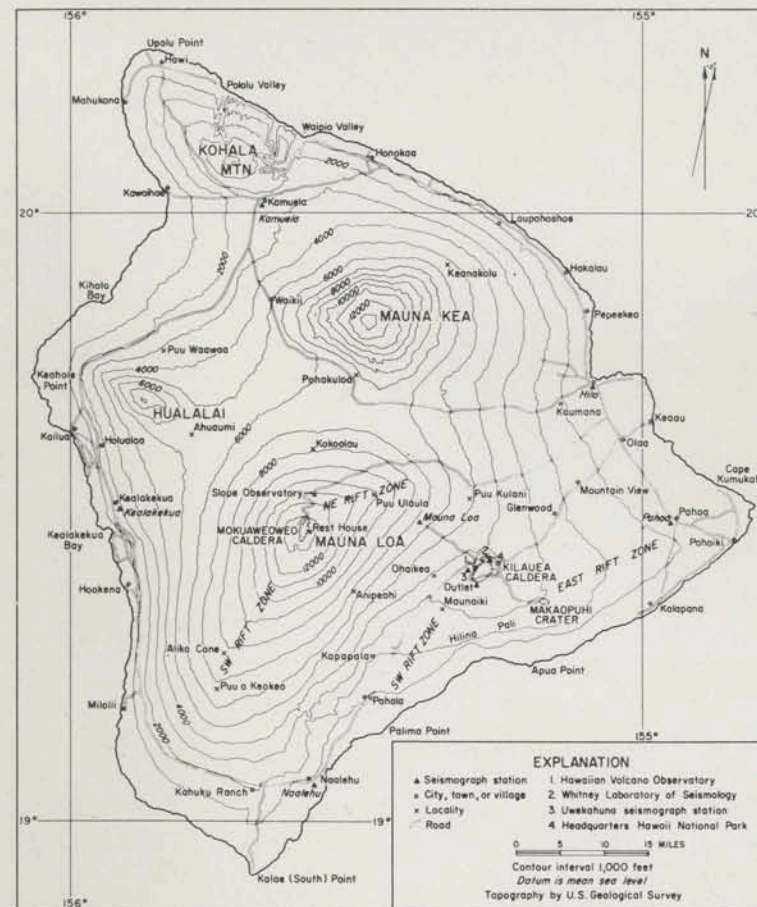
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY  
SUMMARY 9

January-March 1958

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 shorter than once a year. 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. Chronological Summary

##### *January*

Most of the 239 earthquakes registered by seismographs at Uwekahuna during January were very small. The chief sources of this weak seismic activity were Kilauea caldera and the Kaoiki fault zone west of the caldera.

An earthquake from a focus 25 km beneath Kilauea caldera at 2:27 a. m. on January 14 was felt along the north rim of the caldera. At 4:54 a. m. on January 20 an earthquake from an epicenter near Laupahoehoe was felt at Hakalau.

The largest earthquake in the Hawaiian area during January was not reported felt. It originated 15 km southeast of Hana, Maui, at a depth of about 45 km at 9:26 p. m. on January 19.

At 12:54 p. m. on January 28 an earthquake occurred beneath the ocean about 220 km south of Kalapana. This epicenter lies farther southeastward along the prolongation of the Hawaiian chain than that of any earthquake previously reported.

Gentle southeasterly tilting of the earth's surface at the Whitney station replaced the moderate southerly tilting normal for January.

##### *February*

Seismographs at Uwekahuna recorded 292 earthquakes during February. As in previous months most of these earthquakes were very small and originated at shallow depths beneath Kilauea caldera or along the Kaoiki fault zone west of the caldera.

A small, sharp earthquake from the northeast rim of Kilauea caldera was felt at Hawaii National Park Headquarters at 2:11 p.m. on February 11. The largest earthquake of the month, which originated 17 km southeast of Naalehu at a depth of about 35 km, was felt at Naalehu and Pahoa on February 15 at 4:49 p. m. At 7:19 a. m. on February 20 an earthquake from an epicenter 10 km northeast of Honokaa was felt at Kamuela.

An earthquake from a shallow focus 8 km northeast of Ulupau Head, Oahu, awakened residents of windward Oahu at 4:01 a. m. on February 23.

At the Whitney station on the northeast rim of Kilauea caldera, tilting of the earth's surface was in the southwesterly direction normal for February but was much weaker than usual.

### March

Continuing mild seismic activity at Kilauea caldera and along the nearby Kaoiki fault zone accounted for most of the 226 earthquakes recorded by seismographs at Uwekahuna during March.

An earthquake felt in Hilo at 9:44 a. m. on March 9 originated about 15 km southwest of Kalapana.

A swarm of earthquakes from an unusual epicenter, 5 km west of Keanakolu on the northeast flank of Mauna Kea, was recorded by Observatory seismographs from March 9 to March 14. Of the 11 earthquakes of this swarm that were magnitude 2.5 or larger, at least 5 were felt at Honokaa. These earthquakes were felt at 3:09 a. m. on March 10, at 10:13 p. m. on March 11, at 9:06 p. m. and 11:19 p. m. on March 12, and at 8:10 a. m. on March 13.

At 3:09 p. m. on March 13 an earthquake from a focus 20 km beneath Puu Kulani was felt a few km east of Kilauea caldera.

An earthquake from an epicenter 10 km northeast of Apua Point was felt in Hilo at 1:30 p. m. on March 29.

Strong southwesterly tilting of the earth's surface recorded at the Whitney station was normal for March.

### 2. Local Earthquake Summary

Week beginning	Number of Earthquakes		Minutes of continuous tremor*
	magnitude $\geq 2.5$	magnitude $< 2.5$	
Dec. 29	3	63	0
Jan. 5	3	65	0
12	1	45	0
19	2	51	41
26	1	43	0
Feb. 2	0	105	13
9	2	60	0

Table-Continued

Week beginning	Number of Earthquakes		Minutes of continuous tremor*
	magnitude $\geq 2.5$	magnitude $< 2.5$	
Feb. 16	3	68	51
23	1	49	0
Mar. 2	3	25	0
9	14	84	9
16	3	43	0
23	1	34	0

\* Recorded at Uwekahuna on a vertical component electromagnetic seismograph with a peak magnification of 20,000 and galvanometer and seismometer periods of 0.5 second.

### 3. Tilt coordinates\* at seismograph stations on the rim of Kilauea caldera.

	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
Jan. 5	500	500	500	500
12	497	500	499	500
19	496	502	500	504
26	495	504	500	502
Feb. 2	497	499	501	499
9	495	501	503	499
16	495	503	502	498
23	492	501	504	497
Mar. 2	491	498	507	490
9	493	503	504	490
16	488	497	502	491
23	483	491	503	488
30	480	491	503	490

\* All tilt coordinates were arbitrarily set equal to 500 on January 5, 1958. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface: i.e. to a relative subsidence toward the north and east. A one unit change in coordinate reveals a tilting of one part per million (one mm per km) in the direction indicated.

### LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs operated by the Hawaiian Volcano Observatory on the islands of Hawaii and Maui. Except for smaller earthquakes of special interest, only earthquakes with magnitudes of 2.5 or greater were included in the list. The entries for a given earthquake are: date, origin time (Hawaiian standard time), epicenter, and general remarks.

- Jan. 1, 13:47:32, 35 km west of Milolii at a depth of about 15 km. Magnitude 2.9.  
 Jan. 2, 06:01:36, Kealakekua fault. Magnitude 2.8.  
 Jan. 2, 21:19:02, Central Kona. Magnitude 2.7.  
 Jan. 5, 17:35:39, South shore of Kilauea 13 km southwest of Kalapana at a depth of about 5 km. Magnitude 2.5.  
 Jan. 5, 20:37:27, 25 km west of Milolii at a depth of about 15 km. Magnitude 2.9.  
 Jan. 6, 15:39:49, 60 km south of Kalapana at a depth of about 15 km. Magnitude 2.8.  
 Jan. 14, 02:26:59, Beneath Kilauea caldera at a depth of about 25 km. Felt near Hawaii National Park Headquarters. Magnitude 2.6.  
 Jan. 15, 23:07:58, Beneath Puu Koaie at a depth of about 30 km. Magnitude 2.7.  
 Jan. 19, 21:26:04, 15 km southeast of Hana, Maui, at a depth of about 45 km. Magnitude 3.7.  
 Jan. 20, 04:54:17, Near Laupahoehoe at a depth of about 15 km. Felt at Hakalau. Magnitude 2.5.  
 Jan. 28, 12:53:55, 220 km south of Kalapana. Magnitude 3.3.  
 Feb. 11, 14:10:39, Northeast rim of Kilauea caldera at depth of 2 km or less. Felt at Hawaii National Park Headquarters and Kilauea Military Camp. Magnitude 1.9.  
 Feb. 14, 13:38:17, 40 km east of Hana, Maui. Magnitude 3.0.  
 Feb. 15, 16:48:38, 17 km southeast of Naalehu at a depth of about 35 km. Felt at Naalehu and Pahoa. Magnitude 3.9.  
 Feb. 19, 18:53:45, North rim of Kilauea caldera at a depth of about 30 km. Magnitude 2.7.  
 Feb. 20, 07:19:23, 10 km northwest of Honokaa at a depth of about 15 km. Felt at Kamuela. Magnitude 3.0.  
 Feb. 20, 12:51:13, 10 km east of Apua Point at a depth of about 40 km. Magnitude 2.8.  
 Feb. 23, 04:00:35, 8 km northeast of Ulupau Head, Oahu, at a shallow depth. Felt on Oahu. Magnitude 3.7.  
 Mar. 2, 09:52:39, 35 km south of Kilauea caldera at a depth of about 40 km. Magnitude 2.8.  
 Mar. 3, 08:44:20, 7 km west of Pahala at a shallow depth. Magnitude 2.5.  
 Mar. 5, 01:59:25, 10 km southwest of the Mauna Loa seismograph station at a depth of about 5 km. Magnitude 3.1.  
 Mar. 9, 09:43:52, South shore of Kilauea 15 km southwest of Kalapana at a depth of 5 km. Felt in Hilo. Magnitude 3.5.  
 Mar. 10, 03:09:04, 5 km west of Keanakolu. Felt at Honokaa. Magnitude 2.7.  
 Mar. 10, 20:34:57, 2 km east of Puu Koaie at a depth of about 30 km. Magnitude 3.0.  
 Mar. 11, 03:27:39, 5 km west of Keanakolu. Magnitude 2.5.  
 Mar. 11, 18:35:47, 5 km west of Keanakolu. Magnitude 2.6.  
 Mar. 11, 22:13:01, 5 km west of Keanakolu. Felt at Honokaa. Magnitude 2.9.

- Mar. 12, 06:27:33, 5 km west of Keanakolu. Magnitude 2.6.  
 Mar. 12, 21:05:46, 5 km west of Keanakolu. Felt at Honokaa. Magnitude 2.9.  
 Mar. 12, 22:13:53, 5 km west of Keanakolu. Magnitude 2.5.  
 Mar. 12, 23:19:20, 5 km west of Keanakolu. Felt at Honokaa. Magnitude 2.9.  
 Mar. 13, 08:10:21, 5 km west of Keanakolu at a depth of about 15 km. Felt at Honokaa. Magnitude 3.1.  
 Mar. 13, 11:06:41, 5 km west of Keanakolu. Magnitude 2.5.  
 Mar. 13, 15:08:33, Near Puu Kulani at a depth of about 20 km. Felt just east of Kilauea caldera. Magnitude 2.7.  
 Mar. 14, 00:14:31, 5 km northeast of Keanakolu. Magnitude 2.5.  
 Mar. 16, 19:34:11, 10 km south of Puu o Keokeo at a depth of about 5 km. Magnitude 2.7.  
 Mar. 19, 08:48:47, 35 km south of the Mauna Loa seismograph station at a depth of 35 km. Magnitude 3.2.  
 Mar. 20, 23:46:01, 5 km northeast of Apua Point at a depth of about 5 km. Magnitude 2.7.  
 Mar. 29, 13:29:46, 10 km northeast of Apua Point at a depth of about 5 km. Felt in Hilo. Magnitude 3.0.

#### DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on seismographs of the Hawaiian Volcano Observatory on Hawaii (U = Uwekahuna,  $19^{\circ} 25.4' N$ ,  $155^{\circ} 17.6' W$ , 1240m), and Maui (H = Haleakala,  $20^{\circ} 46.0' N$ ,  $156^{\circ} 15.0' W$ , 2090m). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. A "c" following the time of P indicates that the first motion was a compression; a "d", that it was a dilatation. Locations of epicenters, origin times, focal depths, and magnitudes are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

Jan. 5,

U eP 08:16:41.7  
 $2^{\circ} N$ ,  $122\frac{1}{2}^{\circ} E$ , 08:05:11  
 Depth about 550 km.

Jan. 11,

U iP 13:37:33.4 c  
 iS 13:34:16  
 $23\frac{1}{2}^{\circ} S$ ,  $177^{\circ} W$ , 13:18:47

Jan. 13,

U eP 00:09:49.2  
 $52\frac{1}{2}^{\circ} N$ ,  $177^{\circ} E$ , 00:02:24  
 Depth about 100 km.

Jan. 13,

U eP 03:03:19.9  
 eL 03:16:26  
 $7^{\circ} N$ ,  $83^{\circ} W$ , 02:52:40

**Jan. 15,**

U eP 19:27:21.9 d  
 iS 19:37:57  
 eSS 19:44:01  
 iQ 19:50:57  
 eR 19:55:11  
 Tmax 21:06:19

16½° S, 71½° W, 19:14:29  
 Depth about 100 km  
 Magnitude 7 (Pas)

**Jan. 15,**

U eP 22:24:47.2  
 eS 22:31:51  
 eSS 22:35:21  
 eQ 22:36:36  
 iR 22:38:21

13½° S, 167° E, 22:15:44

**Jan. 16,**

U eL 11:26:50  
 14° S, 167° E, 11:03:32

**Jan. 17,**

U eP 04:26:11.5  
 1° S, 127° E, 04:14:02

**Jan. 18,**

U eP 15:34:08  
 29° S, 13° W, 15:14:26

**Jan. 19,**

U eP 14:19:15.6 c  
 ipP 14:19:25  
 iS 14:29:00  
 iR 14:42:33  
 H iP 14:19:28.4 c

1½° N, 79½° W, 14:07:23  
 Magnitude 7½ (Pas)  
 Seismic sea wave damage  
 at Las Emeraldas and  
 Guayaquil, Ecuador.

**Jan. 19,**

U eP 14:55:16  
 iS 15:05:06  
 iR 15:21:21  
 1½° N, 79½° W, 14:43:24  
 Magnitude 6¾ (Pas)

**Jan. 23,**

U iP 09:01:14.7 c  
 H iP 09:01:17.3 c  
 18½° S, 170° E, 08:52:23  
 Depth about 150 km.

**Jan. 24,**

U eP 06:02:42.9 c  
 iS 06:09:36  
 iR 06:15:51  
 56½° N, 163° E, 05:53:58  
 Magnitude 6½ (Pas)

**Jan. 26,**

U eL 04:10:21  
 54° S, 133° W, 03:35:21

**Jan. 27,**

U eP 07:51:29  
 eS 07:57:31  
 iR 08:01:21  
 15° S, 174° W, 07:43:58  
 Magnitude 6¾ (Pas)

**Jan. 30,**

U eS 06:30:50  
 eL 06:38:30  
 7½° S, 155½° E, 06:13:24  
 Magnitude 6½ (Pas)

**Feb. 1,**

U iP 16:22:08.0 d  
 eS 16:31:50  
 eSS 16:36:40  
 eQ 16:42:21  
 iR 16:44:58

2° N, 79° W, 16:10:15  
 Magnitude 6¾-7 (Pas)

**Feb. 1,**

U eP 18:14:38.8  
 iS 18:24:18  
 eR 18:38:28

2° N, 79° W, 18:02:39  
 Magnitude 6¾-7 (Pas)

**Feb. 1,**

U eP 20:57:39  
 eS 21:07:28  
 eQ 21:18  
 eR 21:20:48

1½° N, 79° W, 20:45:45  
 Magnitude 6¾ (Pas)

**Feb. 2,**

U eP 08:20:46  
 eS 08:28:02  
 eR 08:34:17

48½° N, 154½° E, 08:11:53  
 Magnitude 6½-6¾ (Pas)

**Feb. 7,**

U iP 23:36:14.0 c  
 31½° N, 104° E, 23:23:30

**Feb. 12,**

U eP 23:50:47.6  
 eS 23:56:53  
 eR 24:00:07

52° N, 175° W, 23:43:45  
 Magnitude 6 (Pas)

**Feb. 15,**

U eP 01:56:02.9 d  
 eS 02:03:47  
 eR 02:10:50

44° N, 147° E, 01:46:40  
 Magnitude 6-6½ (Pas)

**Feb. 16,**

U eP 06:14:06  
 eS 06:22:00  
 eR 06:29:50

39° N, 142° E, 06:04:05  
 Magnitude 6-6¾ (Pas)

**Feb. 22,**

U iP 10:57:17.6 c  
 iS 11:02:51  
 eQ 11:04:31  
 iR 11:05:55  
 Tmax 11:57:06.2 c

50½° N, 175° W, 10:50:23  
 Magnitude 6¾ (Pas)

**Feb. 23,**

U eP 10:57:37.4 c  
 24° N, 141½° E, 10:47:40

**Feb. 24,**

U eP 12:39:53.2  
 45° N, 99° E, 12:27:06

**Mar. 3,**

U iP 16:26:44.8 d  
 55½° N, 166½° E, 16:18:17  
 Magnitude 6¼-6½ (Pas)

**Mar. 3,**

U eP 17:41:15  
 55½° N, 166° E, 17:32:47

**Mar. 9,**

U eP 10:31:34  
 eS 10:39:57  
 eL 10:47:36

34° S, 178½° W, 10:22:25  
 Depth about 60 km.  
 Magnitude 6½-6¾ (Pas)

**Mar. 11,**

U eP 00:37:29.5  
 epP 00:37:52.4  
 iS 00:46:55  
 eQ 00:55:45  
 iR 01:00:12

25½° N, 125° E, 00:25:56  
 Depth about 60 km  
 Magnitude 7 (Pas)

Mar. 11,

U eS 14:15:44  
eL 14:21:59  
13° S, 167° E, 13:59:00

Mar. 20,

U eP 01:44:47.6  
iS 01:50:11  
eQ 01:51:48  
eR 01:53:20  
51° N, 173° W, 01:38:04

Mar. 31,

U iP 10:40:44.7  
17° N, 93½° W, 10:30:56  
Depth about 100 km.

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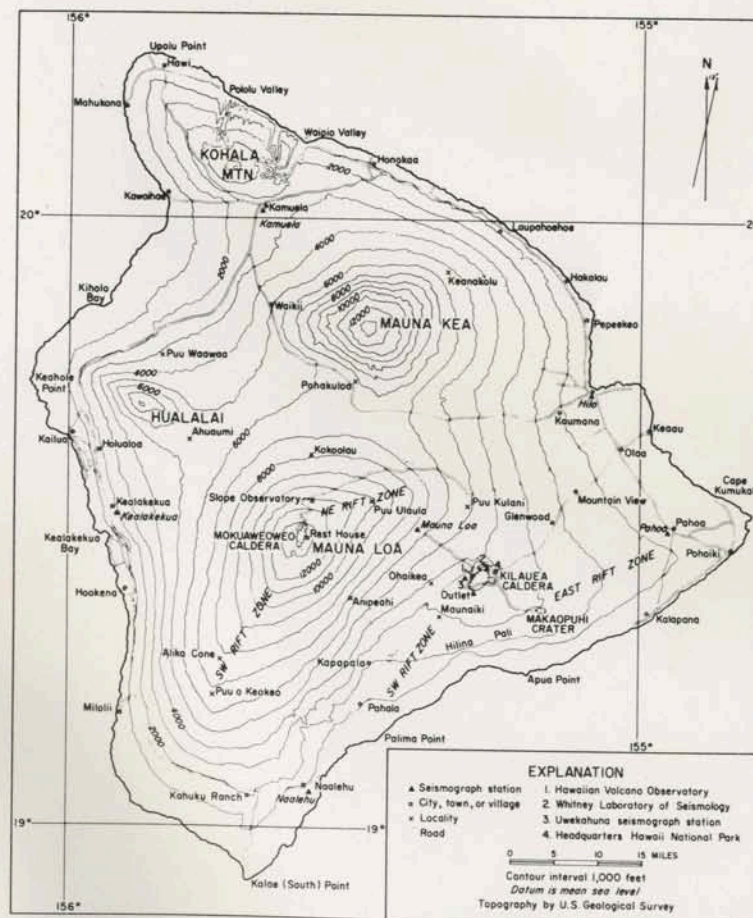
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## 1. Summary of Volcanic Conditions

*April*

Increased seismic activity near Kilauea caldera was responsible for most of the 920 earthquakes recorded during the month by seismographs at Uwekahuna. On April 1 about 200 small earthquakes accompanied by several hours of weak spasmodic tremor originated at a depth of about 60 km a few km north of Uwekahuna. Most of the other earthquakes during April were very small and originated at shallow depths in or near Kilauea caldera.

An earthquake felt in Hilo at 6:07 a.m. on April 21 stemmed from a focus 5 km northwest of Apua Point and 15 km deep.

The largest earthquake of the month was felt over most of the island of Hawaii at 3:07 a.m. on April 24. It originated beneath the ocean 5 km north of Laupahoehoe at a depth of about 25 km.

At the Whitney station gentle northerly tilting of the earth's surface replaced the gentle southerly tilting normal for April.

*May*

Most of the 440 earthquakes registered by seismographs at Uwekahuna during May were very small and originated at shallow depths in or near Kilauea caldera.

The largest earthquake of the month originated 10 km south of Mokuaweoweo at 12:33 a.m. on May 19.

No earthquake was reported felt during May.

Weak westerly tilting of the earth's surface recorded at the Whitney station was normal for May.



## June

Seismographs at Uwekahuna recorded 310 earthquakes during June. Shallow earthquakes at Kilauea caldera were less numerous than during April and May.

Two small earthquakes from shallow foci along the north rim of Kilauea caldera were felt in that region on June 3. The first occurred at 10:52 p.m.; the second, at 10:55 p.m.

The largest earthquake of the month originated 5 km southeast of Ahuaumi at a depth of about 15 km at 11:04 a.m. on June 17. It was not reported felt.

Gentle easterly tilting of the earth's surface at the Whitney station replaced the gentle northerly tilting normal for June.

### 2. Local Earthquake Summary

Week beginning	Number of Earthquakes*		Minutes of continuous tremor*
	magnitude $\geq$ 2.5	magnitude $<$ 2.5	
Mar. 30	3	250	270
Apr. 6	1	250	0
13	2	144	0
20	3	178	0
27	4	129	0
May 4	2	185	0
11	1	131	0
18	3	43	0
25	1	39	4
June 1	7	41	0
8	1	39	5
15	1	36	37
22	1	117	5

\*Recorded at Uwekahuna on a vertical component electromagnetic seismograph with a peak magnification of 20,000 and galvanometer and seismometer periods of 0.5 second.

### 3. Tilt coordinates\* at seismograph stations on the rim of Kilauea caldera.

Week beginning	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
Apr. 6	483	493	503	491
13	486	494	504	491
20	488	493	503	492
27	487	494	504	489
May 4	488	496	506	491
11	488	494	506	486
18	491	495	507	486
25	487	493	507	485

Table—Continued

Week beginning	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
June 1	489	492	503	488
8	492	497	501	490
15	492	497	502	488
22	490	498	506	488
29	489	497	510	482

\* All tilt coordinates were arbitrarily set equal to 500 on January 5, 1958. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface: i.e. to a relative subsidence toward the north and east. A one unit change in coordinate reveals a tilting of one part per million (one mm per km) in the direction indicated.

## LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs operated by the Hawaiian Volcano Observatory on the islands of Hawaii and Maui. Except for smaller earthquakes of special interest, only earthquakes with magnitudes of 2.5 or greater were included in the list. The entries for a given earthquake are: date, origin time (Hawaiian standard time), epicenter, and general remarks.

- Apr. 1, 10:18:56, 5 km north of Uwekahuna at a depth of about 60 km. Magnitude 2.5. This is the largest of several hundred small earthquakes originating at this location between 04:00 and 18:00 on Apr. 1.
- Apr. 3, 10:16:12, southwest rift of Mauna Loa near Puu o Keoeko at a depth of about 5 km. Magnitude 2.7.
- Apr. 4, 00:25:51, beneath the summit of Kohala Mountain at a depth of about 35 km. Magnitude 2.7.
- Apr. 8, 11:35:12,  $20^{\circ} 04' N$ ,  $157^{\circ} W$ , about 140 km south of Honolulu. Magnitude 3.0.
- Apr. 15, 11:13:50, 5 km northwest of Apua Point at a depth of about 5 km. Magnitude 2.8.
- Apr. 18, 07:57:41, on the Kealakekua fault 5 km south of Kealakekua at a depth of about 5 km. Magnitude 2.5.
- Apr. 21, 06:06:36, 5 km northwest of Apua Point at a depth of about 15 km. Felt in Hilo. Magnitude 3.2.
- Apr. 24, 03:06:33, beneath the ocean 5 km north of Laupahoehoe at a depth of about 25 km. Felt over most of the island of Hawaii. Magnitude 4.3.
- Apr. 26, 18:29:43, 10 km southwest of Kiholo Bay at a depth of about 15 km. Magnitude 2.5.
- Apr. 27, 20:53:24, Kealakekua fault at a depth of about 5 km. Magnitude 3.2.

- Apr. 27, 21:58:59, Kealakekua fault 5 km south of Kealakekua at a depth of about 15 km. Magnitude 2.5.
- Apr. 28, 08:11:00, 35 km west of Upolu Point. Magnitude 2.8.
- May 3, 00:12:20, 15 km west of Keahole Point at a depth of about 15 km. Magnitude 2.5.
- May 5, 01:59:18, 25 km southwest of Kealakekua Bay. Magnitude 2.5.
- May 6, 22:37:35, 5 km west of Pahala at a depth of about 5 km. Magnitude 3.0.
- May 13, 05:03:39,  $18^{\circ} 45' N$ ,  $156^{\circ} 20' W$ , about 80 km west of Kalae. Magnitude 3.0.
- May 18, 16:13:48, near coast of Kilauea about 45 km south of Hilo at a depth of about 5 km. Magnitude 3.0.
- May 19, 00:32:48, 10 km south of Mokuaweoweo at a depth of about 10 km. Magnitude 3.2.
- May 22, 08:20:39, 10 km southwest of the Mauna Loa seismograph station at a shallow depth. Magnitude 2.7.
- May 28, 13:28:23, south shore of Hawaii about 15 km south-southeast of Pahoa at a depth of about 5 km. Magnitude 2.6.
- June 3, 22:51:49, north rim of Kilauea caldera at a shallow depth. Felt on the north rim of Kilauea caldera. Magnitude 0.9.
- June 3, 22:55:10, north rim of Kilauea caldera at a shallow depth. Felt on the north rim of Kilauea caldera. Magnitude 1.7.
- June 4, 16:17:46, 10 km east of Kamuela at a depth of 35 km. Magnitude 3.0.
- June 5, 12:57:36, 2 km southwest of Ohaikea at a depth of about 5 km. Magnitude 3.0.
- June 5, 16:43:03, 20 km west-southwest of Naalehu at a depth of 35 km. Magnitude 2.9.
- June 5, 16:47:09,  $18^{\circ} 59' N$ ,  $155^{\circ} 28' W$ , about 15 km southeast Naalehu, at a depth of 35 km. Magnitude 3.3.
- June 5, 16:58:03, aftershock of previous quake. Magnitude 2.7.
- June 5, 21:38:18, 10 km north of Naalehu at a depth of 5 km. Magnitude 2.6.
- June 6, 11:46:25, near Puu o Keokeo at a depth of about 15 km. Magnitude 3.0.
- June 11, 22:34:20, 20 km west of Kailua. Magnitude 2.7.
- June 17, 11:03:55, 5 km southeast of Ahuaumi at a depth of 15 km. Magnitude 3.5.
- June 21, 03:42:35,  $19^{\circ} 10' N$ ,  $154^{\circ} 45' W$ , about 40 km south of Cape Kumukahi. Magnitude 2.4.
- June 25, 02:41:40,  $21^{\circ} 08' N$ ,  $155^{\circ} 00' W$ , about 125 km northeast of Upolu Point. Magnitude 3.1.
- June 30, 04:21:40,  $19^{\circ} 01' N$ ,  $154^{\circ} 53' W$ , about 50 km south of Pahoa. Magnitude 3.0.

## DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on seismographs of the Hawaiian Volcano Observatory on Hawaii (U=Uwekahuna,  $19^{\circ} 25.4' N$ ,  $155^{\circ} 17.6' W$ , 1240m), and Maui (H=Haleakala,  $20^{\circ} 46.0' N$ ,  $156^{\circ} 15.0' W$ , 2090m). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. A "c" following the time of P indicates that the first motion was a compression; a "d", that it was a dilatation. Locations of epicenters, origin times, focal depths, and magnitudes are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

Apr. 7,

U eP 15:39:12.8 c  
 iS 15:46:05  
 iQ 15:49:30  
 iR 15:51:55  
 H eP 15:38:59.6 c  
 eS 15:45:45  
 eQ 15:49:10  
 eR 15:51:05

$66\frac{1}{2}^{\circ} N$ ,  $157^{\circ} W$ , 15:30:38  
 Magnitude 7 (Pas)

Apr. 7,

U eP 18:14:46  
 eS 18:22:40  
 $38\frac{1}{2}^{\circ} N$ ,  $143^{\circ} E$ , 18:05:02

Apr. 9,

U iP 06:22:38  
 $56\frac{1}{2}^{\circ} N$ ,  $139^{\circ} W$ , 06:15:12

Apr. 10,

U eR 23:37:19  
 $4\frac{1}{2}^{\circ} S$ ,  $107^{\circ} W$ , 23:12:47  
 Magnitude 6 (Pas)

Apr. 11,

U iP 23:20:19 c  
 eS 23:27:24  
 eR 23:33:18  
 $47\frac{1}{2}^{\circ} N$ ,  $153\frac{1}{2}^{\circ} E$ , 23:11:26  
 Depth about 100 km  
 Magnitude  $6\frac{1}{4}$  (Pas)

Apr. 12,

U iS 12:01:06  
 eQ 12:04:13  
 eR 12:05:23  
 $26\frac{1}{2}^{\circ} N$ ,  $111^{\circ} W$ , 11:46:58  
 Magnitude  $6\frac{1}{2}$  (Pas)

Apr. 13,

U eP 09:15:55  
 $66^{\circ} N$ ,  $156^{\circ} W$ , 09:07:24  
 Magnitude  $6\frac{1}{4}$  (Pas)

Apr. 13,

U eP 12:37:45  
 iS 12:44:43  
 iR 12:50:38  
 $53^{\circ} N$ ,  $161^{\circ} E$ , 12:29:07  
 Magnitude  $6\frac{1}{2}$  (Pas)

Apr. 14,

U eP 21:44:26  
 iS 21:54:11  
 iSS 21:59:06  
 eQ 22:04:10  
 eR 22:07:28  
 $1^{\circ} N$ ,  $79\frac{1}{2}^{\circ} W$ , 21:32:28  
 Magnitude  $6\frac{1}{4}$ -7 (Pas)

Apr. 15,

U eP 01:42:39  
 eS 01:52:22  
 eSS 01:57:13  
 eR 02:05:50  
 $1^{\circ} N$ ,  $79\frac{1}{2}^{\circ} W$ , 01:30:43

Apr. 15,

U eS 04:13:10  
eR 04:23:36  
9° N, 84° W, 03:52:39  
Magnitude 6 $\frac{3}{4}$  (Pas)

Apr. 16,

U iP 12:48:21.6 c  
14° N, 120 $\frac{1}{2}$ ° E, 12:36:24  
Depth about 150 km

Apr. 17,

U eR 06:50:27  
6° S, 155° E, 06:21:43

Apr. 17,

U eR 10:30:47  
5 $\frac{1}{2}$ ° S, 152° E, 10:04:46

Apr. 19,

U eR 04:22:01  
26 $\frac{1}{2}$ ° N, 110 $\frac{1}{2}$ ° W, 04:03:26  
Magnitude about 6 (Pas)

Apr. 21,

U eP 20:22:25  
eS 20:28:29  
eR 20:31:59  
15° S, 174 $\frac{1}{2}$ ° W, 20:14:47  
Magnitude 6 $\frac{1}{2}$  (Pas)

Apr. 23,

U eS 03:14:23  
eR 03:20:49  
45° N, 152° E, 02:57:40

Apr. 27,

U eS 19:16:12  
eR 19:19:03  
Tmax 19:48:23  
52 $\frac{1}{2}$ ° N, 169° W, 19:03:50

Apr. 28,

U eP 12:00:20  
eS 12:10:49  
eQ 12:23:23  
eR 12:27:29  
11° S, 74° W, 11:47:40  
Magnitude 6 $\frac{1}{2}$  (Pas)

May 1,

U iP 00:37:49.6 c  
H iP 00:37:51.9 c  
13 $\frac{1}{2}$ ° S, 16 $\frac{1}{2}$ ° E, 00:29:15  
Depth about 200 km.  
Magnitude 6 $\frac{1}{4}$  (Pas)

May 6,

U eQ 00:10:36  
eR 00:11:56  
Tmax 00:44:02  
HTmax 00:42:48  
57 $\frac{1}{2}$ ° N, 136 $\frac{1}{2}$ ° W, 23:53:29 (May 5)

May 9,

U eR 01:11:55  
1 $\frac{1}{2}$ ° N, 94 $\frac{1}{2}$ ° W, 00:44:12  
Magnitude 6 (Pas)

May 10,

U eQ 23:12:42  
eR 23:15:49  
65° N, 152 $\frac{1}{2}$ ° W, 22:54:40  
Magnitude 6 $\frac{1}{4}$ -6 $\frac{1}{2}$  (Pas)

May 11,

U eQ 05:43:49  
eR 05:45:44  
65° N, 152 $\frac{1}{2}$ ° W, 05:23:54  
Magnitude 6 $\frac{1}{4}$ -6 $\frac{1}{2}$  (Pas)

May 12,

U eP 18:37:51  
12° N, 162° E, 18:37:58

May 17,

U eQ 07:27:26  
eR 07:30:16  
3° S, 147 $\frac{1}{2}$ ° E, 07:02:25

May 18,

U eP 02:41:52  
eS 02:48:57  
eQ 02:53:35  
eR 02:55:26  
13° S, 167° E, 02:32:52  
Magnitude 6 $\frac{1}{4}$ -6 $\frac{1}{2}$  (Pas)

May 18

U eR 03:54  
13° S, 167° E, 03:31:18

May 18,

U eR 05:50  
13° S, 167° E, 05:26:44  
Depth about 60 km.

May 18,

U eP 12:30:18  
eS 12:37:25  
eQ 12:42:05  
eR 12:43:40  
13° S, 167° E, 12:21:18  
Magnitude 6-6 $\frac{1}{4}$  (Pas)

May 19,

U eR 00:28:35  
13° S, 167° E, 00:06:00

May 22,

U eQ 15:33:32  
eR 15:36:08  
3° S, 146° E, 15:08:00

May 25,

U eR 00:51:46  
51 $\frac{1}{2}$ ° N, 177° W, 00:35:23  
Magnitude 5 $\frac{1}{2}$ -5 $\frac{3}{4}$  (Pas)

May 25,

U eR 15:10:46  
51 $\frac{1}{2}$ ° N, 177° W, 14:54:30

May 25,

U eP 21:23:49  
eS 21:33:51  
iR 21:48:28  
3° S, 77° W, 21:11:45  
Depth about 100 km.  
Magnitude 6 $\frac{1}{2}$  (Pas)

May 26,

U iPup 11:03:31.0 c  
Tmax 11:41:10  
H ePdn 11:03:18.6 d  
Tmax 11:39:12  
53° N, 169 $\frac{1}{2}$ ° W, 10:56:30  
Magnitude 6-6 $\frac{1}{4}$  (Pas)

May 29,

U eP 07:08:44  
16 $\frac{1}{2}$ ° N, 97 $\frac{1}{2}$ ° W, 06:59:11

May 30,

U eP 16:23:19  
25° N, 122° E, 16:11:40  
Depth about 100 km

May 30,

U eP 18:11:43  
iS 18:17:08  
iQ 18:19:14  
iR 18:20:12  
Tmax 18:49:12  
HTmax 18:47:06  
52 $\frac{1}{2}$ ° N, 169° W, 18:04:50  
Magnitude 6-6 $\frac{1}{4}$

May 31,

U iP 19:41:28 c\*  
iS 19:48:41  
iQ 19:52:31  
iR 19:54:41  
Tmax 20:35:10  
15° S, 169° E, 19:32:30  
Magnitude 7 $\frac{1}{2}$  (Pas)

\*c on long period vertical  
d on short period vertical

**June 3,**

U iP 19:40:50.4 c  
 iS 19:47:59  
 eQ 19:51:48  
 iR 19:54:33  
 15° S, 168° E, 19:31:52  
 Magnitude 6½ (Pas)

**June 4,**

U iP 14:36:39.6 d  
 iS 14:42:12  
 eQ 14:43:52  
 iR 14:45:22  
 52½° N, 167° W, 14:29:50  
 Magnitude 6-6¼ (Pas)

**June 6,**

U eP 09:22:29  
 iS 09:31:41  
 iSS 09:36:15  
 iQ 09:40:22  
 iR 09:42:20  
 Tmax 10:38:13  
 8° N, 84½° W, 09:11:14  
 Magnitude 6½-6¾ (Pas)

**June 8,**

U eP 00:45:41  
 eR 00:54:30  
 Tmax 01:23:00  
 HTmax 01:20:54  
 53° N, 167° W, 00:38:52  
 Magnitude 6½-6¾ (Pas)

**June 12,**

U iP 20:59:47  
 iS 21:05:13  
 eQ 21:07:02  
 eR 21:08:08  
 H eP 20:59:37  
 Tmax 21:35:25  
 53° N, 167° W, 20:52:57  
 Magnitude 6½ (Pas)

**June 15,**

U iP 15:01:57  
 iS 15:07:50  
 H iP 15:02:02  
 18° S, 178½° W, 14:54:37  
 Depth about 600 km  
 Magnitude 6¼ (Pas)

**June 16,**

U eQ 08:29:46  
 eR 08:31:36  
 14½° S, 177½° W, 08:13:07

**June 17,**

U eP 19:16:30  
 eR 19:33:43  
 25° N, 142½° E, 19:06:43  
 Depth about 60 km

**June 19,**

U eP 05:26:53  
 eS 05:33:48  
 eR 05:39:09  
 49½° N, 156° E, 05:18:00  
 Magnitude 6½ (Pas)

**June 20,**

U eQ 01:04:25  
 eR 01:07:45  
 16° S, 173° W, 00:47:58

**June 25,**

U eP 09:47:03.2 d  
 eS 09:55:30  
 eQ 10:02:10  
 iR 10:04:50  
 H iP 09:46:59.6 d  
 3° S, 144½° E, 09:36:30  
 Magnitude 6¼-6½ (Pas)

**June 26,**

U iP 04:46:58.6 c  
 ipP 04:47:27  
 iR 05:00:20  
 54½° N, 15½° E, 04:38:12  
 Depth slightly greater than normal  
 Magnitude 6½-6¾ (Pas)

**June 26,**

U eR 23:55:15  
 31° N, 141½° E, 23:29:32

**June 27,**

U eP 05:55:03  
 eR 06:14  
 13° N, 88½° W, 05:44:28  
 Depth about 60 km  
 Magnitude 6 (Pas)

**June 29,**

U eR 09:34  
 16½° S, 172° W, 09:14:37

**June 30,**

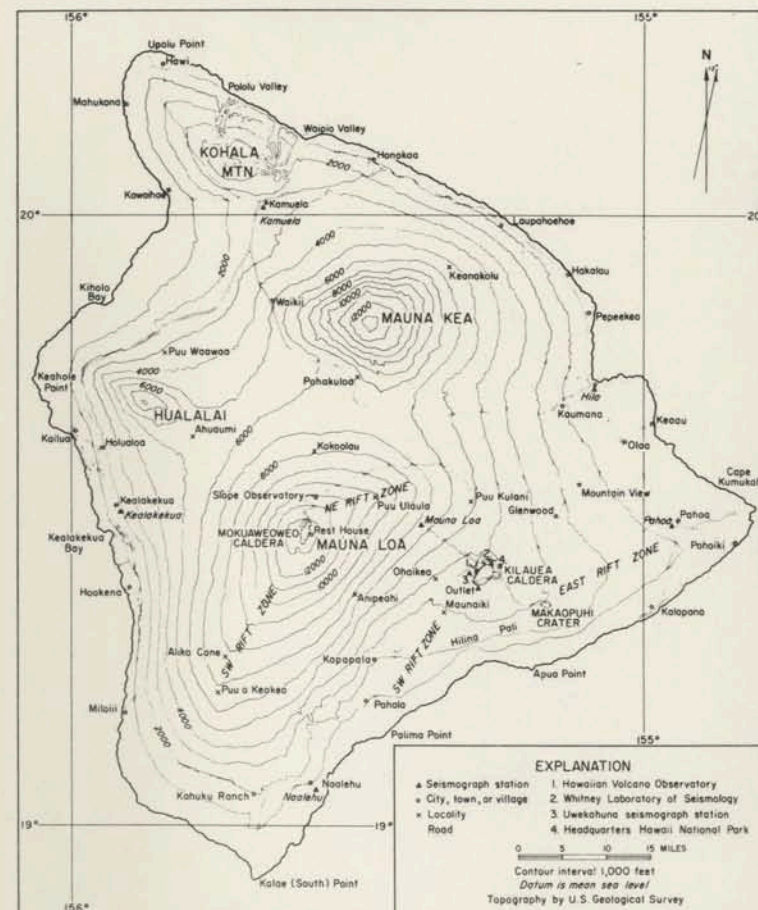
U eS 18:44:05  
 iR 18:50:05  
 31° N, 141½° E, 18:26:20  
 Magnitude 6¼ (Pas)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY  
SUMMARY 11

July-September 1958  
By

J. P. Eaton and Harold L. Krivoy



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

UNITED STATES  
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HAWAIIAN VOLCANO OBSERVATORY  
SUMMARY II

July-September 1958

137

J. P. Eaton and Harold J. Riepe



The figure shows the locations of the stations used in the Hawaiian Volcano Observatory summary for July-September 1958. The stations are: Kilauea, Mauna Loa, Desert, Uwekahuna, Outlet, and Hawaii.

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 shorter than once a year. 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. Chronological Summary

*July*

The first week of July brought the most impressive seismic display recorded in Hawaii since the end of the 1955 eruption of Kilauea. From July 3 through July 6 a great swarm of small earthquakes accompanied by many hours of spasmodic tremor stemmed from a source about 10 km northeast of Kilauea caldera and 55 km deep. Although 48 of these earthquakes were larger than magnitude 2.5, the largest being magnitude 3.4, none was reported felt. Seismographs in the Mauna Loa station and in the new "Desert" station 4 km southwest of Mauna Iki recorded over 2100 separate earthquakes and almost 60 hours of nearly continuous spasmodic tremor during this swarm. On seismographs nearer the caldera in the Outlet and Uwekahuna stations the swarm was less impressive. Fewer earthquakes were discernable at these stations; and records of earthquakes that were recorded were smaller and had less distinct P phases than at Mauna Loa or Desert. Short period earthquake waves such as those characterizing these earthquakes are strongly attenuated when they pass up through the crust beneath Kilauea caldera.

Seismographs at Uwekahuna registered about 1100 earthquakes during July. 150 of these quakes originated at shallow depths beneath the caldera during the last week of the month.

An earthquake from a focus about 12 km south of Cape Kumukahi and 35 km deep was felt in Hilo, Pahoa, and the Volcano district at 2:12 p. m. on July 2. The largest earthquake of the month, magnitude 3.8, occurred about 55 km west of Kailua, Kona,

at 4:21 a. m. on July 13. It was felt in Kealakekua. The earthquake felt in Capt. Cook at 7:18 p. m. on July 16 originated about 25 km north of Naalehu at a depth of 35 km.

Tilting of the earth's surface at the Whitney station on the northeast rim of Kilauea caldera was about normal for July.

### August

Most of the 400 earthquakes recorded by seismographs at Uwekahuna during August were very small and stemmed from shallow foci beneath Kilauea caldera.

Three earthquakes were felt in the vicinity of Kilauea caldera during the month. The first of these originated about 5 km southwest of the Outlet seismograph station at a depth of about 30 km at 9:01 a. m. on August 11. The other two occurred about 15 km beneath Kilauea caldera on August 20; the first, at 9:46 a. m. and the second, at 01:14 p. m.

The largest earthquake of the month originated near Hookena at 12:43 a. m. on August 21. It had a magnitude of 3.8 and was felt in Kealakekua and Capt. Cook.

Moderate northeastward tilting recorded at the Whitney station was about normal for August.

### September

Only 275 earthquakes were registered by seismographs at Uwekahuna during September. Most of these earthquakes originated beneath Kilauea caldera, and some of them had unusually shallow foci.

At 4:06 p. m. on September 8 an earthquake with a magnitude of only 0.6 that originated along the northeast rim of Kilauea caldera was felt just south of Hawaii National Park Headquarters. On September 9 at 11:04 a. m. another earthquake from the same region was felt at Hawaii National Park Headquarters. A magnitude 3.8 earthquake, the largest of the month, that occurred 10 km north of Naalehu at a depth of 25 km was felt from Hilo to Kealakekua at 8:48 p. m. on September 28.

The strong northeastward tilting of the earth's surface recorded at the Whitney station was normal for September.

## 2. Local Earthquake Summary

Week beginning	Number of Earthquakes*		Minutes of continuous tremor*
	magnitude $\geq 2.5$	magnitude $< 2.5$	
June 29	49	700	470
July 6	5	150	0
13	5	44	0
20	2	67	29
27	3	129	45
Aug. 3	6	30	0
10	2	135	18
17	4	35	123
24	0	43	6
31	1	51	18
Sept. 7	2	137	6
14	3	42	7
21	0	31	0
28	2	43	0

\*Recorded at Uwekahuna on a vertical component electromagnetic seismograph with a peak magnification of 20,000 and galvanometer and seismometer periods of 0.5 second.

## 3. Tilt coordinates\* at seismograph stations on the rim of Kilauea caldera.

Date	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
July 6	474	481	506	483
13	476	482	507	482
20	475	482	507	479
27	476	483	504	480
Aug. 3	479	484	505	483
10	480	487	507	477
17	480	486	505	475
24	479	484	507	474
31	482	485	510	474
Sept. 7	487	485	512	478
14	492	486	512	478
21	492	488	512	476
28	496	492	511	474

\*All tilt coordinates were arbitrarily set equal to 500 on January 5, 1958. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface: i.e. to a relative subsidence toward the north and east. A one unit change in coordinate reveals a tilting of one part per million (one mm per km) in the direction indicated.

### LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs operated by the Hawaiian Volcano Observatory on the islands of Hawaii and Maui. Except for smaller earthquakes of special interest, only earthquakes with magnitudes of 2.5 or greater were included in the list. The entries for a given earthquake are: date, origin time (Hawaiian standard time), epicenter, and general remarks.

- July 2, 06:40:38, 15 km west of Keahole Point. Magnitude 2.5.  
 July 2, 14:11:48, 19° 25' N, 154° 48' W, about 12 km south of Cape Kumukahi at a depth of about 35 km. Felt in Hilo, Pahoa, and the Volcano district. Magnitude 3.6.
- July 3-6, On these days a major swarm of earthquakes and associated spasmodic tremor originated about 55 km beneath a region about 10 km northeast of Kilauea caldera. The largest of approximately 2100 earthquakes from this source (abbreviated Kilauea-Mauna Loa deep) are listed separately below. None of these earthquakes was reported felt.
- July 3, 23:32:24, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 3, 23:49:10, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 4, 01:51:52, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 4, 05:14:51, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 05:40:32, 30 km east of Naalehu at a depth of about 15 km. Magnitude 2.5.  
 July 4, 06:34:49, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 08:07:01, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 4, 08:46:06, Kilauea-Mauna Loa deep. Magnitude 3.2.  
 July 4, 09:33:58, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 4, 09:37:30, Kilauea-Mauna Loa deep. Magnitude 3.2.  
 July 4, 10:44:45, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 11:35:15, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 11:39:33, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 11:59:58, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 13:15:18, Kilauea-Mauna Loa deep. Magnitude 2.8.  
 July 4, 14:06:00, Kilauea-Mauna Loa deep. Magnitude 3.3.  
 July 4, 14:20:02, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 14:25:46, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 14:53:08, 30 km west of Hookena at a depth of about 10 km. Magnitude 3.1.  
 July 4, 15:27:36, Kilauea-Mauna Loa deep. Magnitude 2.8.  
 July 4, 15:40:47, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 15:47:36, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 15:51:22, Kilauea-Mauna Loa deep. Magnitude 2.5.

- July 4, 17:09:18, Kilauea-Mauna Loa deep. Magnitude 3.4.  
 July 4, 18:06:37, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 19:19:44, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 20:52:35, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 4, 20:54:25, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 4, 22:09:56, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 4, 22:37:11, Kilauea-Mauna Loa deep. Magnitude 2.9.  
 July 4, 23:45:02, Kilauea-Mauna Loa deep. Magnitude 2.9.  
 July 5, 00:34:38, Kilauea-Mauna Loa deep. Magnitude 2.9.  
 July 5, 02:16:04, Kilauea-Mauna Loa deep. Magnitude 3.3.  
 July 5, 03:04:44, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 5, 04:06:57, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 5, 05:16:49, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 5, 05:40:19, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 5, 05:51:00, Kilauea-Mauna Loa deep. Magnitude 3.1.  
 July 5, 07:36:09, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 5, 08:05:01, Kilauea-Mauna Loa deep. Magnitude 2.9.  
 July 5, 11:49:17, Kilauea-Mauna Loa deep. Magnitude 2.8.  
 July 5, 13:20:53, Kilauea-Mauna Loa deep. Magnitude 2.8.  
 July 5, 15:16:52, Kilauea-Mauna Loa deep. Magnitude 3.0.  
 July 5, 16:12:19, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 5, 18:43:21, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 5, 18:58:39, Kilauea-Mauna Loa deep. Magnitude 2.5.  
 July 6, 02:57:40, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 6, 08:50:02, Kilauea-Mauna Loa deep. Magnitude 2.7.  
 July 6, 11:26:30, Kilauea-Mauna Loa deep. Magnitude 2.6.  
 July 6, 13:25:30, Kilauea-Mauna Loa deep. Magnitude 3.2.  
 July 11, 04:07:15, 15 km northwest of Naalehu at a depth of about 15 km. Magnitude 2.5.  
 July 13, 04:20:52, 55 km west of Kailua, Kona. Felt in Kealakekua. Magnitude 3.8.  
 July 13, 12:04:36, 20 km north of Naalehu at a depth of about 5 km. Magnitude 2.7.  
 July 16, 19:17:58, 25 km north of Naalehu at a depth of about 35 km. Felt in Capt. Cook. Magnitude 3.3.  
 July 17, 15:53:54, 5 km south of Puu Ulaula at a depth of about 10 km. Magnitude 2.6.  
 July 19, 22:57:58, 25 km west of Kealakekua Bay. Magnitude 2.6.  
 July 23, 06:17:39, 15 km east of Apua Point at a depth of about 30 km. Magnitude 2.5.  
 July 26, 06:27:57, 25 km west of Keahole Point. Magnitude 2.9.  
 July 28, 16:26:01, about 30 km from the Haleakala seismograph station at a depth of at least 15 km. Magnitude 2.5.  
 Aug. 2, 09:52:26, 10 km west of Pahala at a depth of about 5 km. Magnitude 2.7.  
 Aug. 2, 19:00:28, 10 km north of Naalehu at a depth of about 5 km. Magnitude 2.6.  
 Aug. 5, 21:52:32, 5 km northwest of Apua Point at a depth of 5 km. Magnitude 2.7.



- Aug. 6, 09:39:13, 50 km from the Haleakala seismograph station. Magnitude 2.9.
- Aug. 8, 11:33:51, 5 km southeast of Hakalau at a depth of about 35 km. Magnitude 2.6.
- Aug. 8, 13:11:06, 5 km southwest of Pahala at a depth of about 40 km. Magnitude 3.0.
- Aug. 8, 18:20:49, 10 km southwest of the Mauna Loa seismograph station at a shallow depth. Magnitude 3.0.
- Aug. 9, 12:53:42, On the Kealakekua fault about 5 km southwest of Kealakekua at a depth of about 10 km. Magnitude 3.2.
- Aug. 11, 09:01:28, 5 km southwest of the Outlet seismograph station at a depth of about 30 km. Felt near Kilauea caldera. Magnitude 3.7.
- Aug. 15, 01:50:03, 5 km southwest of Hookena at a depth of about 15 km. Magnitude 3.1.
- Aug. 17, 00:27:32, 10 km west of Mahukona at a depth of about 45 km. Magnitude 3.3.
- Aug. 20, 09:46:07, beneath Kilauea caldera at a depth of about 15 km. Felt near the east rim of Kilauea caldera and in Hilo. Magnitude 3.7.
- Aug. 20, 13:13:55, beneath Kilauea caldera at a depth of about 15 km. Felt near the east rim of Kilauea caldera. Magnitude 2.5.
- Aug. 21, 00:42:57, near Hookena at a depth of about 5 km. Felt in Kealakekua and Capt. Cook. Magnitude 3.8.
- Sept. 1, 00:05:24, 10 km east of Puu o Keokeo at a depth of about 5 km. Magnitude 2.9.
- Sept. 7, 02:02:07, 10 km south of Apua Point at a depth of about 10 km. Magnitude 3.4.
- Sept. 8, 07:01:59,  $20^{\circ} 52' N$ ,  $155^{\circ} 53' W$ , 15 km northeast of Hana, Maui, at a depth of 40 km. Magnitude 3.4.
- Sept. 8, 16:06:10, near the northeast rim of Kilauea caldera at a very shallow depth. Felt just south of Hawaii National Park Headquarters. Magnitude 0.6.
- Sept. 9, 11:07:39, near the northeast rim of Kilauea caldera at a shallow depth. Felt at Hawaii National Park Headquarters. Magnitude 1.7.
- Sept. 17, 01:47:35, 25 km west of Keahole Point. Magnitude 2.9.
- Sept. 18, 04:13:48, 13 km southeast of Makaopuhi at a depth of about 45 km. Magnitude 3.1.
- Sept. 20, 20:09:18, 10 km east of Kamuela at a depth of about 40 km. Magnitude 2.7.
- Sept. 28, 20:48:06, 10 km north of Naalehu at a depth of about 25 km. Felt from Hilo to Kealakekua. Magnitude 3.8.
- Sept. 29, 01:08:49, 20 km north of Kamuela at a depth of about 25 km. Magnitude 2.5.

## DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on seismographs of the Hawaiian Volcano Observatory on Hawaii (U=Uwekahuna,  $19^{\circ} 25.4' N$ ,  $155^{\circ} 17.6' W$ , 1240m), and Maui (H=Haleakala,  $20^{\circ} 46.0' N$ ,  $156^{\circ} 15.0' W$ , 2090m). Beginnings of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. A "c" following the time of P indicates that the first motion was a compression; a "d", that it was a dilatation. Locations of epicenters, origin times, focal depths, and magnitudes are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

July 1,

U eP 06:00:13 c  
 eS 06:05:54  
 eR 06:09:40

$54\frac{1}{2}^{\circ} N$ ,  $176\frac{1}{2}^{\circ} W$ , 05:53:07  
 Magnitude 6 (Pas)

July 3,

U eP 06:36:32 d  
 iS 06:43:42  
 eR 06:49:47

$29^{\circ} S$ ,  $179^{\circ} W$ , 06:27:44  
 Depth about 400 km  
 Magnitude 6 (Pas)

July 3,

U eR 00:58:22  
 $55^{\circ} S$ ,  $126^{\circ} W$ , 10:23:02

July 4,

U eR 19:10:21  
 $6^{\circ} N$ ,  $125^{\circ} E$ , 18:34:03

July 10,

U iP 06:23:39.6 d  
 iScP 06:29:12  
 iS 06:30:02  
 iL 06:33:03  
 Tmax 07:07:00  
 H eP 06:23:34.8  
 eS 06:29:50  
 eL 06:32:40  
 Tmax 07:05:52

$58.6^{\circ} N$ ,  $137.1^{\circ} W$ , 06:15:51  
 Magnitude 8 (Pas)

July 10,

U iP 08:06:09 c  
 Aftershock

July 10,

U eP 12:34:37 c  
 Aftershock

July 11,

U e 19:35:48  
 eR 19:52:56  
 $21^{\circ} S$ ,  $69^{\circ} W$ , 19:10:20  
 Magnitude  $6\frac{1}{2}$  (Pas)

July 11,

UTmax 20:41:04  
 HTmax 20:40:01  
 $57\frac{1}{2}^{\circ} N$ ,  $137\frac{1}{2}^{\circ} W$ , 19:50:08

July 12,

U eS 01:05:46  
 iR 01:13:04  
 Tmax 01:56:20  
 $5^{\circ} S$ ,  $106\frac{1}{2}^{\circ} W$ , 00:48:30  
 Magnitude 6 (Pas)

July 12,

U eR 02:56:48  
 $4\frac{1}{2}^{\circ} S$ ,  $105\frac{1}{2}^{\circ} W$ , 02:31:55

**July 12,**

U eP 03:37:26.3  
 eR 03:48  
 Tmax 04:17:55  
 HTmax 04:17:53  
 12° N, 165° E, 03:29:58

**July 13,**

UTmax 09:01:09  
 HTmax 08:59:57  
 58.3° N, 136.9° W, 08:10:02  
 Magnitude 5½-5¾ (Pas)

**July 13,**

U iP 12:12:53.3 d  
 H iP 12:12:53.0 d  
 10° S, 161½° E, 12:03:50  
 Depth about 100 km

**July 16,**

U eR 04:08:59  
 51½° N, 176½° W, 03:52:39

**July 16**

U eS 13:13:33  
 iQ 13:20:41  
 29½° S, 113° W, 12:54:18  
 Magnitude 6 (Berk)

**July 16,**

U eS 17:10:30  
 eR 17:16:56  
 12° S, 166½° E, 16:54:17

**July 16,**

U eR 19:02:52  
 12° S, 166½° E, 18:40:21

**July 17,**

UTmax 14:39:50  
 HTmax 14:38:29  
 57½° N, 137° W, 13:48:45

**July 17,**

U eS 19:14:55  
 iR 19:18:37  
 51° N, 176° W, 19:02:10  
 Magnitude 5¾ (Berk)

**July 17,**

U eP 21:06:25  
 eS 21:12:04  
 iR 21:15:39  
 51° N, 177½° W, 20:59:17  
 Magnitude 6 (Berk)

**July 18,**

U eP 00:46:34  
 eS 00:52:04  
 iR 00:55:30  
 51° N, 176½° W, 00:39:18  
 Magnitude 5¾ (Berk)

**July 18.**

U iP 01:59:17.0 c  
 4° S, 78° W, 01:47:21  
 Depth about 100 km

**July 18,**

HTmax 17:54:03  
 58½° N, 138½° W, 17:03:58

**July 19,**

U iP 06:41:16.7 c  
 4° S, 138½° E, 06:30:19  
 Depth about 150 km

**July 19,**

U iP 09:11:16.6 d

**July 19,**

U eP 18:28:40.4 c  
 eQ 18:47:45  
 eR 18:49:05  
 H eP 18:28:41  
 0°, 129½° E, 18:16:52

**July 21,**

U eS 07:41:44  
 iR 07:48:44  
 44½° N, 147½° E, 07:24:58  
 Magnitude 6-6¼ (Berk)

**July 21,**

U iP 14:44:29  
 iS 14:50:12  
 iR 14:53:53  
 Tmax 15:23:30  
 HTmax 15:21:22  
 51½° N, 178° W, 14:37:18  
 Magnitude 6¼ (Berk)

**July 22,**

UTmax 04:46:49  
 HTmax 04:45:42  
 58½° N, 138° W, 03:55:35

**July 23,**

U eP 10:37:08  
 iS 10:45:08  
 iR 10:56:51  
 31° N, 142° E, 10:27:19

**July 24,**

U eR 13:23:28  
 52½° N, 170° W, 13:08:05

**July 26,**

UTmax 21:21:49  
 12° N, 161½° E, 20:29:59

**July 26,**

U iP 17:49:12 d  
 epP 17:51:26  
 iS 17:38:49  
 i 18:00:31  
 isS 18:03:14  
 iSS 18:04:07  
 13½° S, 69° W, 17:37:09  
 Depth about 650 km  
 Magnitude 7-7¼ (Pas)

**July 30,**

U eL 03:11:23  
 44½° N, 148½° E, 02:47:17

**July 30,**

U eP 04:55:55  
 eS 05:05:39  
 eR 05:15:43  
 2½° S, 140° E, 04:44:53

**July 30,**

U eL 15:46:13  
 South Pacific Ocean, 15:10:18

**Aug. 1,**

U i 05:46:53  
 iS 05:50:43  
 esS 05:54:02  
 16° S, 176½° W, 05:37:50  
 Depth about 450 km

**Aug. 3,**

U i 01:14:12.0 c  
 21½° S, 179° W, 01:06:24

**Aug. 4,**

U iP 04:25:06.3 c  
 eQ 04:45:08  
 eR 04:48:36  
 H eP 04:25:02.2  
 6° S, 130° E, 04:13:19  
 Depth about 150 km

**Aug. 6,**

U eP 21:16:47  
 eS 21:22:55  
 eR 21:27:15  
 H iP 21:16:56  
 17° S, 173° W, 21:09:09  
 Magnitude 6¼ (Pas)

**Aug. 10,**

U eR 18:31:43  
 3½° S, 151° E, 18:05:54

**Aug. 11,**

U eR 08:16:44  
 18° S, 168½° E, 07:53:12

Aug. 12,

U eR 08:32:29  
 51½° N, 175° W, 08:15:59

Aug. 12,

U eP 19:37:15  
 eS 19:47:11  
 iG 19:57:43  
 eR 20:01:04

0°, 126½° E, 19:25:05

Aug. 13,

U eR 04:27:29  
 ½° N, 126° E, 03:50:35

Aug. 13,

U eP 20:20:00  
 eS 20:25:40  
 eR 20:29:33

51° N, 177½° W, 20:13:00

Aug. 14,

U eP 15:02:09.6  
 iS 15:07:49  
 iR 15:10:57

52° N, 175° W, 14:55:10  
 Magnitude 6½ (Pas)

Aug. 15,

U eR 02:54:27  
 6° S, 150½° E, 02:26:51

Aug. 15,

U eP 20:04:20.2  
 ePP 20:06:43  
 iS 20:11:17  
 iSS 20:14:58  
 eQ 20:15:30  
 iR 20:17:05  
 H eP 20:04:12  
 eR 20:16:46  
 Tmax 20:54:57

53° N, 160½° E, 19:55:39  
 Depth about 60 km,  
 Magnitude 6¾ (Pas)

Aug. 15,

U iP 22:41:10.7 d  
 ipP 22:42:02  
 iS 22:51:02  
 esS 22:52:01  
 iG 23:01:56  
 eR 23:02:56

1½° N, 125° E, 22:29:17  
 Depth about 200 km  
 Magnitude 6¾-7 (Pas)

Aug. 16,

U eP 13:24:54  
 iS 13:30:33  
 iR 13:34:06  
 HTmax 14:01:43

51½° N, 176° W, 13:17:52  
 Magnitude 6-6¼ (Pas)

Aug. 16,

U eG 20:05:45  
 eR 20:14:25

34½° N, 48° E, 19:13:45

Aug. 17,

U eS 09:21:18  
 iR 09:24:47

51½° N, 176° W, 09:08:35

Aug. 17,

U eR 11:07:10  
 51° N, 176° W, 10:50:40

Aug. 17,

U eR 11:32:25  
 51½° N, 176° W, 11:16:13

Aug. 17,

U eP 18:12:27  
 eS 18:20:15  
 eQ 18:26:25  
 iR 18:29:21

3° S, 145½° E, 18:01:05

Aug. 17,

U iP 21:21:18.1 c  
 eR 21:40:48  
 35½° S, 179½° W, 21:11:09

Aug. 19,

U eP 04:55:48  
 eS 05:01:29  
 iR 05:07:31

19° S, 175° E, 04:45:45

Aug. 19,

U eR 16:22:45

51½° N, 175½° W, 16:06:18

Aug. 19,

U eR 16:51:33

53° N, 160° E, 16:29:44

Aug. 19,

U iS 12:06:16  
 iR 12:14:33

1° S, 149½° E, 21:48:07

Aug. 20,

U iP 03:49:08  
 iS 03:56:23  
 eQ 04:02:28  
 iR 04:03:23

14° S, 167° E, 03:40:07  
 Magnitude 6¼-6½ (Pas)

Aug. 21,

U eP 21:07:30  
 18° S, 176° W, 20:59:10  
 Depth about 250 km.

Aug. 24,

U iP 17:06:14.8 d  
 14° N, 121° E, 16:54:25  
 Depth about 150 km.

Aug. 26,

U eR 12:43:58

14° S, 167° E, 12:20:43

Aug. 26,

U eS 13:01:36  
 eR 13:07:48

14° S, 167° E, 12:45:02

Aug. 26,

U eS 18:11:58  
 eR 18:18:38

14° S, 167° E, 17:55:34

Aug. 26,

U eS 23:48:12  
 eR 23:54:30

14° S, 167° E, 23:31:38

Aug. 27,

U iS 02:43:05  
 eR 02:50:34

4½° S, 104½° W, 02:25:32

Aug. 29,

U eS 12:40:40  
 eR 12:47:00

14½° S, 167° E, 12:24:23  
 Magnitude 5¾-6 (Pas)

Aug. 30,

U eS 18:52:17  
 iR 18:57:35

27½° N, 112° W, 18:38:18

Aug. 31,

U eS 23:15:02  
 iR 23:20:32

63° N, 144½° W, 23:00:16  
 Magnitude 5¾-6 (Pas)

Sept. 1,

U eR 01:18:32

24° S, 175½° W, 00:57:10

Sept. 2,

U eR 02:40:26

10½° S, 164½° E, 02:27:41

**Sept. 2,**

U eR 03:21:37  
 $6\frac{1}{2}^{\circ}$  S,  $155^{\circ}$  E, 02:56:34  
 Depth about 100 km.

**Sept. 2,**

U eR 20:34:33  
 $15^{\circ}$  N,  $92\frac{1}{2}^{\circ}$  W, 20:07:04

**Sept. 3,**

U ePKS 04:07:20  
 ePPS 04:18:09  
 eSS 04:24:41  
 eR 04:44:53  
 $0^{\circ}$ ,  $18^{\circ}$  W, 03:44:24

**Sept. 3,**

U eS 08:28:11  
 iR 08:35:48  
 $40\frac{1}{2}^{\circ}$  N,  $143^{\circ}$  E, 08:10:26  
 Depth about 60 km.

**Sept. 4,**

U eP 22:04:47  
 eS 22:15:34  
 eQ 22:31:36  
 iR 22:35:32  
 $33\frac{1}{2}^{\circ}$  S,  $69\frac{1}{2}^{\circ}$  W, 21:51:08  
 Magnitude  $6\frac{1}{4}$ -7 (Pas)

**Sept. 7,**

U eR 05:09:46  
 $10^{\circ}$  S,  $153^{\circ}$  E, 04:40:57

**Sept. 8,**

U eP 05:34:20  
 eS 05:41:17  
 iS 05:49:25  
 HTmax 06:24:41  
 $53\frac{1}{2}^{\circ}$  N,  $159^{\circ}$  E, 05:25:37

**Sept. 9,**

U eR 11:55:18  
 $46^{\circ}$  N,  $151^{\circ}$  E, 11:32:05

**Sept. 9,**

U eR 22:41:48  
 $54^{\circ}$  N,  $171^{\circ}$  E, 22:23:37

**Sept. 11,**

U eR 18:34:39  
 $7\frac{1}{2}^{\circ}$  N,  $126\frac{1}{2}^{\circ}$  E, 18:01:44

**Sept. 14,**

U iP 14:32:58  
 eR 14:56:51  
 $57^{\circ}$  N,  $121^{\circ}$  E, 14:21:37  
 Magnitude  $6\frac{1}{4}$ - $6\frac{1}{2}$  (Pas)

**Sept. 15,**

U eQ 05:58:30  
 $8\frac{1}{2}^{\circ}$  N,  $103\frac{1}{2}^{\circ}$  W, 05:36:18

**Sept. 15,**

U iP 19:57:11.8 c  
 epP 19:59:24  
 isP 20:00:26  
 eS 20:06:38  
 eSP 20:07:29  
 esS 20:10:47  
 esPS 20:21:23  
 H iP 19:57:08.7  
 $2\frac{1}{2}^{\circ}$  N,  $120\frac{1}{2}^{\circ}$  E, 19:45:40  
 Depth about 600 km  
 Magnitude 6- $6\frac{1}{4}$  (Pas)

**Sept. 17,**

U eR 12:46:13  
 $48\frac{1}{2}^{\circ}$  N,  $155^{\circ}$  E, 12:23:50

**Sept. 19,**

U iP 08:24:34.0 d  
 $2\frac{1}{2}^{\circ}$  N,  $127^{\circ}$  E, 08:12:33

**Sept. 20,**

U iP 17:19:02.8 c  
 iS 17:26:45  
 eQ 17:31:25  
 iR 17:34:21  
 H iP 17:19:01.5 c

**Sept. 24,**

U eP 03:52:20  
 eS 03:58:29  
 iQ 04:01:07  
 iR 04:02:45  
 Tmax 04:35:51

**Sept. 25,**

U ePS 07:48:58  
 eSS 07:54:34  
 eG 08:05:38  
 eR 08:10:48  
 $9^{\circ}$  N,  $39\frac{1}{2}^{\circ}$  W, 07:20:01  
 Magnitude  $6\frac{1}{2}$  (Pas)

Erratum: Tilt coordinates for the Whitney station reported in Summary 10, April-June 1958, were in error. Correct coordinates are as follows:

Date	Whitney station (northeast rim)	
	N-S	E-W
Apr. 6	476	487
13	475	484
20	476	482
27	475	484
May 4	473	481
11	475	481
18	474	478
25	476	483
June 1	471	480
8	472	477
15	472	477
22	472	478
29	472	480

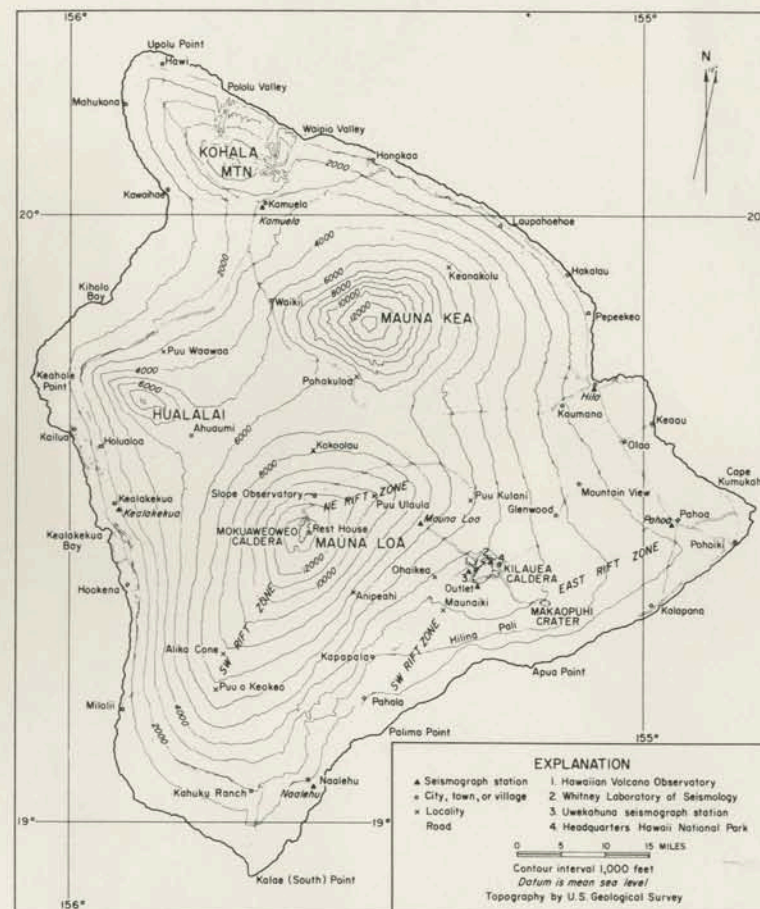
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY  
SUMMARY 12

October-December 1958

By

J. P. Eaton and Harold L. Krivoy



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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Map of the Hawaiian Islands showing the locations of the volcanoes and seismic stations. The map is oriented with North at the top. The Hawaiian Islands are shown in a series of parallel lines, with the main islands labeled. The map is a line drawing and is quite faint.

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 shorter than once a year. 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. Chronological Summary

*October*

Continuing mild, shallow seismic activity at Kilauea caldera accounted for most of the 338 earthquakes recorded at Uwekahuna during October.

An earthquake felt in Kealahou at 10:15 p. m. on October 22 originated beneath the ocean about 20 km west of Hookena. Its magnitude was 2.8.

On October 22, 23, and 24 a group of moderate earthquakes stemmed from a shallow focus beneath the ocean about 25 km south of Uwekahuna. The two largest earthquakes of this group, both of magnitude 4.3, were reported felt. The quake at 11:43 p.m. on October 22 was felt from Hawaii National Park to Kealahou; that at 12:23 p. m. on October 23 was felt at Pahala.

Strong northeasterly tilting recorded at the Whitney station was normal for the month.

*November*

Only 138 earthquakes were recorded at Uwekahuna during November. Most of these were small and occurred near Kilauea caldera.

The largest earthquake of the month originated about 30 km beneath the southeast rim of Kilauea caldera at 5:56 a. m. on November 2. Its magnitude was 4.4, and it was felt from Hawaii National Park to Hilo.

A magnitude 3.0 earthquake that was felt in Kealahou at 8:48 p. m. on November 14 stemmed from a shallow focus about 8 km southwest of Kealahou.

Moderate northeastward tilting at the Whitney station was normal for the month.

### December

216 earthquakes were recorded by seismographs at Uwekahuna during December.

The only earthquake reported felt during the month occurred about 7 km northwest of Hilo at a depth of 45 km at 9:17 a. m. on December 27. This earthquake, with a magnitude of 4.5, was felt over most of Hawaii. It was the largest quake in the Hawaiian Islands since the magnitude 5.6 earthquake that occurred 45 km east of Hana, Maui, on August 18, 1957.

Tilting of the ground at the Whitney station was about normal for the month.

### 2. Local Earthquake Summary

Week beginning	Number of Earthquakes *		Minutes of continuous tremor*
	magnitude $\geq 2.5$	magnitude $< 2.5$	
Oct. 2	1	117	2
9	1	45	0
16	4	74	3
23	7	70	13
30	4	32	0
Nov. 6	2	18	0
13	2	32	0
20	1	35	3
27	0	34	0
Dec. 4	1	32	7
11	1	36	0
18	3	34	0
25	2	97	0

\* Recorded at Uwekahuna on a vertical component electromagnetic seismograph with a peak magnification of 20,000 and galvanometer and seismometer periods of 0.5 second.

### 3. Tilt coordinates\* at seismograph stations on the rim of Kilauea caldera.

Date	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
Oct. 2	499	496	512	470
9	502	496	511	469
16	505	495	512	468

Table-Continued

Date	Whitney station (northeast rim)		Uwekahuna station (west rim)	
	N-S	E-W	N-S	E-W
23	506	502	510	469
30	508	506	512	454
Nov. 6	509	510	511	453
13	512	512	512	462
20	515	516	511	459
27	513	516	512	460
Dec. 4	515	518	512	457
11	516	518	511	458
18	516	516	510	458
25	517	515	510	457

\*All tilt coordinates were arbitrarily set equal to 500 on January 5, 1958. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface: i. e. to a relative subsidence toward the north and east. A one unit change in coordinate reveals a tilting of one part per million (one mm per km) in the direction indicated.

### LOCAL EARTHQUAKES

The data for the following local earthquakes were determined from seismographs operated by the Hawaiian Volcano Observatory on the islands of Hawaii and Maui. Except for smaller earthquakes of special interest, only earthquakes with magnitudes of 2.5 or greater were included in the list. The entries for a given earthquake are: date, origin time (Hawaiian standard time), epicenter, and general remarks.

- Oct. 8, 14:42:41, 10 km southwest of Hilo at a depth of about 25 km. Magnitude 2.5.
- Oct. 9, 04:57:10, 15 km northwest of Mokuaweoweo at a depth of about 5 km. Magnitude 2.5.
- Oct. 21, 10:20:45, 20 km southwest of Kalapana at a depth of about 10 km. Magnitude 2.8.
- Oct. 22, 22:14:47, 20 km west of Hookena at a depth of about 15 km. Felt in Kealakekua. Magnitude 2.8.
- Oct. 22, 23:43:28, offshore south of Kilauea at  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Felt from Hawaii National Park to Kealakekua. Magnitude 4.3.
- Oct. 22, 23:50:53,  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Magnitude 3.9.
- Oct. 23, 03:21:19,  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Magnitude 3.2.

- Oct. 23, 04:38:55,  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Magnitude 3.5.
- Oct. 23, 12:23:23,  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Felt at Pahala. Magnitude 4.3.
- Oct. 24, 17:24:12,  $19^{\circ} 12.5' N$ ,  $155^{\circ} 19' W$  at a shallow depth. Magnitude 2.7.
- Oct. 25, 00:01:49, south rim of Kilauea caldera at a depth of about 15 km. Magnitude 2.5.
- Oct. 26, 19:39:28, 10 km northeast of the summit of Mauna Kea at a depth of about 15 km. Magnitude 2.7.
- Oct. 29, 19:55:27, 20 km southeast of Kamuela at a shallow depth. Magnitude 2.8.
- Oct. 30, 13:17:19, 15 km northwest of Mokuaweoweo at a depth of about 30 km. Magnitude 2.6.
- Oct. 31, 03:55:37, offshore 10 km northeast of Honokaa at a depth of 5 km. Magnitude 3.1.
- Nov. 1, 08:52:16, 10 km northwest of Pahala at a depth of about 15 km. Magnitude 3.0.
- Nov. 2, 05:55:44, 4 km southeast of Uwekahuna at a depth of about 30 km. Felt from Hawaii National Park to Hilo. Magnitude 4.4.
- Nov. 7, 08:59:07, about 5 km west of Puu o Keokeo at a depth of about 15 km. Magnitude 3.2.
- Nov. 10, 01:36:54, 5 km northwest of Apua Point at a depth of about 25 km. Magnitude 3.0.
- Nov. 14, 20:47:47, 8 km southwest of Kealakekua at a depth of about 5 km. Felt at Kealakekua. Magnitude 3.0.
- Nov. 14, 20:49:46, 8 km southwest of Kealakekua at a shallow depth. Magnitude 2.6.
- Nov. 23, 12:10:19, 20 km southeast of Naalehu at a depth of about 25 km. Magnitude 3.0.
- Dec. 7, 21:41:15, 8 km southwest of Kalapana at a depth of about 25 km. Magnitude 2.6.
- Dec. 15, 23:37:16, 15 km southeast of Kamuela at a depth of about 30 km. Magnitude 3.2.
- Dec. 23, 21:17:35, 5 km north of Kapapala at a depth of about 25 km. Magnitude 3.4.
- Dec. 24, 17:05:21, about 5 km west of Ohaikea at a depth of about 10 km. Magnitude 3.5.
- Dec. 27, 09:17:24, 7 km northwest of Hilo at a depth of about 45 km. Felt from Hilo to Kealakekua. Magnitude 4.5.
- Dec. 31, 00:55:42, 10 km southeast of Hookena at a depth of about 15 km. Magnitude 2.7.

#### DISTANT EARTHQUAKES

The following earthquakes of distant origin were recorded on seismographs of the Hawaiian Volcano Observatory on Hawaii (U=Uwekahuna,  $19^{\circ} 25.4' N$ ,  $155^{\circ} 17.6' W$ , 1240m), and Maui (H=Haleakala,  $20^{\circ} 46.0' N$ ,  $156^{\circ} 15.0' W$ , 2090m). Beginnings

of phases are given in Greenwich civil time, which is 10 hours faster than Hawaiian standard time. A "c" following the time of P indicates that the first motion was a compression; a "d", that it was a dilatation. Locations of epicenters, origin times, focal depths, and magnitudes are from the notices of Preliminary Determinations of Epicenters published by the U. S. Coast and Geodetic Survey.

- Oct. 1,  
U eR 10:11:13  
 $57^{\circ} S$ ,  $147^{\circ} E$ , 09:29:43
- Oct. 2,  
U eP 15:12:42.4  
 $7\frac{1}{2}^{\circ} N$ ,  $127^{\circ} E$ , 15:00:50
- Oct. 3,  
U eP 00:45:22.7  
 $13\frac{1}{2}^{\circ} N$ ,  $120^{\circ} E$ , 00:33:07
- Oct. 4,  
U eR 12:12:24  
 $22\frac{1}{2}^{\circ} N$ ,  $144\frac{1}{2}^{\circ} E$ , 11:33:07
- Oct. 6,  
U eP 00:56:42.9  
 $32^{\circ} S$ ,  $179\frac{1}{2}^{\circ} E$ , 00:47:20  
Depth about 250 km.
- Oct. 7,  
U eP 12:42:38  
iS 12:50:30  
eG 12:56:26  
iR 12:58:32  
 $5^{\circ} S$ ,  $15\frac{1}{2}^{\circ} E$ , 12:32:40  
Magnitude  $6\frac{1}{4}$ - $6\frac{1}{2}$
- Oct. 9,  
U eS 11:58:16  
iR 12:19:09  
 $55\frac{1}{2}^{\circ} S$ ,  $27\frac{1}{2}^{\circ} W$ , 11:20:17

- Oct. 10,  
U eP 08:39:01  
eS 08:46:01  
iR 08:52:04  
 $53\frac{1}{2}^{\circ} N$ ,  $160\frac{1}{2}^{\circ} E$ , 08:30:26  
Depth about 100 km.
- Oct. 10,  
U eS 15:38:42  
eR 15:51:02  
 $27\frac{1}{2}^{\circ} N$ ,  $125\frac{1}{2}^{\circ} E$ , 15:18:42  
Depth about 250 km.  
Magnitude  $6\frac{3}{4}$
- Oct. 19,  
U eR 02:29:44  
 $19^{\circ} S$ ,  $172\frac{1}{2}^{\circ} W$ , 01:53:54
- Oct. 19,  
U eP 11:52:37  
 $34\frac{1}{2}^{\circ} S$ ,  $178^{\circ} W$ , 11:42:42
- Oct. 20,  
U eP 01:02:42  
iR 01:12:02  
HTmax 01:38  
 $52^{\circ} N$ ,  $175^{\circ} W$ , 00:55:34
- Oct. 20,  
U iR 01:57:20  
 $9\frac{1}{2}^{\circ} S$ ,  $112\frac{1}{2}^{\circ} E$ , 01:12:30
- Oct. 26,  
U eP 02:30:20  
 $5\frac{1}{2}^{\circ} N$ ,  $117^{\circ} E$ , 02:17:32



Oct. 28,

U eR 04:52:16

62½° S, 157° W, 04:14:55

Oct. 28,

U eR 11:36:36

30½° N, 85° E, 10:46:27

Oct. 29,

U iR 00:07:17

52° N, 179½° E, 23:50:08 (Oct. 28)

Oct. 29,

U eP 07:51:29.2 d

Tmax 08:31:55

H eP 07:51:17

Tmax 08:29:30

51½° N, 179½° E, 07:44:10

Magnitude 6¼

Oct. 31,

U iP 23:51:05.5 d

25° N, 122½° E, 23:39:27

Depth about 100 km.

Nov. 1,

U eP 03:48:40.7

iS 03:56:41

eG 04:01:38

iR 04:05:00

3° S, 150° E, 03:38:35

Magnitude 6¼-6½

Nov. 1,

U eP 12:25:38

eS 12:33:18

iR 12:40:10

17½° S, 168° E, 12:16:36

Magnitude 6-6¼

Nov. 1,

U eS 16:07:10

eR 16:14:18

17½° S, 168° E, 15:50:10

Nov. 4,

U eP 08:41:01

eR 08:55:19

28° N, 140½° E, 08:28:28

Nov. 4,

U eR 23:30:35

50° S, 115° W, 22:54:46

Nov. 6,

U eP 15:41:49

6° S, 128° E, 15:30:06

Depth about 250 km.

Nov. 6,

U iP 23:07:21.5 c

iS 23:14:31

iR 23:22:11

Tmax 24:04:30

H iP 23:07:10.9 c

iS 23:14:24

eQ 23:18:54

iR 23:21:07

44½° N, 148½° E, 22:58:06

Depth about 60 km.

Magnitude 8-8¼

Nov. 7,

U eP 01:52:11

44½° N, 149½° E, 01:42:56

Nov. 7,

U eR 05:27:41

44½° N, 149° E, 04:59:56

Depth about 60 km.

Nov. 8,

U iP 09:31:31.8 d

iS 09:38:45

eR 09:47:21

52° N, 159½° E, 09:22:53

Nov. 12,

U eR 11:04:20

7° S, 156° E, 10:39:47

Depth about 100 km.

Nov. 12,

U iP 20:32:44.8 c

e 20:39:07

iS 20:40:13

eSS 20:43:43

iQ 20:44:43

iR 20:47:43

Tmax 21:13:33

H eP 20:32:32.9

44½° N, 148½° E, 20:23:26

Magnitude 6¼-7

Nov. 13,

U eR 03:20:43

44° N, 148½° E, 02:56:26

Nov. 13,

U eR 04:28:27

44½° N, 148° E, 04:04:37

Nov. 14,

U eR 05:39:04

36° S, 102° W, 05:04:25

Nov. 14,

U iP 05:56:36.2 c

iP 05:56:53.0

Nov. 14,

U eR 05:58:56

44° N, 149° E, 05:34:53

Nov. 14,

U eP 14:00:15.2

eG 14:17:29

eR 14:23:44

6° S, 131° E, 13:48:20

Nov. 15,

U iR 09:24:39

44° N, 149° E, 09:00:45

Magnitude 6½-6¾

Nov. 16,

U iR 18:02:05

16° S, 172° W, 17:44:48

Magnitude 6¼

Nov. 17,

U eP 09:55:39.4

10½° S, 162½° E, 09:46:30

Nov. 18,

U eR 08:02:25

50½° N, 179° E, 07:45:20

Nov. 19,

U eS 09:40:50

eR 09:47:46

44° N, 149° E, 09:23:51

Depth about 60 km.

Nov. 19,

U iP 04:03:38.0

31° S, 179° W, 03:53:56

Nov. 19,

U iP 15:09:58.4 c

60½° N, 150½° W, 15:02:15

Depth about 60 km.

Nov. 20,

U eR 05:58:21

52° N, 159½° E, 05:36:33

Nov. 20,

U eP 14:27:24.3

eR 14:31:46

45° N, 149½° E, 14:18:04

Depth about 60 km.

Nov. 30,

U iP 01:42:29.7 c  
eR 01:58:14

32° N, 137½° E, 01:32:41  
Magnitude 6

Dec. 2,

HTmax 18:25:36  
40½° N, 125° W, 17:43:30  
Magnitude 4-4½

Dec. 3,

U eR 10:26:30  
19° N, 121½° E, 09:48:26

Dec. 6,

U eR 10:06:40  
6½° N, 83° W, 09:33:45  
Magnitude 6-6¼

Dec. 7,

U iP 02:57:52.4  
4° N, 127° E, 02:45:49

Dec. 8,

U eR 12:32:30  
44° N, 149½° E, 12:08:23

Dec. 10,

U iP 07:12:51.1  
ipP 07:13:48.4  
iS 07:20:57  
isS 07:23:09  
H iP 07:12:56.7  
37° N, 176½° E, 07:02:59  
Depth about 300 km  
Magnitude 6¾

Dec. 10,

U eP 14:50:45.2  
5° N, 126° E, 14:39:00  
Depth about 200 km.

Dec. 10,

U iR 22:08:40  
24½° N, 109° W, 21:49:20  
Magnitude 5¾

Dec. 14,

U iR 07:43:31  
35° S, 108½° W, 07:11:28  
Magnitude 6

Dec. 17,

U eP 09:06:50.7  
33° N, 137° E, 08:57:10  
Depth about 400 km.

Dec. 19,

U eR 18:52:51  
51½° N, 177½° W, 18:36:23

Dec. 23,

U eR 07:02:36  
2° N, 79° W, 06:27:15

Dec. 25,

U iP 08:15:32.2 c  
eS 08:23:33  
iR 08:32:07  
H iP 08:15:30.3 c

Dec. 30,

U eP 08:49:20.3 d  
35½° S, 105½° W, 08:37:56  
Magnitude 6