UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

Summary 33

January, February, and March 1964

By

Robert Y. Koyanagi, Arnold T. Okamura
and Howard A. Powers

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

Summary 33

January, February, and March 1964

By

Robert Y. Koyanagi, Arnold T. Okamura

and Howard A. Powers

Issued February 1965

Observatory Staff

Geology

J. G. Moore (Transferred to Menlo Park 2/4/64)
H. A. Powers (Scientist in charge--Arrived from Denver 1/10/64)
D. L. Peck

Geophysics

D. P. Hill (Arrived from Denver 2/18/64)
W. T. Kinoshita
George Kojima
R. Y. Koyanagi
H. L. Krivoy (Transferred to Denver 1/27/64)
A. T. Okamura

Geochemistry

R. T. Okamura
T. L. Wright (Arrived from Washington 2/5/64)

Support

E. T. Endo
J. C. Forbes
W. H. Francis
B. J. Loucks
Akira Yamamoto

Contents

Chronological Summary

The first quarter of 1964 showed less activity associated with the volcanoes than has been experienced for several years. Mauna Loa continues to appear calm, and Kilauea has shown no restlessness, although the density of sulfurous fumes and the amount of sulfur stain on the lava crusts have increased.

January 7, about 01^h00^m--some residents of the Hilo and Puna Districts were awakened by a quake of magnitude 3.7 and about 8 km deep along the Poliokeawe fault system, southeast of Makaopuhi, near the coast; 44 small aftershocks were recorded.

January 29-February 6--a cluster of seismic events included: a felt quake on the east flank of Mauna Loa, a felt quake 30 km deep of magnitude 3.3 with 15 aftershocks, 2 half-hour spells of deep tremor, and more than 100 small shallow local Kilauea quakes in 5 consecutive days.

February 20 at 22^h32^m--residents of Maui and northern parts of Hawaii felt a quake of magnitude 4.3. The epicenter was located at about 13 km depth off the southwest shore of Maui.

March was ushered in by 3 days of more than a hundred shallow local Kilauea caldera quakes each, and ended with Alaska's Good Friday earthquake, its tsunami and aftershocks.

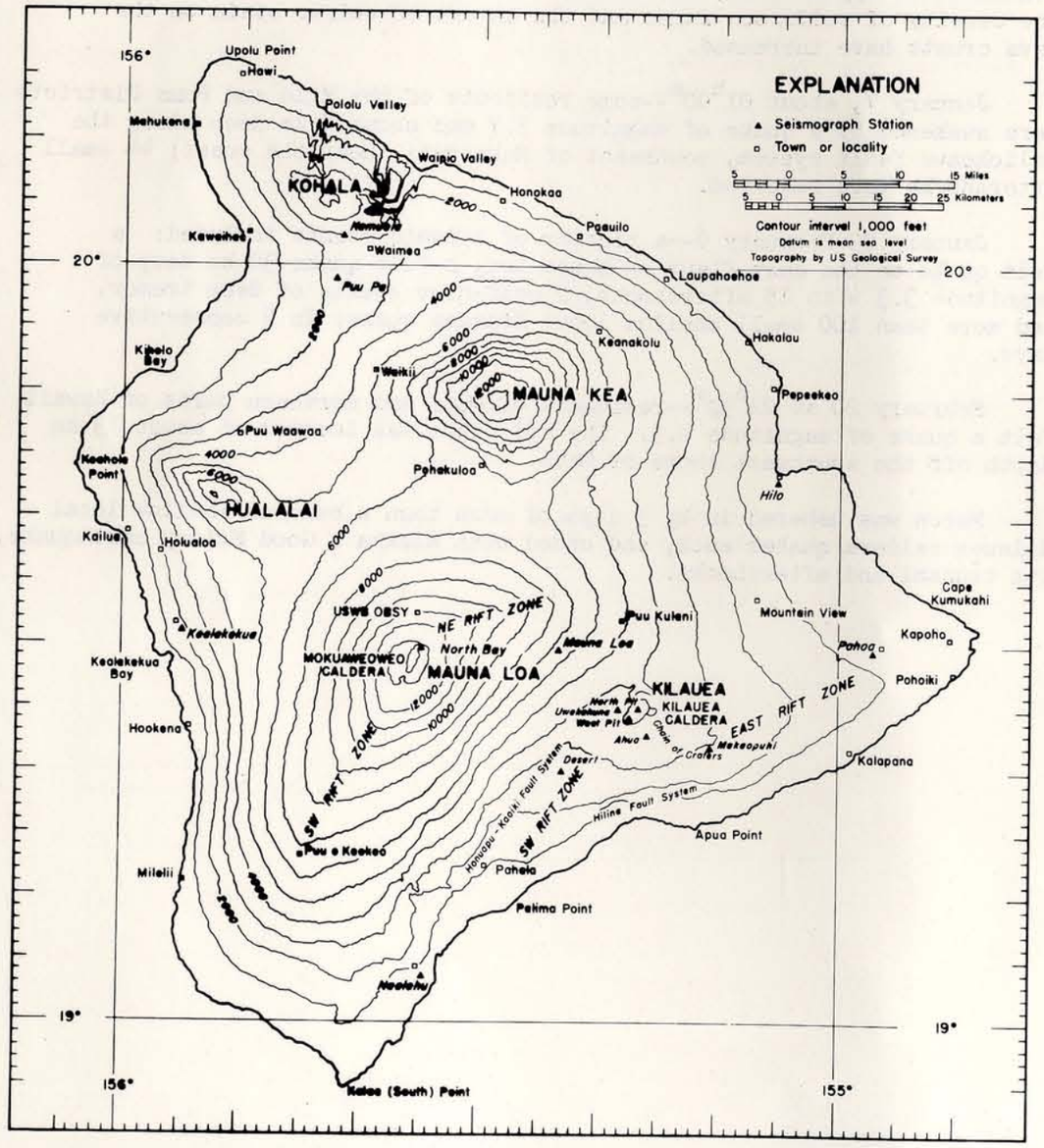

Figure 1.--Map of the island of Hawaii showing seismograph stations operated by the Geological Survey and localities mentioned in the text. Epicenters of local earthquakes are given in terms of geographic coordinates, which are indicated at the edges of the map.

Tilting of the ground around Kilauea caldera.--Tilting of the ground around the summit of Kilauea is monitored daily by a short-base water-tube tiltmeter in Uwekahuna Vault (table 1), and at irregular intervals it is measured on a regional scale by means of a network of field tilt bases and a portable water-tube tiltmeter. The attitude of the ground surface at each tilt base is reported in terms of north-south and east-west tilt coordinates. Both coordinates at each station were set equal to 500 when measurements at that station were begun. 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 corresponds to a tilting of 1 microradian (1 mm per km) in the direction indicated.

Table 1.--Tilt coordinates at Uwekahuna Vault, January, February, and March 1964

Date	N-S	E-W	Date	N-S	E-W
Jan. 5	467	504	Mar. 1	462	505
12	463	507	8	461	507
19	462	507	15	461	507
26	459	509	22	462	504
Feb. 2	462	508	29	460	504
9	461	508			
16	462	504			
23	461	506			

First quarter, 1964

Table 2.--Tilt coordinates and changes at base bases around Kilauea caldera. (See tilt diagram, fig. 2.)

Tilt Base (location)	Date (1964)	Tilt coordinates N-S	Tilt coordinates E-W	Rate (10^{-6} rad/mo) and direction of tilting since last reading		Date of last reading (1963)	Tilt coordinates N-S	Tilt coordinates E-W	Rate (10^{-6} rad/mo) and direction of tilting since last reading		Date of last reading (1963)
Uwekahuna (19°25.5' N., 155°17.4' W.)	Jan. 22	440.6	503.1	9.1	N. 51° W.	Oct. 10	442	503.1	9.1	N. 51° W.	Oct. 10
Tree Molds (19°26.3' N., 155°17.3' W.)	21	436.3	508.5	4.5	N. 28° W.	9	441	508.5	4.5	N. 28° W.	9
Sand Spit (19°24.1' N., 155°16.8' W.)	23	850.4	769.3	10.0	S. 55° W.	11	853	769.3	10.0	S. 55° W.	11
Kalihipaa (19°21.4' N., 155°15.3' W.)	20	340.4	386.0	1.4	N. 18° W.	7	340	386.0	1.4	N. 18° W.	7
Keamoku (19°25.1' N., 155°19.0' W.)	23	492.3	599.4	2.9	S. 35° W.	7	493	599.4	2.9	S. 35° W.	7
Ahua Kamokukolau (19°22.7' N., 155°16.6' W.)	22	631.2	536.6	2.1	S. 66° E.	10	631	536.6	2.1	S. 66° E.	10
Kipuka Nene (19°19.4' N., 155°16.7' W.)	20	485.4	509.6	0.4	S. 73° W.	14	485	509.6	0.4	S. 73° W.	14
Hilina Pali (19°18.2' N., 155°18.6' W.)		Not occupied this epoch				14	495.2	503.3	0.6	S. 82° E.	11
Kapapala Ranch (19°20.5' N., 155°23.8' W.)	21										

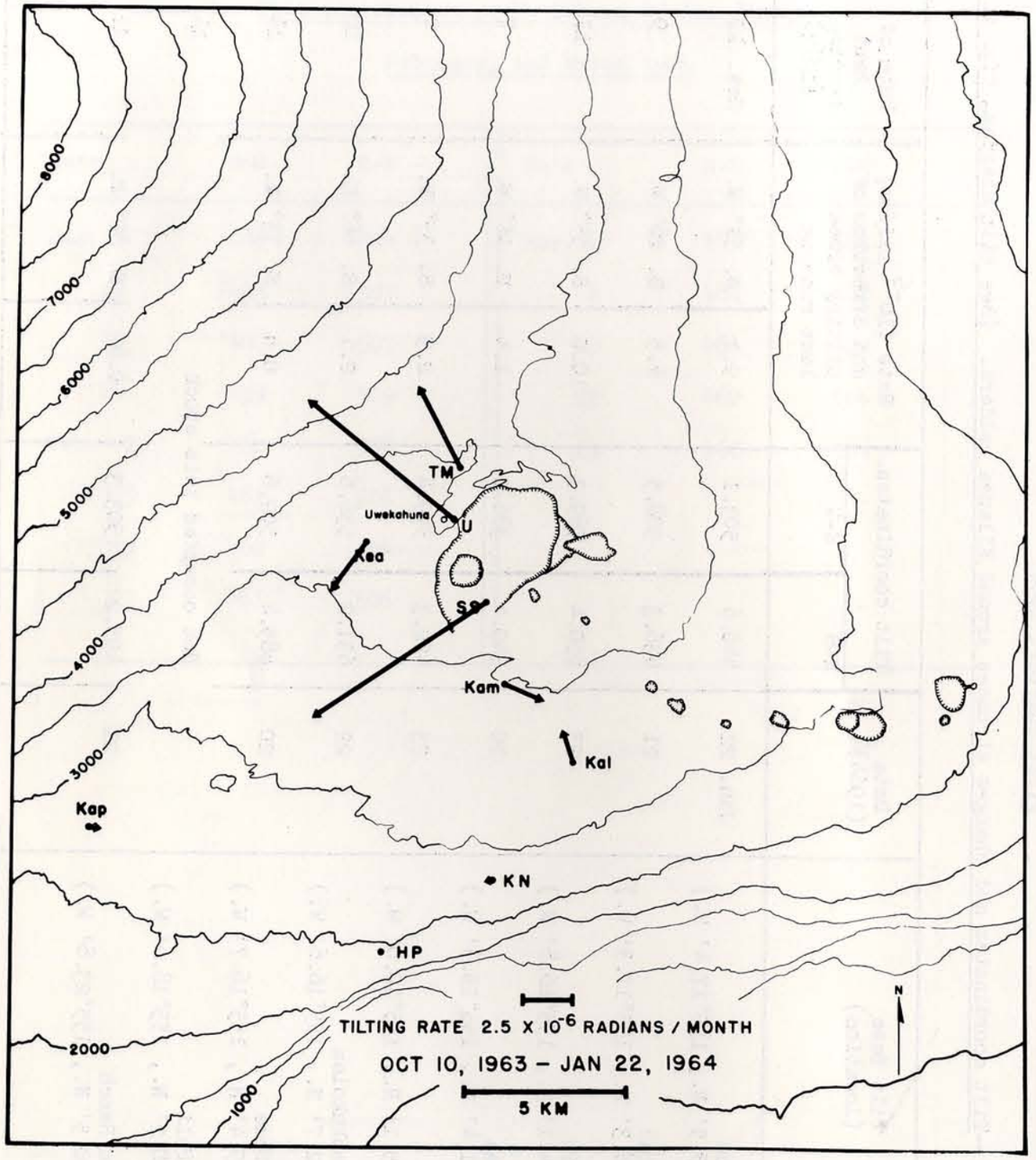

Figure 2.--Tilting of the ground around Kilauea caldera, Oct. 10, 1963 to Jan. 22, 1964. The vector depicting tilting at a given tilt base points in the direction of maximum relative subsidence and has a length proportional to the rate of tilting during the measurement interval. Closed circles represent field tilt bases; open circles, short-base water-tube tiltmeters.

Seismic summary.--Events recorded by the U.S. Geological Survey seismograph network in Hawaii fall into two categories: local earthquakes and tremor originating in the region of the Hawaiian Islands, usually within 100 km of at least one seismograph, and distant earthquakes originating more than 3,000 km from Hawaii. As an index of seismic activity at Hawaiian volcanoes, daily counts of earthquakes and minutes of tremor recorded by seismographs in Hawaii are listed in table 3. The earthquakes are separated into groups on the basis of region of origin as determined by analysis of records obtained daily at the Observatory (U, M, A, D, N, WP, MP). Earthquakes of magnitude 2.5 or greater are generally sufficiently well recorded to be located with greater precision; they are listed individually in table 4. Data on identifiable phases from distant earthquakes are listed in table 5.

Locations of the seismograph stations are shown on figure 1, and essential data on the stations are listed in table 6.

Table 3.--Number of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera

Tremor is separated into three categories: deep, intermediate, and shallow, on the basis of relative amplitudes on seismographs in the summit region. Unless otherwise stated, tremor is presumed to be associated with movement of magma within the central complex of Kilauea.

Earthquake categories are: Halemaumau rock slides, which are detected by the characteristic record they produce on the North Pit seismograph; shallow earthquakes in the Kilauea caldera region; shallow earthquakes along the SW. rift zone of Kilauea and the adjacent portion of the Kaoiki fault system; earthquakes along the eastern half of Kilauea's east rift zone--detected largely on the Pahoa short-period vertical; earthquakes from a source about 30 km beneath Halemaumau; earthquakes from the upper east rift zone and the adjacent fault systems of Kilauea's south flank (these are usually first arrivals at the Ahua meter or at the new experimental geophone near Makaopuhi Crater (MP)); and earthquakes from other regions: Kona, Mauna Kea, etc.

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Hale-maumau 30 km	Upper East rift	Others
Jan. 1	----	----	-----	-----	65	9	----	1	6	----------
2	----	----	-----	-----	44	20	----	4	7	----------
3	----	----	-----	-----	50	21	1	1	2	----------
4	----	----	-----	-----	83	13	----	----	6	2 Kona
5	----	----	-----	-----	121	20	----	1	6	1 Mauna Loa
6	----	6	-----	-----	115	14	----	----	35	1 off south shore 1 Mauna Kea
7	----	----	-----	1	125	17	----	7	9	2 Kohala Mt. region 1 off south shore
8	----	----	-----	-----	160	9	----	----	15	1 off west coast 1 Kohala Mt. 1 Mauna Loa
9	----	----	4	-----	105	18	1	7	22	1 off north shore 1 off south shore
10	----	----	-----	-----	105	13	1	8	10	----------
11	----	----	-----	1	120	10	----	5	4	----------

Table 3.--Number of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, AND MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Hale-maumau 30 km	Upper East rift	Others
Jan. 12	----	-----	-----	-----	60	9	-----	-----	7	----------
13	----	-----	-----	1	64	18	-----	3	6	1 Mauna Loa
14	----	-----	-----	-----	26	12	-----	1	3	----------
15	----	-----	-----	-----	50	3	-----	-----	3	1 Kohala
16	----	-----	-----	-----	15	2	-----	1	5	1 Waimea region
17	----	-----	-----	-----	35	8	-----	1	2	----------
18	----	-----	-----	-----	52	10	-----	-----	7	----------
19	----	-----	-----	-----	58	21	-----	2	7	----------
20	----	-----	-----	-----	50	6	-----	-----	7	----------
21	----	-----	-----	-----	60	5	-----	1	1	----------
22	----	-----	-----	-----	80	14	-----	-----	7	----------
23	----	-----	-----	-----	80	6	-----	-----	8	2 Offshore
24	----	-----	-----	-----	70	6	-----	5	7	----------
25	----	-----	-----	-----	55	5	-----	2	11	----------
26	----	-----	-----	-----	60	7	-----	-----	5	1 Kona 1 Hilina Pali System
27	----	-----	-----	-----	35	6	-----	-----	----	----------
28	----	-----	-----	-----	60	7	1	-----	5	----------
29	----	-----	-----	-----	75	3	-----	2	4	1 Mauna Loa
30	----	-----	-----	-----	55	------	-----	16	3	----------
31	30	-----	-----	-----	43	17	-----	2	8	1 off west coast
Feb. 1	----	-----	-----	-----	50	13	-----	6	11	1 Kona 1 Mauna Kea
2	45	-----	-----	-----	51	6	-----	-----	6	1 Mauna Kea
3	----	-----	-----	-----	100	11	-----	3	4	1 off west coast
4	----	-----	-----	-----	130	5	-----	-----	4	----------
5	7	-----	-----	1	120	12	-----	4	5	----------
6	----	-----	-----	-----	50	9	-----	6	7	----------
7	----	-----	-----	-----	65	5	-----	4	3	----------

Table 3.--Number of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Hale-maumau 30 km	Upper East rift	Others
Feb. 8	----	-----	-----	-----	30	10	1	3	6	2 off south shore
9	----	-----	-----	-----	30	7	2	4	7	1 Kona
10	----	-----	-----	-----	40	4	----	2	5	----------
11	----	-----	-----	-----	85	3	----	4	3	----------
12	----	-----	-----	-----	80	5	----	3	3	----------
13	----	-----	-----	-----	50	6	----	2	3	----------
14	----	-----	-----	-----	46	3	----	1	4	1 off north shore
15	----	-----	-----	-----	68	6	----	1	----	----------
16	25	-----	5	-----	60	13	----	2	5	----------
17	32	-----	-----	-----	60	11	----	1	----	----------
18	38	-----	-----	-----	80	9	----	8	----	1 Kona 1 Mauna Loa
19	----	-----	-----	-----	88	17	----	6	4	1 Kona 1 Mauna Kea
20	----	-----	-----	-----	52	14	----	3	3	1 offshore-Maui
21	----	-----	-----	-----	49	10	----	9	9	1 Kona
22	22	10	-----	-----	50	6	----	4	4	1 Kona
23	21	-----	-----	-----	50	4	----	4	6	----------
24	----	-----	-----	1	66	22	1	3	5	1 Kona 1 off south shore
25	----	22	-----	-----	50	16	----	6	3	----------
26	----	-----	-----	-----	45	7	1	3	3	----------
27	----	-----	-----	-----	20	5	----	3	5	----------
28	----	-----	-----	-----	75	5	----	3	6	----------
29	----	-----	-----	-----	50	7	1	2	14	1 Mauna Loa
Mar. 1	----	-----	-----	-----	50	6	----	2	5	----------
2	30	-----	-----	1	150	12	----	5	15	----------
3	----	2	-----	-----	150	10	----	-----	1	----------
4	----	-----	-----	-----	170	14	----	-----	12	----------
5	----	-----	-----	-----	88	7	----	-----	7	1 Mauna Kea

Table 3.--Number of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Hale-maumau 30 km	Upper East rift	Others
Mar. 6	----	-----	-----	-----	75	10	----	1	6	1 Kona
7	----	-----	-----	-----	88	10	----	1	10	2 offshore-Kona
8	----	-----	-----	-----	65	12	----	4	----	----------
9	----	-----	-----	-----	60	4	----	1	4	----------
10	----	-----	-----	-----	70	4	1	3	3	----------
11	----	-----	-----	1	107	9	----	4	2	1 Kohala
12	----	-----	-----	-----	75	6	----	-----	4	----------
13	----	-----	-----	-----	105	8	----	1	2	2 Mauna Loa
14	----	-----	-----	-----	76	12	----	3	3	----------
15	----	-----	-----	-----	88	9	----	-----	5	2 Kona
16	----	-----	-----	-----	100	24	----	3	3	1 off west coast
17	20	-----	-----	-----	75	10	----	6	7	----------
18	----	-----	-----	1	127	13	----	12	7	----------
19	Severe electrical storm--instruments turned off									
20	-do-	-do--	-do--	-do--	--do--	-do--	-do-	--do--	-do-	do.
21	----	-----	-----	1	60	3	----	------	6	----------
22	----	-----	4	9	53	6	2	2	6	----------
23	----	-----	4	11	63	5	----	6	6	----------
24	7	-----	-----	-----	48	9	1	4	4	----------
25	----	-----	-----	-----	76	6	----	2	10	----------
26	----	-----	-----	-----	59	10	----	5	14	1 Mauna Kea 1 Mauna Loa
27	----	-----	-----	-----	101	5	1	1	----	----------
28	----	-----	-----	-----	71	20	----	5	6	----------
29	----	-----	-----	-----	60	7	----	5	7	----------
30	----	-----	-----	-----	73	7	----	5	6	----------
31	----	-----	-----	-----	80	6	----	3	12	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, January, February, and March 1964

[Entries for a given quake are: date, origin time (Hawaiian Standard Time), magnitude, depth, epicenter, and felt report. All earthquakes of magnitude 2.5 and larger, as well as many favorably located smaller ones, occurring on or near the island of Hawaii are included in the list.

In the following list some origin times are followed by "KM 30" and a statement of magnitude. These are all members of a continuing family of quakes noted also in other Summaries. The best mean focus for this group is beneath Halemaumau at a depth of 30 km (19°24.1' N., 155°17.1' W.).

In the following list a number of quakes are described as "Upper east rift" (see Summary 28). Their average epicenter is approximately 19°21.5' N., 155°14' W. about 2 km south of Aloi Crater at near-surface depth.

The mean focus of the magnitude 6.1 Kaoiki fault system earthquake of June 27, 1962, and its aftershocks is 19°24' N., 155°25' W., at a depth of 3-8 km. This focus has been abbreviated "Kaoiki"]

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
Jan. 1	20	52	22.4	2.3	-----	--------	--------	Kaoiki----------	----------
2	06	20	27.4	2.5	-----	--------	--------	--do----------	----------
3	06	18	33.9	2.6	-----	--------	--------	KM 30----------	----------
3	13	47	04.0	3.1	-----	--------	--------	Kaoiki----------	----------
6	05	24	22.4	2.6	8	19°08.3'	155°24.5'	22 km SSW of Desert seismometer.	----------
6	17	11	45.3	3.0	13	19°49.1'	155°31.8'	8 km N. of Pohakuloa------	Felt in Honokaa
7	01	06	25.0	3.7	8	19°18.0'	155°13.5'	9 km SSW of Makaopuhi-----	Felt over half the island of Hawaii.
7	01	27	39.5	2.2	8	19°16.2'	155°13.4'	12 km SSW of Makaopuhi----	----------
7	02	04	17.9	3.6	5	19°16.3'	155°11.8'	2 km N. of Apua Pt--------	----------
7	08	14	43.0	2.7	8	19°14.8'	155°13.2'	3 km SW of Apua Pt--------	----------
7	18	11	01.6	2.4	13	19°51.6'	155°31.5'	12 km N. of Pohakuloa-----	----------
7	22	54	52.5	2.3	-----	--------	--------	Kaoiki----------	----------
8	01	10	14.0	2.8	13	19°57'	156°53'	112 km WNW of Kealakekua	----------
8	03	14	55.0	2.9	13	20°05.6'	155°39.7'	8 km NNE of Kamuela	Felt in Kamuela

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, January, February, and March 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
Jan. 8	11	08	19.5	2.3	8	19°09.8'	155°41.9'	17 km NW of Naalehua--------	----------
9	09	47	44.5	3.1	13	20°20'	156°02'	20 km WNW of Upolu Pt-------	----------
9	15	01	12.4	2.2	< 3	19°22.1'	155°05.7'	9 km E. of Makaopuhi--------	----------
9	18	32	31.3	2.4	3	19°14.8'	155°12.0'	2 km SSW of Apua Pt---------	----------
10	01	58	14.5	2.2	----	--------	---------	Kaoiki----------	----------
10	19	13	15.4	2.5	8	19°16.5'	155°13.2'	4 km NW of Apua Pt----------	----------
15	04	59	33.9	2.0	8	19°16.6'	155°14.3'	6 km NW of Apua Pt----------	----------
16	15	40	57.0	3.0	13	20°06.4'	155°49.8'	16 km WNW of Kamuela--------	Felt in Waimea
18	20	46	49.9	2.3	----	--------	---------	Kaoiki----------	----------
23	15	43	49.5	2.0	3	19°24.8'	155°08.2'	7 km NE of Makaopuhi--------	----------
23	17	43	07.5	3.0	13	19°42'	156°08'	32 km NW of Kealakekua-------	----------
23	19	04	47.0	2.7	13	18°50'	155°19'	40 km SE of Naalehu----------	----------
25	23	58	23.0	2.5	8	19°15.6'	155°13.2'	3 km W. of Apua Pt----------	----------
26	20	40	44.0	2.5	45	19°13.3'	155°03.8'	16 km ESE of Apua Pt--------	----------
30	05	38	43.3	3.2	----	--------	---------	Kaoiki----------	Felt in the Kilauea summit region.
31	00	29	00.1	3.3	----	--------	---------	KM 30----------	Felt in the Kilauea summit region.
31	05	44	36.0	2.2	----	--------	--------	KM 30----------	----------
31	18	31	41.0	2.6	8	19°33.4'	155°59.8'	10 km WNW of Kealakekua------	----------
Feb. 1	19	44	16.5	2.4	8	19°48.1'	155°34.5'	8 km NW of Pohakuloa--------	----------
2	13	48	40.0	2.3	3	19°17.1'	155°12.8'	12 km SSE of Ahua seismometer	----------
2	22	12	48.0	2.2	----	--------	---------	Kaoiki----------	----------
3	09	27	20.0	2.0	8	19°13.7'	155°29.3'	3 km NNW of Pahala----------	----------
3	11	06	34.0	2.8	8	19°35.5'	156°07.5'	24 km WNW of Kealakekua-----	----------
4	11	29	41.6	2.5	13	19°26.8'	155°16.9'	3 km NNE of Uwekahuna-------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, January, February, and March 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
Feb. 5	15	57	09.5	2.2	----	--------	---------	Kaoiki----------	----------
6	01	18	08.6	2.2	----	--------	---------	KM 30----------	----------
7	01	35	46.5	2.7	3	19°16.3'	155°07.5'	8 km ENE of Apua Pt--------	----------
7	08	06	02.0	2.8	3	19°18.0'	155°03.0'	16 km ESE of Makaopuhi-----	----------
8	14	22	35.0	3.4	13	18°40'	156°56'	137 km WSW of South Point	----------
8	20	05	24.0	2.0	8	19°01.5'	155°20.5'	27 km ESE of Naalehu-------	----------
9	12	09	32.5	2.5	8	19°18.9'	155°48.2'	27 km SSE of Kealakekua----	----------
9	21	06	34.0	2.9	----	--------	---------	KM 30----------	Felt near the Kilauea summit region
10	12	57	50.2	2.5	----	--------	---------	Kaoiki----------	----------
13	21	21	27.0	2.8	----	--------	---------	Kaoiki----------	----------
14	21	50	11.0	3.1	13	20°34'	155°49'	33 km NNE of Upolu Pt------	----------
16	03	10	37.5	3.0	----	--------	---------	Kaoiki----------	Felt in the Kilauea summit region
18	02	59	48.3	2.4	8	19°07.8'	155°43.3'	16 km WNW of Naalehu-------	----------
19	23	56	15.0	2.5	8	19°49.4'	155°35.8'	8 km SE of Waikii----------	----------
20	22	31	44.5	4.3	13	20°42'	155°50'	41 km ESE of Haleakala-----	Felt in east Maui, Kohala, Honokaa, Kamuela, and the Kilauea summit region
21	00	39	54.0	2.4	8	19°42.8'	155°47.2'	27 km NE of Kealakekua-----	----------
21	17	14	30.8	2.1	----	--------	---------	Kaoiki----------	----------
21	23	45	53.0	2.3	3	19°18.2'	155°07.5'	10 km SE of Makaopuhi------	----------
22	14	45	57.5	2.5	8	19°15.9'	155°52.2'	10 km NNE of Milolii-------	----------
23	18	22	48.9	2.0	13	19°24.9'	155°14.5'	5 km NNE of Ahua seismometer	----------
24	05	42	52.0	2.3	8	19°17.2'	154°50.9'	16 km SE of Kalapana-------	----------
25	00	51	37.0	2.1	3	19°20.3'	155°05.9'	9 km ESE of Makaopuhi------	----------
25	23	51	28.0	2.4	8	19°18.1'	155°09.0'	8 km SSE of Makaopuhi------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, January, February, and March 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
Feb. 26	09	29	27.3	2.5	----	--------	---------	KM 30----------	----------
26	16	55	59.8	2.2	----	--------	---------	KM 30----------	----------
29	22	46	49.5	3.1	5	19°19.0'	155°07.0'	8 km ESE of Makaopuhi-----	----------
29	23	49	36.2	2.6	8	19°14.8'	155°34.8'	20 km N. of Naalehu-------	----------
Mar. 1	12	33	55.7	2.1	3	19°17.2'	155°11.8'	3 km N. of Apua Pt--------	----------
1	15	42	56.0	2.5	----	--------	---------	KM 30----------	----------
1	19	22	27.0	2.7	----	--------	---------	Kaoiki----------	Felt near Pahala
2	11	12	49.2	2.8	----	--------	---------	Kaoiki----------	Felt near Pahala
5	22	19	12.3	3.0	13	19°52.2'	155°36.5'	19 km SSE of Kamuela------	Felt in Honokaa, Kamuela, and near Pohakuloa.
7	01	05	01.0	2.7	13	19°18.8'	155°53.5'	23 km SSE of Kealakekua---	----------
7	19	01	46.5	3.0	13	19°12'	156°28'	67 km WSW of Kealakekau---	----------
7	20	15	07.0	2.0	----	--------	---------	Kaoiki----------	----------
10	00	54	38.0	3.6	8	19°16.5'	155°10.9'	2 km NE of Apua Pt--------	Felt over east half of island of Hawaii.
10	15	00	03.3	2.0	8	19°11.5'	155°26.8'	3 km ESE of Pahala--------	----------
10	22	09	08.4	2.0	----	--------	---------	Kaoiki----------	----------
11	19	08	14.5	2.6	8	20°04.6'	155°49.3'	13 km WNW of Kamuela------	----------
11	19	30	56.4	3.7	10	19°17.5'	155°05.8'	12 km SE of Makaopuhi-----	Felt in the Hilo region.
13	11	55	09.0	2.8	3	19°30.8'	155°36.0'	3 km NW of North Bay seismometer.	----------
13	21	20	20.5	2.4	8	19°09.1'	155°40.0'	14 km NW of Naalehu-------	----------
14	05	44	42.0	2.5	----	--------	---------	Kaoiki----------	----------
14	15	58	15.5	2.3	3	19°23.2'	155°47.1'	21 km SE of Kealakekua----	----------
15	12	56	36.9	3.2	3	19°21.1'	155°07.1'	7 km ESE of Makaopuhi-----	----------
15	19	55	37.0	2.4	8	19°22.8'	155°56.3'	4 km WSW of Hookena-------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, January, February, and March 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
Mar. 15	19	55	37.0	2.4	8	19°22.8'	155°56.3'	4 km WSW of Hookena	----------
16	09	09	56.7	3.1	13	19°15'	156°25'	62 km WSW of Kealakekua	----------
16	12	17	36.5	2.4	----	--------	--------	Kaoiki----------	----------
16	23	06	46.0	2.8	----	--------	--------	Kaoiki----------	Felt near Pa
17	21	13	12.9	2.1	3	19°18.8'	155°05.8'	12 km ESE of Makaopuhi	----------
18	13	25	35.5	2.3	25	19°18.0'	155°15.5'	8 km S. of Ahua seismometer.	----------
19	21	14	20.0	2.3	8	19°08.3'	155°02.0'	30 km SSE of Makaopuhi	----------
20	07	52	13.5	2.5	----	--------	--------	KM 30----------	----------
23	03	08	50.0	2.0	----	--------	--------	KM 30----------	----------
24	02	05	12.7	2.0	3	19°15.9'	155°12.3'	2 km NW of Apua Pt----	----------
24	02	43	14.0	2.0	8	19°22.8'	155°02.9'	15 km ENE of Makaopuhi	----------
24	12	57	07.5	3.0	3	19°22.1'	155°05.2'	11 km E. of Makaopuhi	Felt in Hilo
24	16	12	35.5	2.0	8	19°15.5'	155°29.4'	16 km SW of Desert seismometer.	----------
25	17	32	42.7	2.9	----	--------	--------	Kaoiki----------	----------
26	00	54	49.0	2.4	8	19°52.5'	155°10.0'	19 km NNW of Hilo----	----------
26	17	11	30.0	2.6	8	19°11.3'	155°25.9'	22 km NE of Naalehu---	----------
27	02	10	22.5	2.4	3	19°21.8'	154°54.8'	15 km SSE of Pahoa----	----------
28	12	03	46.2	2.5	----	--------	--------	KM 30----------	----------
29	16	16	15.0	2.2	8	19°16.2'	155°13.8'	4 km WNW of Apua Pt----	----------
30	11	22	47.0	2.6	----	--------	--------	Kaoiki----------	----------
30	12	15	35.0	2.6	3	19°17.4'	155°10.7'	10 km S of Makaopuhi	Felt near Hilo

Table 5.--Distant earthquakes

[Times are reported in Greenwich Civil Time which is 10 hours faster than Hawaiian Standard Time. A "c" following the time of P indicates compressional first motion; a "d" indicates dilatational first motion. Station symbols, locations, and instrumentation are presented in table 6. Magnitudes calculated from the Hawaii seismograms are followed by (HVO). Location of epicenter, origin time, focal depth, and magnitude are taken from "Preliminary Determination of Epicenters" published by the U.S. Coast and Geodetic Survey.

The great number of aftershocks following the March 28 Alaskan earthquake necessitated a separate listing of these events (end of this table). Many Alaskan aftershocks continued to occur after the end of the quarter, and these will again be listed separately as "Alaskan aftershocks" in HVO Summary 34]

Jan. 5, 1964

M	Z	eP	18:46:51.8 c
D	Z	eP	50.6 c
MP	Z	iP	49.8 c
U	Z	iP	50.7 c
Pa	Z	iP	49.6 c
Ke	Z	eP	52.8 c

C&GS card 1-64:
18:33:54.7
8.0° S., 74.5° W.
Central Peru
h about 150 km
Magnitude 5.2 (CGS).

Jan. 5-6

M	Z	eP'	00:05:52.0 d
D	Z	eP'	50.8 d
Na	Z	eP'	49.7 d
Ke	Z	eP'	52.3 d
Ha	Z	eP'	00:06:01.8 d
U	PEN	iSS	00:29:25
U	PEE	eL	00:47:05
U	PEN	eG	00:48:32
U	PEZ	eR	00:55:17

C&GS card 3-64:
23:46:10.7
52.3° S., 28.6° E.
Prince Edward Islands region
h about 33 km
Magnitude 6.5 (HVO).

Jan. 6

M	Z	eP	23:54:05.5 c
U	PEE	eS	00:01:07
U	PEN	iG	00:05:27
U	PEZ	iR	00:07:31

C&GS card 1-64:
23:45:23.4
50.9° N., 157.3° E.
Southern Kamchatka
h about 33 km
Magnitude 5.6 (CGS)
5.9 (HVO).

Jan. 7

M	Z	iP	08:54:56.0 c
A	Z	eP	57.5 c
D	Z	iP	57.8 c
MP	Z	eP	58.0 c
U	Z	eP	57.0 c
Pa	Z	eP	56.9 c

C&GS card 1-64:
08:46:48.0
54.0° N., 165.5° W.
Fox Islands, Aleutian Islands
h about 80 km
Magnitude 4.7 (CGS).

Jan. 8

M	Z	iP	22:43:30.1 c

C&GS card 1-64:
22:30:52.5
3.8° S., 119.3° E.
Celebes
h about 112 km
Magnitude 5.3 (CGS).

Jan. 10, 1964

M	Z	iP	05:00:34.5 c
D	Z	eP	35.0 c
U	PEE	iS	05:08:30
U	PEZ	eR	05:16:32

C&GS card 1-64:
04:50:53.4
42.0° N., 142.6° E.
Near south coast of Hokkaido, Japan
h about 33 km
Magnitude 5.75-6 (Brk), 5.5 (CGS), 6.2 (HVO).

Jan. 10

M	Z	iP	17:06:44.2 c

C&GS card 2-64:
16:57:26.5
45.4° N., 150.0° E.
Kurile Islands
h about 50 km
Magnitude 5.4 (CGS).

Jan. 12

M	Z	iP	06:07:02.1 d
A	Z	iP	03.1 d
D	Z	iP	03.2 d
U	Z	iP	02.6 d
Pa	Z	iP	02.5 d
Hi	Z	iP	00.6 d
Na	Z	iP	05.0 d
Ha	Z	iP	06:06:50.2 d
U	PEZ	eR	06:16:07
M	Z	Tmax	06:44:30
A	Z	Tmax	06:44:57
D	Z	Tmax	06:44:35
U	Z	Tmax	06:44:26
Pa	Z	Tmax	06:44:36
Ha	Z	Tmax	06:42:41
Hi	Z	Tmax	06:44:08

C&GS card 4-64:
06:00:13.2
53.2° N., 166.3° W.
Fox Islands, Aleutian Islands
h about 33 km
Magnitude 5.5 (CGS), 5.8 (HVO).

Jan. 13

M	Z	Tmax	08:57:57
A	Z	Tmax	56
D	Z	Tmax	54
MP	Z	Tmax	52
U	Z	Tmax	53
Pa	Z	Tmax	54
Hi	Z	Tmax	57
Na	Z	Tmax	52

No C&GS preliminary listing.

Jan. 15

M	Z	eP	21:45:55.9 d
A	Z	iP	57.2 d
D	Z	iP	56.0 d
U	Z	iP	57.0 d
Pa	Z	iP	59.1 d
Hi	Z	iP	57.7 d
Na	Z	iP	56.2 d
Ke	Z	iP	50.8 d
Ha	Z	iP	47.6 d
U	PEZ	iR	22:08:34

C&GS card 3-64:
21:36:05.0
29.1° N., 140.8° E.
South of Honshu, Japan
h about 70 km
Magnitude 6.75 (Pas)
6.4 (CGS).

Jan. 18

M	Z	iP	12:16:38.6 c
D	Z	eP	38.7 c
U	Z	iP	39.3 c
Ke	Z	iP	32.3 c
Na	Z	iP	37.2 c
Hi	Z	iP	40.0 c
Pa	Z	iP	41.2 c
U	PEE	iS	12:27:24
U	PEN	iL	12:36:26
U	PEZ	eR	12:40:26

C&GS card 4-64:
12:04:40.0
23.1°N., 120.5°E.
Taiwan
110 dead, 479 injured
h about 33 km
Magnitude 6.75 (Pas), 6.75-7 (Brk), 6.5-6.75 (Pal), 6.1 (CGS), 6.5 (HVO).

Jan. 20, 1964

M	Z	eP	17:17:37.4 c
A	Z	eP	37.1 c
U	Z	eP	37.2 c
Na	Z	eP	33.9 c
Hi	Z	eP	40.0 c
U	PEZ	i	17:18:16 d
U	PEE	iS	17:24:56
U	PEN	eSS	17:28:57
U	PEN	eG	17:30:18

C&GS card 7-64:
17:08:37.4
20.7° S., 169.9° E.
Loyalty Islands region
h about 141 km
Magnitude 6.75 (Pas), 6.1 (CGS), 6.0 (HVO).

Jan. 22, 23

M	Z	eP	00:08:52 d
U	PEN	eS	00:15:58
U	PEN	eG	00:20:22
U	PEZ	eR	00:22:46

C&GS card 9-64:
23:59:43.6
13.7° S., 165.9° W.
New Hebrides Islands
h about 33 km
Magnitude 6.0 (CGS), 6.1 (HVO).

Jan. 24

M	Z	iP	17:27:44.3 c
A	Z	eP	45.1 c
D	Z	iP	44.5 c
MP	Z	iP	45.4 c
U	Z	eP	44.7 c
Ha	Z	iP	35.7 c
Ke	Z	iP	41.0 c
Na	Z	iP	44.4 c
Hi	Z	iP	44.8 c
Pa	Z	iP	45.9 c

C&GS card 7-64:
17:17:45.5
38.7° N., 129.4° E.
Near East Coast of Korea
h about 54.2 km
Magnitude 5.3 (CGS).

Jan. 26

A	Z	iP	09:22:20.4 c
D	Z	iP	20.7 c
MP	Z	iP	20.1 c
U	Z	iP	20.6 c
Pa	Z	iP	19.4 c
Hi	Z	iP	20.6 c
Ke	Z	iP	24.6 c

C&GS card 9-64:
09:09:33.9
16.3° S., 71.7° W.
Southern Peru
6 injured, slight damage at Arequipa
h about 116 km
Magnitude 6.1 (CGS).

Feb. 5, 1964

Hi	Z	eP	11:40:08 d
U	PEE	eS	11:48:04
U	PEZ	eR	11:56:16
M	Z	Tmax	12:43:02
A	Z	Tmax	12:42:55
MP	Z	Tmax	12:42:57
U	Z	Tmax	12:42:53
Pa	Z	Tmax	12:43:04

C&GS card 12-64:
11:30:15.7
36.5° N., 141.0° E.
Central Honshu, Japan
Felt: Tokyo
h about 46 km
Magnitude 6.25 (Pas), 5.4 (CGS), 5.8 (HVO).

Feb. 5

D	Z	eP	11:43:01.4 c
U	Z	eP	02.6 c
Na	Z	eP	11:42:59.3 c
Pa	Z	iP	11:43:03.8 d
Hi	Z	iP	05.1 c
Ha	Z	eP	07.3 d

C&GS card 12-64:
11:35:18.6
19.7° S., 179.8° W.
Fiji Islands region
h about 414 km
Magnitude 5.5 (CGS)

Feb. 6, 1964

M	Z	iP	13:14:26.1 c
A	Z	eP	27.1 c
D	Z	eP	27.4 c
U	Z	eP	26.4 c
Ha	Z	eP	18.3 c
Pa	Z	eP	25.7 c
Na	Z	iP	30.2 c
Ke	Z	iP	25.8 c
U	PEN	iS	13:20:12
U	PEZ	iR	13:24:02
M	Z	Tmax	13:52:57
A	Z	Tmax	50
D	Z	Tmax	44
MP	Z	Tmax	13:52:48
U	Z	Tmax	59
Pa	Z	Tmax	55
Ke	Z	Tmax	40
Ha	Z	Tmax	13:51:05

C&GS card 14-64:
13:07:25.2
55.7° N., 155.8° W.
Kodiak Island region
h about 33 km
Magnitude 6.75-7 (Pas), 6.5-6.75 (Brk), 6.75-7 (Pal), 6.5 (HVO).

Feb. 6

M	Z	iP	13:20:45.9 c
P	Z	iP	47.0 c
U	Z	eP	46.3 c
Pa	Z	iP	45.2 c
Na	Z	iP	49.5 c
M	Z	Tmax	13:59:04
A	Z	Tmax	04
D	Z	Tmax	13:58:57
MP	Z	Tmax	13:59:00
U	Z	Tmax	07
Pa	Z	Tmax	13:58:55
Ha	Z	Tmax	13:57:34
Ke	Z	Tmax	13:58:44

Feb. 6--Continued

C&GS card 14-64:
13:13:45.2
55.8° N., 155.9° W.
Kodiak Island region
h about 33 km
Magnitude 5.4 (CGS).

Feb. 6

M	Z	eP	15:32:28.5 d

C&GS card 12-64:
15:19:38.1
10.5° S., 120.7° E.
Sumba Island region
h about 43 km
Magnitude 4.9 (CGS).

Feb. 6

M	Z	Tmax	15:45:46
U	Z	Tmax	44
Pa	Z	Tmax	35
Ha	Z	Tmax	15:43:54

C&GS card 17-64:
15:00:32.6
56.1° N., 154.3° W.
Kodiak Island region
h about 33 km
Magnitude 4.4 (CGS).

Feb. 8

M	Z	iP	11:25:15.7 c

Feb. 8, 1964--Continued

A	Z	iP	17.1 d
U	Z	eP	16.2 c
Ha	Z	iP	08.9 d
Pa	Z	iP	17.5 d
Hi	Z	iP	15.3 d
Na	Z	iP	18.2 d
Ha	Z	Tmax	12:05:08

C&GS card 12-64:
11:17:46.5
52.3° N., 175.6° E.
Rat Islands, Aleutian Islands
h about 60 km
Magnitude 5.4 (CGS).

Feb. 9

M	Z	iP	02:07:23.4 c
A	Z	eP	23.0 c
U	Z	iP	23.2 c
Na	Z	iP	19.2 c
Hi	Z	iP	25.7 c
Ha	Z	iP	28.0 c

C&GS card 12-64:
02:00:07.3
16.5° S., 179.2° W.
Fiji Islands region
h about 480 km
Magnitude 5.3 (CGS).

Feb. 12

U	PEZ	iR	22:51:31
M	Z	Tmax	23:23:08
Ke	Z	Tmax	23:22:55

C&GS card 16-64:
22:33:59.2
15.3° S., 174.4° W.
Samoa Islands region
h about 33 km
Magnitude 5.75 (Brk), 5.0 (CGS).

Feb. 14

A	Z	eP	16:39:32.0 c
Na	Z	iP	28.2 c
U	PEE	eS	16:47:35
U	PEN	eG	16:53:43
U	PEZ	eR	16:56:07

Feb. 14--Continued

C&GS card 15-64:
16:29:45.0
5.1° S., 151.7° E.
New Britain
h about 55 km
Magnitude 6.75 (Pas), 6.0 (CGS), 6.4 (HVO).

Feb. 20

M	Z	iP	10:02:53.6 d
D	Z	eP	54.3 d

C&GS card 15-64:
09:53:51.1
44.6° N., 150.0° E.
Kurile Islands
h about 50 km
Magnitude 5.2 (CGS).

Feb. 26

M	Z	Tmax	21:14:56
A	Z	Tmax	56
U	Z	Tmax	56
Pa	Z	Tmax	34
Ka	Z	Tmax	56
Ha	Z	Tmax	37

C&GS card 16-64:
20:32:53.6
40.2° N., 124.6° W.
Near coast of Humboldt County, California
h about 27 km
Magnitude 4.6 (CGS)

Mar. 2

M	Z	iP	19:40:30.8 c
A	Z	iP	30.5 c
U	Z	iP	30.7 c
Pa	Z	iP	32.4 c
Ha	Z	iP	36.3 c

C&GS card 24-64:
19:32:41.7
18.9° S., 174.8° W.
Tonga Islands
h about 105 km
Magnitude 5.3 (CGS).

Mar. 3, 1964

M Z Tmax 20:44:04
Ha Z Tmax 20:43:42

C&GS card 18-64:
20:02:33.1
40.3° N., 125.1° W.
Near coast of Northern California
h about 33 km
Magnitude 4.8 (CGS).

Mar. 8

A Z iP 01:47:09.3 d
Pa Z iP 01:47:10.6 d

C&GS card 31-64:
01:35:48.1
44.0° S., 168.4° E.
South Island, New Zealand
h about 33 km
Magnitude 5.6 (CGS).

Mar. 10

M Z eP 14:11:41.2 c

C&GS card 20-64:
13:59:54.8
1.9° N., 127.5° E.
Molucca Passage
h about 117 km
Magnitude 5.6 (CGS).

Mar. 11

M Z iP 01:17:55.1 d

C&GS card 20-64:
01:06:00.4
1.8° N., 127.1° E.
Molucca Passage
h about 58 km
Magnitude 5.6 (CGS).

Mar. 14

M Z iP 15:13:24.8 d
NB Z iP 24.0 d
Pa Z iP 26.9 d
Na Z iP 21.0 d

Mar. 14--Continued

Ha Z eP 27.1 d

C&GS card 27-64:
15:05:54.4
13.7° S., 172.3° E.
New Hebrides Islands region
h about 611 km
Magnitude 5.1 (CGS).

Mar. 15

U PEZ ePP 22:50:18 c
U PEN iPS 23:00:12
U PEZ iSS 23:06:46
U PEE eSSS 23:09:44
U PEE eL 23:18:52
U PEZ iR 23:25:04

C&GS card 20-64:
22:30:26.0
36.2° N., 7.6° W.
West of Strait of Gibraltar
Felt: Portugal, Spain, Morocco
h about 27 km
Magnitude 6.75-7 (Pas), 7-7.25 (Bks), 6.25-6.5 (Pal), 6.2 (CGS), 6.8 (HVO).

Mar. 18

M Z iP 04:45:49.6 d
D Z iP 50.9 d
U Z iP 50.8 d
NB Z iP 49.0 d
Pa Z iP 51.1 d
Na Z iP 51.5 d
Hi Z iP 49.4 d
Ke Z iP 47.0 d
Ha Z iP 39.7 d
U PEN iS 04:52:40
U PEN esS 04:55:00

C&GS card 23-63:
04:37:26.9
52.5° N., 153.6° E.
Sea of Okhotsk
h about 440 km
Magnitude 5.6 (CGS).

Mar. 19, 1964

Na Z eP 21:51:21.4 d
Ke Z eP 26.5 d
U PEN eS 21:57:28
U PEZ eR 22:01:00

C&GS card 24-64:
21:44:03.8
15.1° S., 172.6° W.
Samoa Islands region
h about 33 km
Magnitude 5.6 (CGS).

Mar. 21

U Z iP 03:53:51.4 c
Pa Z iP 53.3 c
Na Z iP 49.6 c
Hi Z iP 53.5 c
Ke Z iP 48.6 c
U PEN iS 04:03:26
U PEN iSS 04:08:40

C&GS card 25-64:
03:42:19
6.4° S., 127.9° E.
Banda Sea
Felt: Darwin, Australia
h about 367 km.

Mar. 21

U Z iP 16:36:14.9 d
Hi Z iP 17.9 d
Ke Z iP 14.9 d
Ha Z iP 20.9 c

C&GS card 25-64:
16:27:11.7
27.6° S., 177.2° W.
Kermadec Islands region
h about 33 km
Magnitude 5.6 (CGS).

Mar. 22

M Z iP 05:44:17.6 d

C&GS card 26-64:
05:32:07.7
2.7° S., 126.4° E.

Mar. 22--Continued

C&GS card--Continued

Ceram Sea
h about 33 km
Magnitude 5.1 (CGS).

Mar. 24

Pa Z Tmax 10:23:53
Ha Z Tmax 10:23:03

C&GS card 25-64:
09:37:56.2
51.1° N., 129.6° W.
Vancouver Island region
h about 22 km
Magnitude 4.2 (CGS).

Mar. 25

Pa Z Tmax 09:28:04
Ha Z Tmax 09:28:02

C&GS card 26-64
08:46:13.0
40.4° N., 124.8° W.
Near Coast of Northern California
h about 33 km
Magnitude 4.5 (CGS).

Mar. 26

WP Z iP 02:14:45.8 d
U PEZ eR 02:32:01

C&GS card 27-64:
02:04:20.2
11.3° N., 142.0° E.
Mariana Islands
h about 33 km
Magnitude 4.9 (CGS).

Mar. 26

M	Z	eP	13:39:28.1 d
U	PEZ	eS	13:47:23
U	PEN	eG	13:52:37
U	PEZ	eR	13:54:55
M	Z	Tmax	14:39:05
A	Z	Tmax	14:39:08
D	Z	Tmax	14:39:04
MP	Z	Tmax	14:38:52
U	Z	Tmax	14:39:03
Pa	Z	Tmax	14:38:22
Na	Z	Tmax	14:38:58
Hi	Z	Tmax	14:38:37
NB	Z	Tmax	14:38:30
Ha	Z	Tmax	14:40:19

C&GS card 25-64:
13:29:56.2
4.4° S., 104.7° W.
1500 km southwest of Galapagos Islands
h about 33 km
Magnitude 4.9 (CGS)

Mar. 27

M	Z	eP	20:30:12.6 c
A	Z	eP	12.2 c
U	Z	eP	12.6 c
Ke	Z	iP	11.2 c
Hi	Z	eP	13.8 c
Ka	Z	eP	14.7 c
Ha	Z	eP	18.7 c

C&GS card 25-64:
20:22:10.6
23.7° S., 179.9° E.
South of Fiji Islands
h about 520 km
Magnitude 5.0 (CGS).

Mar. 27

M	Z	eP	20:30:12.6 c
A	Z	eP	12.2 c
U	Z	eP	12.9 c
Ke	Z	iP	10.2 c
Ha	Z	eP	18.7 c

Mar. 27--Continued

C&GS card 25-64:
20:22:10.6
23.7° S., 179.9° E.
South of Fiji Islands
h about 520 km
Magnitude 5.0 (CGS).

Major Alaskan Earthquake and its aftershocks are listed separately.

Mar. 28

M	Z	iP	11:42:22.3 d
A	Z	eP	22.2 d
D	Z	iP	21.4 d
U	Z	iP	22.5 d
Pa	Z	iP	23.9 d
Na	Z	iP	19.0 d
Hi	Z	eP	24.3 d
Ke	Z	iP	19.1 d

C&GS card 31-64:
11:30:09.8
0.5° N., 122.3° E..
Northern Celebes
h about 140 km
Magnitude 5.8 (CGS).

Mar. 29

M	Z	iP	21:50:15.6 c
D	Z	iP	14.8 c
Pa	Z	eP	18.0 c
Na	Z	iP	11.3 c
Ke	Z	iP	12.3 c
U	PEZ	eR	22:05:26

C&GS CARD 31-64:
21:40:32.7
6.7° S., 155.1° E.
Solomon Islands
Felt: Rabaul
h about 68 km
Magnitude 6 (Pal), 5.3 (CGS).

Mar. 31, 1964

M	Z	eP	00:23:24 c
Hi	Z	iP	00:23:23.4 c
U	PEE	eS	00:30:50
U	PEN	eG	00:35:10
U	PEZ	eR	00:37:18

C&GS card 31-64:
00:14:11.7
45.3° N., 151.0° E.
Kurile Islands
h about 60 km
Magnitude 5.5-5.75 (Pal), 5.3 (CGS).

Mar. 31

Ke	Z	iP	09:08:48.0 c
NB	Z	eP	09:08:43.5 c
U	PEE	eS	09:14:38
U	PEN	i	09:17:02
U	PEZ	eR	09:18:06
M		Tmax	09:47:16
A		Tmax	36
D		Tmax	27
U		Tmax	39
Pa		Tmax	29
Hi		Tmax	09
Ha		Tmax	09:46:43

C&GS card 31-64:
09:01:30.2
50.8° N., 130.2° W.
Vancouver Island region
h about 15 km
Magnitude 6 (Pas), 6-6.25 (Brk), 6.5-6.75 (Pal), 5.6 (CGS).

The Good Friday Alaskan Earthquake and its aftershocks

Mar. 28, 1964

A Z iP 03:44:05.3 d
D Z iP 05.4 d
U Z iP 04.6 d
Ke Z iP 03.9 d
Pa Z eP 03.8 d
Hi Z eP 01.6 d
Na Z iP 07.9 d
Ha Z eP 03:43:54.1 d

C&GS card 28-64:
03:36:12.7
61.1° N., 147.6° W.
Prince William Sound, Alaska
114 dead or missing, many injured and major property damage in Alaska. Extensive damage from seismic sea waves throughout the Gulf of Alaska, along the West Coast of North America, and in Hawaii.
h about 20 km
Magnitude 8.4 (Pas), 8.5-8.75 (Brk), 8.6 (Pal), (8.5 (CGS).

Mar. 28

M Z Tmax 06:22:30
Pa Z Tmax 29
Hi Z Tmax 07
Ha Z Tmax 06:20:59

C&GS card 28-64:
05:31:05.4
58.1° N., 150.1° W.
h about 33 km
Magnitude 5.3 (CGS).

Mar. 28

U Z Tmax 06:25:08
Pa Z Tmax 08

C&GS card 28-64:
05:33:52.6
60.2° N., 146.2° W.
h about 20 km
Magnitude 5.6 (CGS).

Mar. 28

U Z Tmax 06:35:50
Pa Z Tmax 39
Hi Z Tmax 27
Ha Z Tmax 06:34:15

C&GS card 28-64:
05:44:54.9
60.1° N., 148.4° W.
h about 33 km
Magnitude 4.9.

Mar. 28

M Z iP 06:16:26.9 d
D Z iP 28.2 d

C&GS card 28-64:
06:08:44.2
60.1° N., 148.6° W.
h about 20 km
Magnitude 4.25-4.5 (Brk), 5.6 (CGS).

Mar. 28

U Z eP 06:40:19.3 d
M Z iP 18.9 d
D Z iP 19.9 d
A Z iP 19.5 d

C&GS card 28-64:
06:32:38.6
60.1° N., 147.6° W.
h about 33 km
Magnitude 4.5-4.75 (Brk), 5.5 (CGS).

Mar. 28

M Z iP 06:49:09.9
U Z eP 10.1
Hi Z iP 07.4
U Z Tmax 07:31:16
Hi Z Tmax 01
Pa Z Tmax 33
Ha Z Tmax 07:30:05

The Good Friday Alaskan Earthquake and its aftershocks

Mar. 28--Continued

C&GS card 28-64:
06:41:28.0
59.9° N., 147.8° W.
h about 15 km
Magnitude 4.75-5 (Brk), 5.5 (CGS).

Mar. 28

U Z iP 06:51:22.8 d
Pa Z eP 06:51:21.1 d
Hi Z eP 20.0 d

C&GS card 28-64:
06:43:57.4
58.3° N., 151.3° W.
h about 25 km
Magnitude 5.5-5.75 (Brk), 6.1 (CGS).

Mar. 28

U Z eP 06:58:12.0 d
Hi Z iP 09.1 d

C&GS card 28-64:
06:50:48.9
57.1° N., 152.3° W.
h about 33 km
Magnitude 5.0 (CGS).

Mar. 28

U Z iP 07:01:07.0 c
Hi Z iP 04.3 c

C&GS card 28-64:
06:53:35.6
58.8° N., 149.5° W.
h about 20 km.

Mar. 28

U Z iP 07:17:52.5 d
Pa Z eP 50.9 d
Hi Z eP 49.9 d
Ha Z iP 42.4 d
Pa Z Tmax 07:59:22

C&GS card 28-64:
07:10:21.4
58.8° N., 149.5° W.
h about 20 km
Magnitude 6.2 (Pas), 5.75-6 (Brk), 6.1 (CGS).

Mar. 28

U Z Tmax 08:15:33
Pa Z Tmax 52
Hi Z Tmax 31
Ha Z Tmax 08:14:23

C&GS card 28-64:
07:24:21.7
59.3° N., 149.8° W.
h about 20 km
Magnitude 5.0 (CGS).

Mar. 28

U Z Tmax 08:17:22
Pa Z Tmax 45
Hi Z Tmax 27
Ha Z Tmax 08:16:01

C&GS card 28-64:
07:28:20.5
57.9° N., 150.4° W.
h about 20 km
Magnitude 5.0 (CGS).

Mar. 28

M Z iP 07:37:49.5 d
Pa Z Tmax 08:19:38

C&GS card 28-64:
07:30:29.6
57.4° N., 151.7° W.
h about 15 km
Magnitude 5.25-5.5 (Brk), 5.7 (CGS).

Mar. 28

U Z Tmax 08:37:19
Pa Z Tmax 37

The Good Friday Alaskan Earthquake and its aftershocks

Mar. 28--Continued

C&GS card 28-64:
07:47:47.1
58.3° N., 150.2° W.
h 33 km
Magnitude 4.8 (CGS).

Mar. 28

Pa Z Tmax 08:38:26

C&GS card 28-64:
07:48:47.8
57.0° N., 153.3° W.
h about 15 km
Magnitude 5.0 (CGS).

Mar. 28

Pa Z Tmax 08:47:20

C&GS card 28-64:
07:59:40.7
57.9° N., 150.3° W.
h about 25 km
Magnitude 4.4 (CGS).

Mar. 28

U Z iP 08:41:10.7 c
Pa Z iP 09.4 c

C&GS card 28-64:
08:33:47.0
58.1° N., 151.1° W.
h about 25 km
Magnitude 5.25-5.5 (Brk), 5.6 (CGS).

Mar. 28

M Z iP 08:47:14.0 c
U Z Tmax 09:27:27
Pa Z Tmax 27
Ha Z Tmax 09:25:53

C&GS card 28-64:
08:39:54.9
57.5° N., 151.6° W.
h about 20 km

Mar. 28

U Z Tmax 09:42:07
Pa Z Tmax 09:41:47
Ha Z Tmax 09:40:27

C&GS card 28-64:
08:55:22.8
56.7° N., 151.9° W.
h about 25 km
Magnitude 5.1 (CGS).

Mar. 28

U Z eP 09:08:10.7 d
Hi Z eP 07.6 d
U Z Tmax 09:47:32
Pa Z Tmax 31
Ha Z Tmax 09:46:02

C&GS card 28-64:
09:01:00.5
56.5° N., 152.0° W.
h about 20 km
Magnitude 6.2 (Pas), 5.5-5.75 (Brk), 6.0 (CGS).

Mar. 28

U Z Tmax 09:52:17
Pa Z Tmax 09:52:16
Hi Z Tmax 09:51:56
Ha Z Tmax 09:50:49

C&GS card 28-64:
09:05:56.4
56.6° N., 153.2° W.
h about 25 km
Magnitude 5.3.

The Good Friday Alaskan Earthquake and its aftershocks

Mar. 28

U Z Tmax 10:20:21
Pa Z Tmax 10:20:19
Hi Z Tmax 10:20:00
Ha Z Tmax 10:18:47

C&GS card 28-64:
09:34:01.5
56.8° N., 152.3° W.
h about 20 km
Magnitude 5.0 (CGS).

March 28

M Z eP 10:00:34.7 c
Pa Z eP 33.6 c
Hi Z eP 32.0 c
Pa Z Tmax 10:43:41
Hi Z Tmax 10:43:17
Ha Z Tmax 10:42:20

C&GS card 28-64:
09:52:55.7
59.7° N., 146.6° W.
h about 30 km
Magnitude 6.2 (Pas), 5-5.25 (Brk), 5.5 (CGS).

March 28

U Z Tmax 11:04:20
Pa Z Tmax 11:04:15
Ha Z Tmax 11:02:42

C&GS card 28-64:
10:17:48.5
56.6 N., 152.2 W.
h about 15 km
Magnitude 5.1 (CGS).

Mar. 28

U Z eP 10:40:19.1 c
Hi Z eP 16.0 c

C&GS card 28-64:
10:33:00.2
57.7° N., 152.2° W.
h about 35 km
Magnitude 5.2 (CGS).

Mar. 28

U Z Tmax 11:27:30
Hi Z Tmax 11:27:15
Ha Z Tmax 11:26:17

C&GS card 28-64:
10:35:31.2
60.9° N., 143.7° W.
h about 25 km
Magnitude 5.1 (CGS).

Mar. 28

U Z eP 10:42:52.6 d
Pa Z iP 52.1 d
U Z Tmax 11:22:43
Pa Z Tmax 11:22:29
Hi Z Tmax 11:22:07
Ha Z Tmax 11:21:05

C&GS card 28-64:
10:35:38.9
57.2° N., 152.4° W.
h about 33 km
Magnitude 6.3 (Pas), 5.75-6 (Brk), 6.0 (CGS).

Mar. 28

Pa Z Tmax 11:48:45

C&GS card 28-64:
10:57:18.1
60.6° N., 144.7° W.
h about 33 km
Magnitude 4.7.

Mar. 28

Pa Z Tmax 11:46:25

C&GS card 28-64:
10:59:16.3
57.4° N., 151.6° W.
h about 30 km
Magnitude 5.2(CGS).

Mar. 28

U Z iP 11:16:15.1 d
Pa Z 13.6 d
Hi Z 12.0 d
Pa Z Tmax 11:59:38

C&GS card 28-64:
11:08:26.0
60.1° N., 148.4° W.
h about 15 km
Magnitude 5.6 (Pas), 5.25-5.5 (Brk), 5.7 (CGS).

Mar. 28

M Z iP 11:39:50.3 d

C&GS card 28-64:
11:32:19.0
59.0° N., 149.5° W.
h about 20 km
Magnitude 4.9 (CGS).

Mar. 28

U Z eP 12:11:03.6 d
Hi Z iP 01.1 d
U Z Tmax 12:56:50
Pa Z Tmax 12:56:46
Hi Z Tmax 12:56:24
Ha Z Tmax 12:55:01

C&GS card 28-64:
12:03:16.5
60.3° N., 146.6° W.
h about 15 km
Magnitude 5.1 (Pas), 5.4 (CGS).

Mar. 28

U Z iP 12:27:59.4 c
Pa Z iP 58.2 c
Hi Z iP 56.8 c
U Z Tmax 13:07:07
Pa Z Tmax 13:07:08
Hi Z Tmax 13:06:42
Ha Z Tmax 13:05:38

Mar. 28--Continued

C&GS card 28-64:
12:20:49.8
56.5° N., 154.0° W.
h about 25 km
Magnitude 6.5 (Pas), 5.25-5.75 (Brk), 6.1 (CGS).

Mar. 28

U Z Tmax 13:20:21
Pa Z Tmax 13:20:18
Ha Z Tmax 13:18:46

C&GS card 28-64:
12:31:29.8
59.1° N., 149.6° W.
h about 20 km
Magnitude 4.7 (CGS).

Mar. 28

U Z eP 13:08:57.7 c
Pa Z eP 56.6 c
Hi Z eP 55.4 c
U Z Tmax 13:52:22
Pa Z Tmax 13:52:13
Hi Z Tmax 13:51:58
Ha Z Tmax 13:50:46

C&GS card 28-64:
13:01:14.2
60.1° N., 147.0° W.
h about 20 km
Magnitude 5.1 (CGS).

Mar. 28

M Z iP 14:02:15.4 c
U Z Tmax 14:48:17
Pa Z Tmax 14:48:09
Hi Z Tmax 14:47:48
Ha Z Tmax 14:46:24

C&GS card 28-64:
13:54:19.9
62.1° N., 147.1° W.
h about 15 km
Magnitude 4.6 (CGS).

Mar. 28

U Z Tmax 15:32:42
Pa Z Tmax 15:32:47
Hi Z Tmax 15:32:21
Ha Z Tmax 15:30:55

C&GS card 31-64:
14:46:33.6
56.7° N., 153.6° W.
h about 33 km
Magnitude 4.9 (CGS).

Mar. 28

U Z iP 14:55:25.0 c
Pa Z iP 24.3 c
Hi Z iP 22.3 c
U Z Tmax 15:39:14
Pa Z Tmax 15:39:11
Hi Z Tmax 15:38:32
Ha Z Tmax 15:37:20

C&GS card 28-64:
14:47:37.1
60.4° N., 146.5° W.
h about 10 km
Magnitude 6.3 (Pas), 5.75-6 (Brk), 6.5-6.75 (Pal), 5.7 (CGS).

Mar. 28

U Z iP 14:57:00.9 d
Pa Z iP 14:56:59.7 d
Hi Z eP 14:56:58.2 d
U Z Tmax 15:40:50
Pa Z Tmax 15:40:56
Hi Z Tmax 15:40:27
Ha Z Tmax 15:39:30

C&GS card 28-64:
14:49:13.7
60.4° N., 147.1° W.
h about 10 km
Magnitude 6.5 (Pas), 5.5-5.75 (Brk), 5.8 (CGS).

Mar. 28

U Z Tmax 17:13:46
Pa Z Tmax 17:13:38
Ha Z Tmax 17:12:21

C&GS card 28-64:
16:26:16.9
57.5° N., 150.9° W.
h about 30 km
Magnitude 5.0 (CGS).

Mar. 28

U Z eP 16:52:12.1 c
U Z Tmax 17:35:14
Pa Z Tmax 17:34:47
Hi Z Tmax 17:34:32
Ha Z Tmax 17:33:22

C&GS card 28-64:
16:44:35.9
59.3° N., 147.8° W.
h about 25 km
Magnitude 4.75-5 (Brk), 5.3 (CGS).

Mar. 28

Pa Z Tmax 18:52:45

C&GS card 28-64:
18:02:54.9
59.5° N., 149.3° W.
h about 33 km
Magnitude 4.6.

Mar. 28

U Z iP 20:36:45.5 d
Pa Z iP 44.7 d
Hi Z iP 42.3 d
Ha Z eP 37.6 d
U PEZ iS 20:42:57
U PEE eG 20:45:45
U PEZ iR 20:47:39
U Z Tmax 21:20:22
Pa Z Tmax 21:20:18
Hi Z Tmax 21:19:59
Ha Z Tmax 21:19:02

Mar. 28--Continued

C&GS card 28-64:
20:29:08.6
59.8° N., 148.7° W.
h about 40 km
Magnitude 6.6 (Pas), 6.5-6.75 (Brk, Pal), 5.8 (CGS), 6.6 (HVO).

Mar. 28

U	Z	Tmax 00:34:09
Pa	Z	Tmax 00:33:55
Hi	Z	Tmax 00:33:31
Ha	Z	Tmax 00:32:21

C&GS card 28-64:
23:46:22.0
57.5° N., 151.1° W.
h about 33 km
Magnitude 5.0 (Pas), 5.5-5.75 (Brk), 5.2 (CGS).

Mar. 29

Pa	Z	Tmax 00:59:09

C&GS card 29-64
00:12:32.3
56.8° N., 153.4° W.
h about 33 km
Magnitude 4.5 (CGS).

Mar. 29

M	Z	eP	01:17:16.4 c

C&GS card 29-64:
01:09:36.4
59.8° N., 149.2° W.
h about 20 km
Magnitude 5.2 (Pas), 5.25-5.5 (Brk), 5.5 (Pal), 5.5 (CGS).

Mar. 29

U	Z	Tmax 02:17:05
Pa	Z	Tmax 02:17:05
Hi	Z	Tmax 02:16:42
Ha	Z	Tmax 02:15:42

Mar. 29--Continued

C&GS card 29-64:
01:29:33.7
57.5° N., 151.3° W.
h about 20 km
Magnitude 4.6 (Pas), 5.75-6 (Brk), 5.6 (CGS).

Mar. 29

U	Z	Tmax 02:34:31
Pa	Z	Tmax 02:34:22
Hi	Z	Tmax 02:34:06
Ha	Z	Tmax 02:32:52

C&GS card 29-64:
01:48:18.5
56.3° N., 153.7° W.
h about 20 km
Magnitude 4.8 (CGS).

Mar. 29

U	Z	Tmax 02:54:09
Pa	Z	Tmax 02:54:09
Hi	Z	Tmax 02:53:43
Ha	Z	Tmax 02:52:38

C&GS card 29-64:
02:07:41.6
56.5° N., 152.6° W.
h about 20 km
Magnitude 4.5 (CGS).

Mar. 29

U	Z	Tmax	03:12:25
Pa	Z	Tmax	03:12:21

C&GS card 29-64:
02:25:25.1
57.0° N., 151.7° W.
h about 20 km
Magnitude 5.2 (CGS).

Mar. 29

U	Z	iP	04:20:01.9 c
U	Z	Tmax	05:03:45
Pa	Z	Tmax	05:03:42
Hi	Z	Tmax	05:03:23

Mar. 29--Continued

Ha	Z	Tmax 05:02:18

C&GS card 29-64:
04:12:15.7
60.2° N., 145.5° W.
h about 15 km
Magnitude 5.2 (Pas), 4.75-5 (Brk), 5.3 (CGS).

Mar. 29

U	Z	Tmax 05:38:29
Pa	Z	Tmax 05:38:35
Hi	Z	Tmax 05:38:05
Ha	Z	Tmax 05:36:56

C&GS card 29-64:
04:51:53.3
56.8° N., 152.4° W.
h about 40 km
Magnitude 4.8.

Mar. 29

Pa	Z	Tmax 05:54:50

C&GS card 29-64:
05:08:25.8
56.7° N., 152.7° W.
h about 20 km
Magnitude 4.6 (CGS).

Mar. 29

Pa	Z	Tmax 06:04:21

C&GS card 29-64:
05:13:42.4
59.5° N., 147.4° W.
h about 33 km
Magnitude 3.9 (CGS).

Mar. 29

Pa	Z	Tmax 06:08:24

C&GS card 29-64:
05:21:09.8
57.1° N., 150.4° W.

Mar. 29

C&GS card--Continued

h about 20 km
Magnitude 4.4 (CGS).

Mar. 29

Pa	Z	Tmax 06:24:21

C&GS card 29-64:
05:37:47.4
56.9° N., 153.3° W.
h about 25 km
Magnitude 4.8.

Mar. 29

U	Z	eP	06:11:48.7 c
U	PEZ	iS	06:17:34
U	PEE	iG	06:20:10
U	PEZ	iR	06:21:50
U	Z	Tmax	06:50:49
Pa	Z	Tmax	06:50:46
Hi	Z	Tmax	06:50:22
Ha	Z	Tmax	06:48:58

C&GS card 29-64:
06:04:44.5
56.1° N., 154.3° W.
h about 30 km
Magnitude 5.8 (Pas), 5.25-5.5 (Brk), 6-6.25 (Pal), 5.6 (CGS).

Mar. 29

U	Z	Tmax	07:39:23
Pa	Z	Tmax	07:39:20
Ha	Z	Tmax	07:38:00

C&GS card 29-64:
06:53:19.5
56.1° N., 154.5° W.
h about 25 km
Magnitude 4.8 (CGS).

Mar. 29, 1964

Pa Z Tmax 08:04:51

C&GS card 29-64:
07:18:08.0
57.0° N., 151.8° W.
h about 25 km
Magnitude 4.8 (CGS).

Mar. 29

M Z eP 08:00:00.2 d
U Z Tmax 08:38:59
Pa Z Tmax 08:38:32
Hi Z Tmax 08:38:37
Ha Z Tmax 08:37:13

C&GS card 29-64:
07:52:46.4
56.1° N., 154.2° W.
h about 25 km
Magnitude 4.9 (Pas), 4.8 (CGS).

Mar. 29

Pa Z Tmax 08:52:21

C&GS card 29-64:
08:06:03.7
56.6° N., 152.4° W.
h about 25 km
Magnitude 4.5 (CGS).

Mar. 29

U Z Tmax 08:54:08
Pa Z Tmax 08:54:05
Ha Z Tmax 08:52:38

C&GS card 29-64:
08:07:52.3
56.5° N., 152.6° W.
h about 20 km
Magnitude 4.9 (CGS).

Mar. 29

Pa Z Tmax 09:36:25

C&GS card 29-64:
08:50:03.6

Mar. 29--Continued

C&GS card 29-64--Continued

56.7° N., 152.1° W.
h about 33 km
Magnitude 4.3 (CGS).

Mar. 29

Pa Z Tmax 09:53:09

C&GS card 29-64:
09:06:44.8
56.6° N., 152.2° W.
h about 15 km
Magnitude 4.8.

Mar. 29

M Z eP 09:23:29.2 d

C&GS card 31-64:
09:15:55.4
58.4° N., 150.5° W.
h about 15 km
Magnitude 4.6 (CGS).

Mar. 29

U Z iP 10:15:44.2 d

C&GS card 29-64:
10:08:02.4
60.0° N., 148.6° W.
h about 20 km
Magnitude 5.0 (Pas), 5.25-5.5 (Brk), 5.3 (CGS).

Mar. 29

M Z eP 10:57:05.2 c
Pa Z Tmax 11:37:39

C&GS card 29-64:
10:49:40.3
58.2° N., 150.4° W.
h about 25 km
Magnitude 5.2 (CGS).

Mar. 29, 1964

M Z eP 12:03:56.5 c

C&GS card 29-64:
11:56:33.0
58.0° N., 151.6° W.
h about 20 km
Magnitude 5.1 (CGS).

Mar. 29

U Z Tmax 13:39:22
Pa Z Tmax 13:39:19
Hi Z Tmax 13:38:59
Ha Z Tmax 13:37:59

C&GS card 29-64:
12:48:05.9
59.9° N., 145.6° W.
h about 25 km
Magnitude 4.5 (CGS).

Mar. 29

Pa Z Tmax 16:25:17

C&GS card 29-64:
15:39:28.6
56.1° N., 154.4° W.
h about 25 km
Magnitude 4.2 (CGS).

Mar. 29

U Z eP 16:17:02.8 d

C&GS card 29-64:
16:09:15.3
60.3° N., 146.6° W.
h about 15 km
Magnitude 4.8 (CGS).

Mar. 29

U Z Tmax 17:10:05
Pa Z Tmax 17:09:59
Hi Z Tmax 17:09:39

C&GS card 29-64:
16:18:29.3
60.4° N., 146.0° W.

Mar. 29--Continued

h about 15 km
Magnitude 4.9 (Pas), 5.0 (CGS).

Mar. 29

U Z eP 16:48:41.8 c
Pa Z eP 41.2 c
Hi Z eP 39.0 c
Ha Z eP 33.8 c
U PEZ eS 16:55:06
U PEE eG 16:58:08
U PEZ iR 16:59:50
U Z Tmax 17:31:47
Pa Z Tmax 17:31:52
Hi Z Tmax 17:31:33

C&GS card 31-64:
16:40:57.9
59.7° N., 147.0° W.
h about 15 km
Magnitude 5.8 (Pas), 5.5-5.75 (Brk), 5.6 (CGS).

Mar. 29

U Z eP 16:53:15.4 d
U Z Tmax 17:36:26
Pa Z Tmax 17:36:29
Hi Z Tmax 17:36:01

C&GS card 31-64:
16:45:33.6
59.8° N., 146.9° W.
h about 20 km
Magnitude 4.75-5 (Pas), 6.25 (Pal), 5.3 (CGS).

Mar. 29

U Z iP 17:01:14.3 c
Hi Z iP 11.5 c
U Z Tmax 17:44:58
Pa Z Tmax 17:45:10
Hi Z Tmax 17:44:40
Ha Z Tmax 17:43:46

C&GS card 29-64:
16:53:26.6
60.3° N., 146.1° W.
h about 15 km
Magnitude 4.75-5 (Brk), 5.2 (CGS).

Mar. 29, 1964

Pa Z Tmax 18:12:18

C&GS card 29-64:
17:26:00.2
56.4° N., 153.3° W.
h about 33 km
Magnitude 4.1 (CGS).

Mar. 29

Pa	Z	Tmax	20:00:26
Hi	Z	Tmax	20:00:08
Ha	Z	Tmax	19:58:57

C&GS card 29-64:
19:09:03.3
60.1° N., 146.0° W.
h about 15 km
Magnitude 4.6 (CGS).

Mar. 29

M	Z	iP	23:57:10.7 d
Hi	Z	Tmax	00:39:45
Ha	Z	Tmax	00:38:55

C&GS card 29-64:
23:49:28.6
59.9° N., 147.1° W.
h about 20 km
Magnitude 4.8 (CGS).

Mar. 30

U	Z	eP	02:25:18.2 c
Pa	Z	eP	17.0 c
Hi	Z	eP	15.4 c
Ha	Z	iP	11.0 c
U	PEN	iS	02:31:16
U	PEZ	iR	02:35:00
U	Z	Tmax	03:04:25
Pa	Z	Tmax	03:04:31
Hi	Z	Tmax	03:04:04
Ha	Z	Tmax	03:03:05

Mar. 29--Continued

C&GS card 30-64:
02:18:06.3
56.6° N., 152.9° W.
h about 25 km
Magnitude 6.6 (Pas), 6.5-6.75 (Brk), 6.75 (Pal), 5.8 (CGS).

Mar. 30

U	Z	Tmax	03:28:20
Pa	Z	Tmax	03:28:15
Hi	Z	Tmax	03:28:01
Ha	Z	Tmax	03:26:52

C&GS CARD 30-64:
02:41:59.6
56.5° N., 153.0° W.
h about 30 km
Magnitude 4.9.

Mar. 30

U	Z	Tmax	05:13:29
Pa	Z	Tmax	05:13:17
Hi	Z	Tmax	05:12:57
Ha	Z	Tmax	05:11:54

C&GS card 30-64:
04:22:43.1
59.5° N., 146.3° W.
h about 15 km
Magnitude 4.5 (CGS).

Mar. 30

U	Z	eP	07:17:18.2 c
Pa	Z	iP	17.4 c
Ha	Z	iP	08.8 c
U	PEZ	iS	07:23:32
U	PEN	i	07:26:58
U	PEZ	iR	07:28:12
U	Z	Tmax	08:00:49
Pa	Z	Tmax	08:00:52
Hi	Z	Tmax	08:00:27
Ha	Z	Tmax	07:59:31

Mar. 30--Continued

C&GS card 30-64:
07:09:34.0
59.9° N., 145.7° W.
h about 15 km
Magnitude 6.2 (Pas), 5.75-6 (Brk) 6.25-6.5 (Pal), 5.6 (CGS).

Mar. 30

Pa	Z	Tmax	08:42:34
Ha	Z	Tmax	08:41:40

C&GS card 30-64:
07:56:29.1
56.3° N., 154.4° W.
h about 20 km
Magnitude 5.0 (CGS).

Mar. 30

Pa	Z	Tmax	09:26:32
Ha	Z	Tmax	09:24:56

C&GS card 30-64:
08:40:10.7
56.5° N., 153.0° W.
h about 20 km
Magnitude 4.3 (CGS).

Mar. 30

U	Z	Tmax	10:14:14
Pa	Z	Tmax	10:14:21
Hi	Z	Tmax	10:13:55
Ha	Z	Tmax	10:12:55

C&GS card 30-64:
09:23:05.0
59.9° N., 145.6° W.
h about 33 km
Magnitude 4.5 (CGS).

Mar. 30

Ha Z Tmax 11:46:17

Mar. 30--Continued

C&GS card 30-64:
10:59:27.6
58.4° N., 149.2° W.
h about 25 km
Magnitude 5.0 (CGS).

Mar. 30

M	Z	eP	11:55:51.2 c
U	Z	Tmax	02:35:10
Pa	Z	Tmax	02:35:01
Hi	Z	Tmax	02:34:44
Ha	Z	Tmax	02:33:27

C&GS card 30-64:
11:48:40.4
56.4° N., 152.5° W.
h about 20 km
Magnitude 5.2 (CGS).

Mar. 30

M	Z	eP	12:13:27.0 c
U	Z	Tmax	12:56:51
Pa	Z	Tmax	12:56:43
Hi	Z	Tmax	12:56:33
Ha	Z	Tmax	12:55:29

C&GS card 30-64:
12:05:43.5
60.1° N., 147.0° W.
h about 25 km
Magnitude 5.0 (Pas), 5.0 (CGS).

Mar. 30

M Z eP 12:21:41.1 c

C&GS card 30-64:
12:14:28.4
58.9° N., 151.6° W.
h about 25 km
Magnitude 5.0 (CGS).

Mar. 30, 1964--Continued

U Z Tmax 13;29:07
Pa Z Tmax 13:29:06
Hi Z Tmax 13:28:39
Ha Z Tmax 13:27:41

C&GS card 30-64:
12:38:16.0
59.7° N., 146.9° W.
h about 30 km
Magnitude 5.0 (CGS).

Mar. 30

U Z Tmax 13:45:54
Pa Z Tmax 13:45:59
Hi Z Tmax 13:45:37
Ha Z Tmax 13:44:41

C&GS card 30-64:
12:55:12.5
59.7° N., 147.0° W.
h about 30 km
Magnitude 4.6 (CGS).

Mar. 30

M Z eP 13:10:45.7
U Z Tmax 13:50:08
Pa Z Tmax 13:49:55
Hi Z Tmax 13:49:47
Ha Z Tmax 13:48:35

C&GS card 31-64:
13:03:34.9
56.5° N., 152.7° W.
h about 20 km
Magnitude 5.3 (CGS), 4.75-5 (Brk), 5.5-5.75 (Pal), 5.3 (CGS).

Mar. 30

U Z Tmax 14:18:45
Pa Z Tmax 14:18:35
Hi Z Tmax 14:18:20
Ha Z Tmax 14:17:11

Mar. 30--Continued

C&GS card 30-64:
13:32:18.5
56.4° N., 152.6° W.
h about 15 km
Magnitude 4.8 (CGS).

Mar. 30

M Z eP 15:15:27.1 d

C&GS card 30-64:
15:07:49.3
58.7° N., 149.6° W.
h about 25 km
Magnitude 5.3 (CGS).

Mar. 30

Hi Z iP 16:16:36.5 c
U Z Tmax 16:56:02
Pa Z Tmax 16:55:55
Hi Z Tmax 16:55:34
Ha Z Tmax 16:54:35

C&GS card 30-64:
16:09:28.4
56.6° N., 152.1° W.
h about 25 km
Magnitude 5.5 (Pas), 5.5-5.75 (Brk), 5.75-6 (Pal), 5.5 (CGS).

Mar. 30

U Z Tmax 17:30:51
Pa Z Tmax 17:30:35
Hi Z Tmax 17:30:11
Ha Z Tmax 17:29:16

C&GS card 30-64:
16:38:26.5
60.1° N., 150.7° W.
h about 15 km
Magnitude 4.4 (CGS).

Mar. 30

U Z Tmax 17:39:48

Mar. 30--Continued

Pa Z Tmax 17:39:35
Hi Z Tmax 17:39:18
Ha Z Tmax 17:38:11

C&GS card 30-64:
16:53:07.7
56.6° N., 152.2° W.
h about 15 km
Magnitude 5.0 (CGS).

Mar. 30

Pa Z Tmax 17:50:47
Ha Z Tmax 17:49:19

C&GS card 31-64:
17:04:21
56.7° N., 152.5° W.
h about 33 km
Magnitude 4.3 (CGS).

Mar. 30

Ha Z Tmax 18:05:18

C&GS card 30-64:
17:16:06.7
59.6° N., 146.5° W.
h about 33 km
Magnitude 4.3 (CGS).

Mar. 31

Ha Z Tmax 02:44:17

C&GS card 30-64:
01:57:54.3
57.6° N., 150.1° W.
h about 20 km
Magnitude 4.8 (CGS).

Mar. 31

Pa Z Tmax 03:29:49
Ha Z Tmax 03:27:56

C&GS card 30-64:
02:43:35.6
56.7° N., 154.0° W.

Mar. 31--Continued

h about 20 km
Magnitude 4.7 (CGS).

Mar. 31

Pa Z Tmax 05:33:44
Hi Z Tmax 05:33:21
Ha Z Tmax 05:32:12

C&GS card 30-64:
04:46:06.1
57.6° N., 151.2° W.
h about 33 km
Magnitude 4.7 (CGS).

Mar. 31

U Z iP 11:11:06.2 c
Pa Z eP 04.6 c

C&GS card 30-64:
11:03:35.4
58.9° N., 149.9° W.
h about 20 km
Magnitude 5.0 (CGS).

Mar. 31

U Z Tmax 12:39:50
Pa Z Tmax 12:40:07
Hi Z Tmax 12:39:37
Ha Z Tmax 12:38:33

C&GS card 34-64:
11:53:14.4
56.5° N., 152.3° W.
h about 25 km
Magnitude 4.8 (CGS).

Mar. 31

Pa Z Tmax 13:40:07
Ha Z Tmax 13:38:39

C&GS card 31-64:
12:53:43.6
56.7° N., 152.2° W.
h about 33 km
Magnitude 4.3 (CGS).

Table 5.--Distant earthquakes--Continued

The Good Friday Alaskan Earthquake and its aftershocks

Mar. 31, 1964 M Z iP 21:11:27.7 c C&GS card 30-64: 21:04:01.1 58.2° N., 150.3° W. h about 20 km Magnitude 5.2 (CGS).	

Table 6.--U.S. Geological Survey seismograph stations in Hawaii

Station	Symbol	Location		Altitude (m) above sea level	Equipment (Z, vertical; N, north-south; E, east-west)
		Latitude N.	Longitude W.		
Uwekahuna (Hawaiian Volcano Observatory)	U	19°25.4'	155°17.6'	1,240	Long-period Press-Ewing: N, E, Z. (Seismometer and galvanometer periods are 15 and 90 seconds, respectively.) Short-period Sprengnether: E, Z. HVO-1: Z 1/. Short-base liquid-level tiltmeter.
Mauna Loa	M	19°29.8'	155°23.3'	2,010	Remote recording HVO-2: Z 2/.
Ahua	A	19°22.4'	155°15.9'	1,070	Do.
Desert	D	19°20.2'	155°23.3'	815	Do.
North Pit	N	19°24.9'	155°17.0'	1,115	Do.
West Pit	WP	19°24.7'	155°17.5'	1,115	Do.
Makaopuhi	MP	19°21.8'	155°10.7'	885	1.0 sec. Benioff with transistorized pre-amplifier: Z. Wired into HVO-2 recording system.
Hilo	Hi	19°43.2'	155°05.3'	20	HVO-1: Z. Wood-Anderson: N, E. Operated by Sister Thecla at St. Joseph's School.
Kipapa Oahu	Kip	21°25.4'	158°00.9'	76	HVO-1: Z. Operated by U.S. Coast and Geodetic Survey.

Table 6.--U.S. Geological Survey seismograph stations in Hawaii

Station	Symbol	Location		Altitude (m) above sea level	Equipment (Z, vertical; N, north-south E, east-west)
		Latitude N.	Longitude W.		
Naalehu	Na	19°03.8'	155°35.2'	205	1.0 sec. EV-17 seismometer, 0.5 s galvanometer: Z. Operated by Rev. D. Thompson at Naalehu School.
Pahoa	Pa	19°29.7'	154°56.8'	205	HVO-1: Z. Operated by Mr. K. Kimura at Pahoa School.
Kamuela	Ka	20°01.9'	155°42.0'	740	HVO-1: Z. Operated by Mr. Ed. Van Gorder, Preparatory Academy, Kamuela.
Haleakala, Maui	Ha	20°46.0'	156°15.0'	2,090	HVO-1: Z. Wood-Anderson: N, E. Operated by the staff of Haleakala National Park, Maui.
North Bay Installed 3/12/64	NB	19°29.7'	155°34.8'	4,005	0.8 sec. EV-17: Z. with helicorder. Operated by U.S. Weather Bureau.
Kealakekua Installed 1/28/64	Ke	19°31.2'	155°55.3'	505	1.0 sec. EV-17, 0.2 sec. galvanometer: Z. Wood-Anderson: N, E. Operated by Mr. H. Nelson at Kona County Hospital.

See footnotes at end of table, p.43 .

Table 6.--U.S. Geological Survey seismograph stations in Hawaii--Continued

1/ HVO-1 is a moving-coil, hinged, vertical-component seismograph with seismometer and galvanometer periods of 0.5 second. Over-damping of both seismometer and galvanometer is used to control the strong galvanometer reaction. This seismograph has a peak magnification of about 20,000 at a period of 0.25 second. Recording is optical, on photographic paper.

2/ HVO-2 is a moving-coil, vertical-component seismograph with a seismometer period of 0.8 second. Its signal is transmitted over telephone wires to the Hawaiian Volcano Observatory, where it is recorded on smoked paper. The response of this seismograph is similar to that of HVO-1. Records from these seismographs at M, A, and D, and at N, WP, and MP (Benioff) are recorded on two 3-component drums to permit more accurate comparison of arrival times at these stations.

The following persons or agencies reported "felt" earthquakes during the first quarter, 1964. Their assistance is gratefully acknowledged.

Kilauea summit area

Mr. and Mrs. G. Yong
Mrs. W. Mist
Mr. H. Powers
Mrs. C. Wentworth
Mrs. V. Hansen
Miss M. English
Mr. W. Cuskelly
Mr. R. Koyanagi
Mr. A. Yamamoto
Mrs. O. Duncan
Mr. J. Forbes

North Hawaii

Honokaa Police Dept.
Mrs. R. Eklund
Mrs. P. Christensen
Mrs. P. Richards
Mrs. A. Walker
Mr. E. Van Gorder
Mrs. E. Lindsey

Hilo region

Mr. R. Baldwin
Mr. C. Shoemaker
Mr. J. Bryan
Mr. H. Pierce
Mrs. B. Shaffer
Mr. W. Southward
Mrs. C. Guerin o
Miss E. Patten
Mrs. H. Lewis
Mrs. C. Hubbard
Miss R. Chiquita

Puna

Mr. R. Williamson
Mrs. D. Isbell
Mr. H. Warner
Mr. K. Kimura

Kau

Mrs. P. Billings
Mrs. A. Paiva

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

SUMMARY 34

April, May, and June 1964

by

Arnold T. Okamura, Robert Y. Koyanagi
and Willie T. Kinoshita

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

SUMMARY 34

April, May, and June 1964

by

Arnold T. Okamura, Robert Y. Koyanagi
and Willie T. Kinoshita

Issued February 1965

Observatory Staff

Geology

H. A. Powers (Scientist-in-charge)
D. L. Peck

Geophysics

D. P. Hill
W. T. Kinoshita
George Kojima
R. Y. Koyanagi
A. T. Okamura

Geochemistry

R. T. Okamura
T. L. Wright

Support

E. T. Endo
J. C. Forbes
W. H. Francis
B. J. Loucks
Akira Yamamoto

Chronological summary

Hawaiian volcanoes were exceptionally quiet during the second quarter of 1964. From April 1 to May 15 no measurable tilting was indicated by the short-base tiltmeter that is read daily. During this span of time there were a few bursts of tremor (April 16 to April 22) and six scattered earthquakes barely large enough to be felt. On May 23, in the Kaoiki fault system, an earthquake of magnitude 3 was followed by 27 aftershocks in less than 2 hours. A Kohala-centered quake of 3.5 magnitude was felt on May 28. Two quakes were felt on June 4, the first at about 08^h30^m from 45 km depth under Kilauea, and the second at about 13^h30^m, from a shallow quake on the southeast flank of Mauna Loa. Other quakes were felt on June 8, 17, and 18.

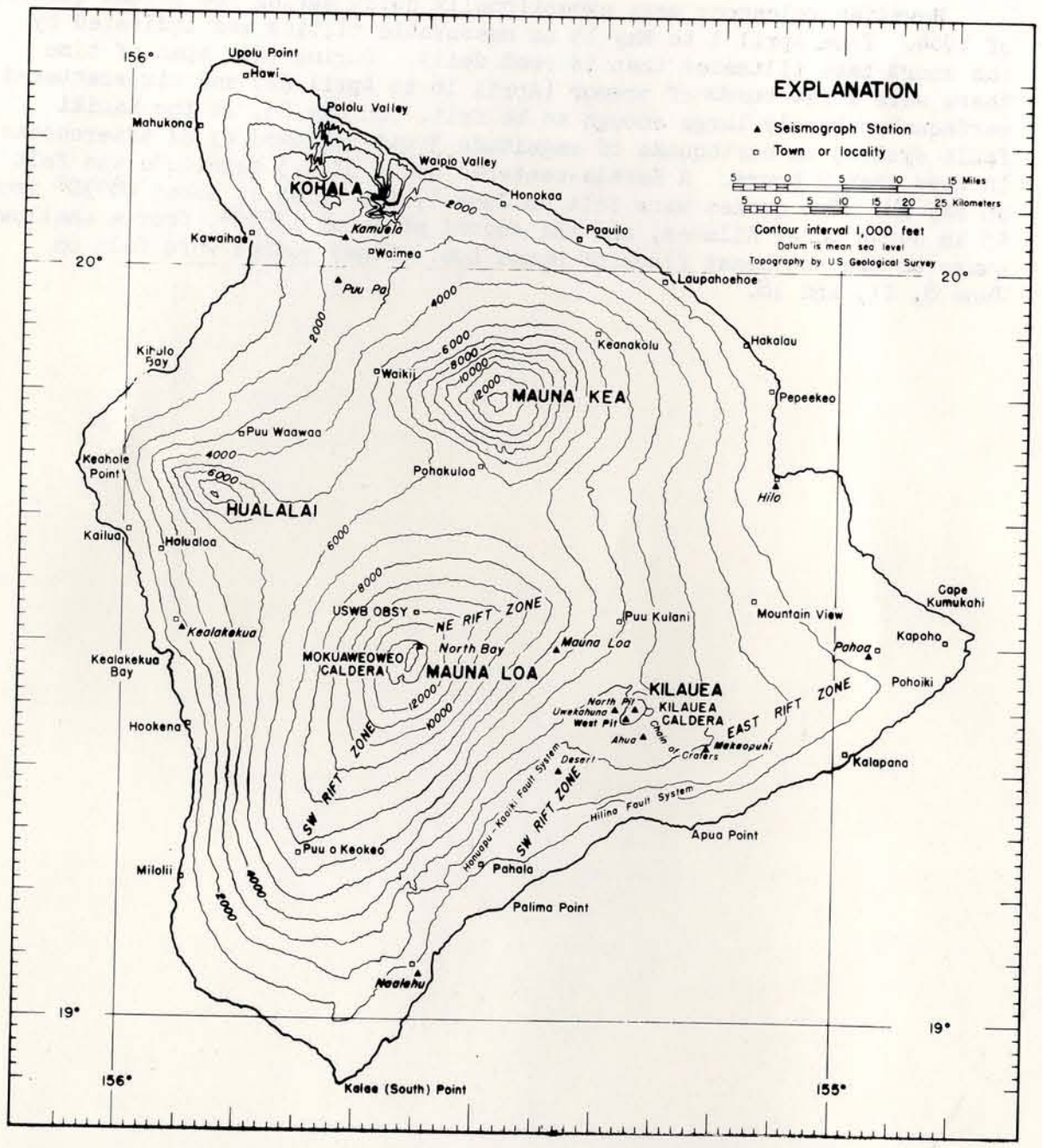

Figure 1.--Map of the island of Hawaii showing seismograph stations operated by the Geological Survey and localities mentioned in the text. Epicenters of local earthquakes are given in terms of geographic coordinates, which are indicated at the edges of the map.

Tilting of the ground around Kilauea caldera.--Tilting of the ground around the summit of Kilauea is monitored daily by a short-base water-tube tiltmeter in Uwekahuna Vault, and at irregular intervals it is measured on a regional scale by means of a network of field tilt-bases and a portable water-tube tiltmeter. The attitude of the ground surface at each tilt base is reported in terms of north-south and east-west tilt coordinates. Both coordinates at each station were arbitrarily set equal to 500 when measurements at that station were begun. 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 corresponds to a tilting of 1 microradian (1 mm per km) in the direction indicated.

Table 1.--Tilt coordinates at Uwekahuna Vault, April, May, and June 1964

Date	N-S	E-W	Date	N-S	E-W
Mar. 5	460	506	June 7	465	506
12	461	506	14	466	505
19	461	506	21	466	507
26	462	503	28	467	502
May 3	463	502			
10	462	503			
17	464	501			
24	464	501			
31	464	500			

Second quarter, 1964

Table 2.--Tilt coordinates and changes at bases around Kilauea caldera (See tilt diagram, fig. 2.)

Tilt base (location)	Date (1964)	Tilt coordinates N-S	Tilt coordinates E-W	Rate (10^{-6} rad/mo) and direction of tilting since last reading	Date of last reading (1964)
Uwekahuna (19°25.5' N., 155°17.4' W.)	April 29	452.5	491.9	5.0 N. 43.3° W.	Jan. 22
Tree Molds (19°26.3' N., 155°17.3' W.)	May 1	433.2	510.9	2.2 N. 19.3° W.	21
Sand Spit (19°24.1' N., 155°16.8' W.)	May 1	848.5	768.5	0.6 S. 25.7° E.	23
Kalihipaa (19°21.4' N., 155°15.3' W.)	April 27	338.6	383.8	1.0 S. 45.0° W.	20
Keamoku (19°25.1' N., 155°19.0' W.)	April 28	495.8	591.9	2.7 N. 65.0° W.	23
Ahua Kamokukolau (19°22.7' N., 155°16.6' W.)	May 1	620.3	532.3	3.5 S. 21.5° W.	22
Kipuka Nene (19°19.4' N., 155°16.7' W.)	April 27	485.3	511.0	0.4 S. 84.3° E.	20
Hilina Pali (19°18.2' N., 155°18.6' W.)	April 30	498.1	497.8	0.6 N. 79.8° W.	Oct. 14, 1963
Kapapala Ranch (19°20.5' N., 155°23.8' W.)	April 28	495.3	502.3	0.3 N. 83.5° W.	Jan. 21, 1964

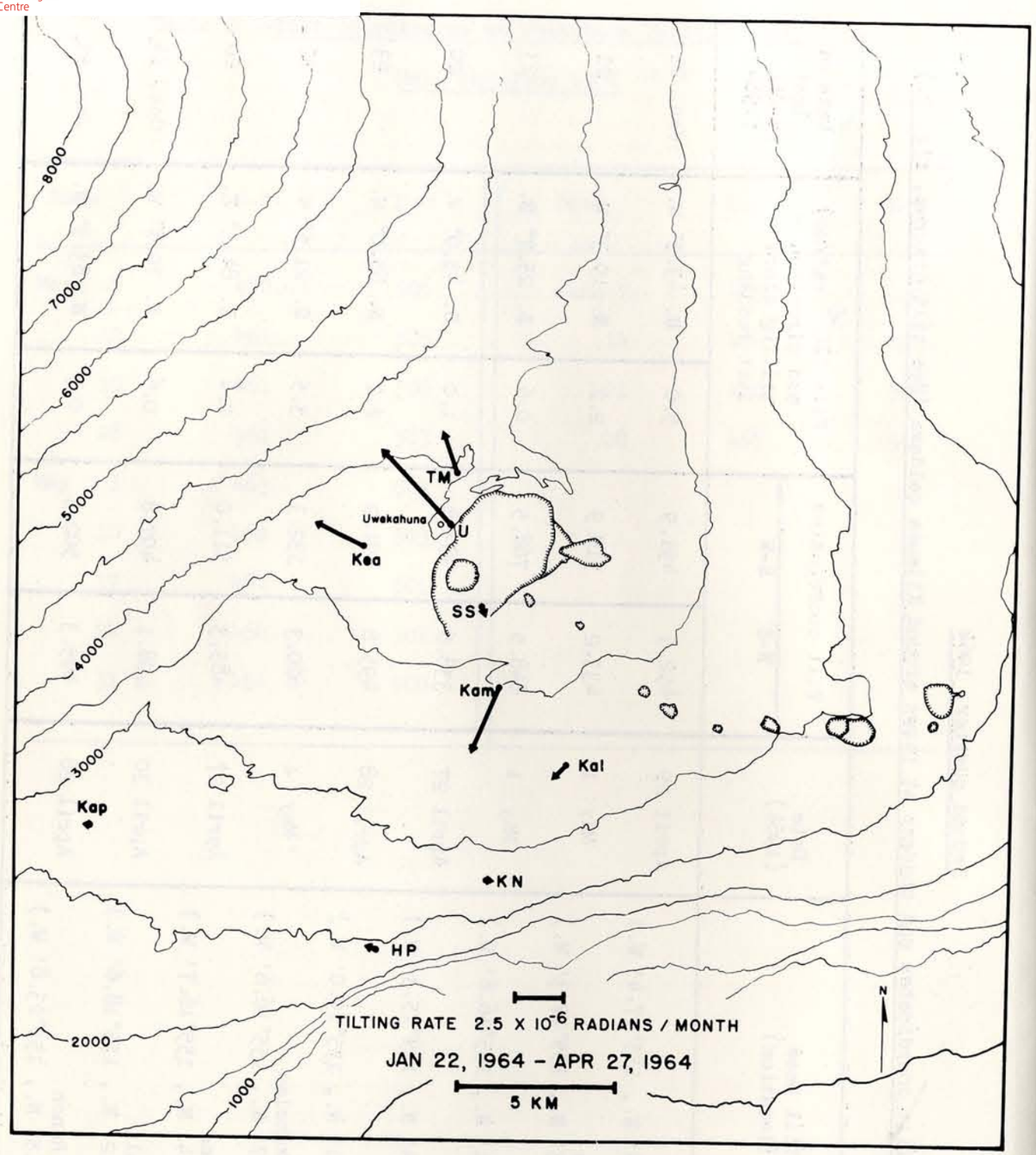

Figure 2.--Tilting of the ground around Kilauea caldera, January 22 to April 27, 1964. The vector depicting tilting at a given tilt base points in the direction of maximum relative subsidence and has a length proportional to the rate of tilting during the measurement interval. Closed circles represent field tilt bases; open circles, short-base water-tube tiltmeters.

Seismic summary.--Events recorded by the U.S. Geological Survey seismograph network in Hawaii fall into two categories: local earthquakes and tremor originating in the region of the Hawaiian Islands, usually within 100 km of at least one seismograph, and distant earthquakes originating more than 3,000 km from Hawaii. As an index of seismic activity at Hawaiian volcanoes, daily counts of earthquakes and minutes of tremor recorded by seismographs in Hawaii are listed in table 3. The earthquakes are separated into groups on the basis of region of origin as determined by analysis of records obtained daily at the Observatory (U, M, A, D, N, WV, MP). Earthquakes of magnitude 2.5 or greater are generally sufficiently well recorded to be located with greater precision; they are listed individually in table 4. Data on identifiable phases from distant earthquakes are listed in table 5.

Locations of the seismograph stations and essential data on the stations are listed in table 6, of summary 33.

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera

Tremor is separated into three categories: deep, intermediate, and shallow, on the basis of relative amplitudes on seismographs in the summit region. Unless otherwise stated, tremor is presumed to be associated with movement of magma within the central complex of Kilauea.

Earthquake categories are: Halemaumau rock slides, which are detected by the characteristic record they produce on the North Pit seismopgraph; shallow earthquakes in the Kilauea caldera region; shallow earthquakes along the SW. rift zone of Kilauea and the adjacent portion of the Kaoiki fault system; earthquakes along the eastern half of Kilauea's east rift zone--detected largely on the Pahoa short-period vertical; earthquakes from a source about 30 km beneath Halemaumau; earthquakes from the upper east rift zone and the adjacent fault systems of Kilauea's south flank (these are usually first arrivals at the Ahua meter or at the new experimental seismometer near Makaopuhi Crater (MP)); and earthquakes from other regions: Kona, Mauna Kea, etc.

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Halemaumau 30 km	Upper East rift	Others
Apr. 1	-----	-------	-------	------	70	8	----	8	7	----------
2	19	-------	-------	------	82	6	1	1	9	1 Kilauea south flank.
3	-----	-------	-------	1	85	6	1	1	3	1 off shore of Kona.
4	-----	-------	-------	-------	64	22	----	11	9	1 Mauna Kea region.
5	-----	-------	-------	-------	58	12	----	6	3	----------
6	-----	-------	-------	-------	73	12	----	2	3	----------
7	-----	-------	-------	-------	52	16	----	13	2	1 Mauna Kea region.
8	----	-------	-------	-------	39 ?	5	-----	5	5	1 Kohala region 1 Mauna Loa region.

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Halemaumau 30 km	Upper East rift	Others
Apr. 9	----	-----	------	-----	44	3	------	2	5	----------
10	----	-----	------	-----	56	15	------	1	3	----------
11	----	-----	------	1	39	9	------	3	1	----------
12	----	-----	------	-----	37	15	1	3	1	1 Mauna Kea region
13	----	-----	------	-----	51+	30	1	3	4	----------
14	----	-----	------	-----	48	19	3	8	1	2 Kona---------- 1 near Kalapana.
15	----	-----	------	1	48	4	------	3	3	----------
16	----	-----	------	-----	45	12	------	3	?	----------
17	----	-----	------	-----	35	11	------	-----	2	----------
18	75	-----	------	-----	40	16	------	4	6	----------
19	----	-----	------	-----	44	13	1	14	1	1 near Kalapana--------
20	40	-----	------	-----	66	12	------	3	3	2 Kona
21	----	-----	------	-----	59	16	------	4	2	2 Mauna Loa----------
22	27	-----	------	-----	76	12	1	8	2	1 Mauna Loa----------
23	----	-----	------	-----	46	12	------	4	3	----------
24	----	-----	------	-----	58	4	------	1	-----	----------
25	----	-----	------	-----	48	18	------	-----	14?	----------
26	----	-----	------	-----	49	5	------	5	6	----------
27	----	-----	------	-----	48	8	------	3	2	----------
28	56	-----	------	-----	64	4	------	2	4	----------
29	----	-----	------	-----	52	9	------	2	1	2 Kona----------
30	----	-----	------	-----	40	8	------	1	2	1 Kona----------
May 1	----	-----	------	-----	40+	4	------	-----	3	----------
2	----	-----	------	-----	40	9	------	4	6	----------
3	----	-----	------	-----	39	13	1	8	2	----------
4	----	-----	------	-----	32	6	------	2	5	1 Kona----------

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Halemaumau 30 km	Upper East rift	Others
May 5	-----	------	------	-----	46	10	-----	10	2	1 Mauna Kea
6	-----	------	------	-----	48	5	-----	8	3	----------
7	-----	------	------	-----	46	10	-----	2	2	----------
8	-----	------	------	-----	40	5	-----	3	4	1 off south shore of Hawaii.
9	-----	------	------	-----	54	10	-----	6	3+	----------
10	-----	------	------	-----	39	7	-----	3	3	1 Kona----------
11	-----	------	------	-----	42	20	-----	10	3	1 Near Apua Point
12	-----	------	------	-----	35	12	-----	4	1	----------
13	-----	------	------	-----	46+	11	1	3	2	----------
14	-----	------	60	-----	58	13	-----	3	3	----------
15	-----	------	60	-----	50	14	-----	3	4	----------
16	-----	------	------	-----	67	22	-----	2	2+	1 Kona
17	-----	------	------	-----	43	12	-----	9	1+	----------
18	-----	------	------	-----	52	37	-----	5	?	2 Mauna Kea, 1 Kona
19	-----	------	------	-----	40	15	-----	4	?	----------
20	-----	------	------	-----	40+	8	-----	3	----	----------
21	-----	------	------	-----	39	40	-----	1	----	----------
22	-----	3	------	-----	33	5	-----	----	5	1 Mauna Loa 1 offshore Kona
23	-----	5	------	-----	30	32	4	2	----	1 Mauna Kea---------
24	-----	------	------	-----	30	8	1	2	?	----------
25	6	------	------	-----	40	7	-----	6	5	1 Kona----------
26	37	------	------	-----	42	9	-----	2	----	----------
27	-----	3	------	-----	85	10	-----	3	2	3 Kohala region----
28	-----	------	------	-----	62	7	-----	2	2	----------
29	-----	------	3	-----	58	8	1	8	5	2 Kona----------
30	-----	------	------	-----	57	8	-----	3	1	1 Near Kapoho------

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Halemaumau 30 km	Upper East rift	Others
May 31	----	32	-----	-----	60	8	----	2	----	1 Mauna Kea---------- 1 near Apua Point------
June 1	----	-----	2	-----	53	8	----	3	----	1 Kona, 1 Kohala---------
2	15	-----	6	-----	65	9	----	3	3	1 Mauna Kea region-----
3	----	-----	-----	-----	60	8	----	3	2	----------
4	----	-----	-----	-----	60	4	----	2	2?	----------
5	----	-----	-----	-----	53	12	----	3	5?	----------
6	----	-----	-----	1	54	8	----	3	2	1 Kona, 1 Mauna Kea
7	38	-----	-----	-----	51	6	----	10	----	1 Mauna Loa----------
8	9	-----	-----	-----	52	5	----	3	3	1 Mauna Loa---------- 1 off south shore of Hawaii.
9	10	-----	-----	-----	54	7	----	5	2	----------
10	----	-----	-----	-----	71	7	1	1	17	----------
11	----	5	-----	-----	58	9	----	1	----	2 Mauna Loa----------
12	4	-----	-----	-----	57	4	----	1	2	1 Kona----------
13	----	-----	-----	-----	40	4	1	1	2	----------
14	31	-----	-----	-----	35	6	1	1	13	1 Mauna Loa----------
15	----	-----	-----	-----	53	8	----	1	3	----------
16	----	-----	-----	-----	36	10	----	------	----	----------
17	----	-----	-----	-----	37	4	----	4	1	2 Kona, 1 Mauna Kea region.
18	----	-----	-----	-----	62	11	----	1	1	----------
19	----	-----	-----	-----	60	7	----	2	2	----------
20	----	-----	-----	-----	65	9	----	2	5	----------
21	----	-----	-----	-----	65	8	2	2	1	1 Kona----------
22	----	-----	-----	-----	60	7	----	3	1	----------
23	----	-----	6	-----	53	8	----	1	----	----------
24	----	-----	-----	-----	72	16	----	3	3	1 Kohala region--------
25	----	-----	-----	-----	70	21	----	------	2	----------

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern East rift	Halemaumau 30 km	Upper East rift	Others
June 26	----	------	-------	-----	67	17	-----	2	11	1 Kona
27	35	13	-------	-----	49	10	-----	11	6	1 near Apua Point
28	----	------	15	-----	70	9	-----	6	5	----------
29	----	9	-------	-----	46	6	-----	2	4	----------
30	----	------	-------	-----	67	11	-----	3	-----	1 Mauna Kea
										1 Kona----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, April, May, and June 1964

[Entries for a given quake are: date, origin time (Hawaiian Standard Time), magnitude, depth, epicenter, and felt report. All earthquakes of magnitude 2.5 and larger, as well as many favorably located smaller ones, occurring on or near the island of Hawaii are included in the list.

In the following list, some origin times are followed only by "KM 30" and a statement of magnitude. These are all members of a continuing family of quakes noted also in other Summaries. The best mean focus for this group is beneath Halemaumau at a depth of 30 km (19°24.1' N., 155°17.1' W.).

In the following list a number of quakes are described as "Upper east rift" (see Summary 28). Their average epicenter is approximately 19°21.5' N., 155°14' W. about 2 km south of Aloi Crater at near-surface depth.

The mean focus of the magnitude 6.1 Kaoiki fault system earthquake of June 27, 1962, and its aftershocks is 19°24' N., 155°25' W., at a depth of 3-8 km. This focus has bee abbreviated "Kaoiki"]

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long W.	Description	
April 1	02	28	53.0	3.9	----	---------	----------	Kaoiki----------	Felt over half of island of Hawaii.
2	00	47	08.0	2.4	8	19°16.1'	155°13.8'	4 km WNW of Apua Point	----------
2	05	41	57.4	2.0	----	---------	----------	KM 30----------	----------
2	22	18	51.0	2.9	----	---------	----------	Kaoiki----------	Felt in Pahala
3	10	07	25.5	2.7	8	19°48'	156°09'	40 km NW of Kealakekua	----------
3	18	04	54.5	2.0	3	19°21.7'	155°08.0'	5 km E. of Makaopuhi	----------
4	17	39	08.5	2.5	3	19°54.0'	155°54.0'	17 km NNE of Pohakuloa	----------
5	01	00	00.2	2.0	----	--------	--------	KM 30----------	----------
6	04	19	22.0	2.3	3	19°19.0'	155°10.2'	6 km S. of Makaopuhi--	----------
7	11	45	57.5	2.3	8	19°45.8'	155°22.2'	32 km WNW of Hilo-----	----------
7	19	03	24.5	2.3	----	--------	---------	KM 30----------	----------
8	07	39	49.5	2.5	13	19°32.1'	155°37.1'	7 km NW of North Bay seismometer.	----------
9	08	02	40.1	2.1	3	19°17.7'	155°11.9'	9 km SSW of Makaopuhi	----------
10	19	13	09.5	2.7	----	--------	---------	KM 30----------	----------
10	21	50	32.7	2.1	3	19°18.5'	155°09.3'	8 km SSE of Makaopuhi	----------
11	03	29	53.3	2.5	----	--------	---------	Kaoiki----------	----------
11	19	51	01.5	2.4	13	19°13.7'	155°29.8'	3 km NW of Pahala----	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, April, May, and June 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
April 12	05	43	58.5	2.0	13	19°44.5'	155°26.3'	9 km ESE of Pohakuloa	Felt in Naaleh
12	19	29	08.8	2.0	8	19°17.8'	155°10.6'	8 km S. of Makaopuhi	----------
14	02	45	20.4	2.2	3	19°26.5'	155°52.9'	9 km SSE of Kealakekua	----------
14	05	41	54.0	2.1	8	19°19.5'	155°02.5'	7 km WSW of Kalapana	----------
14	13	08	31.9	3.0	----	--------	---------	KM 30----------	Felt at Volcano
14	13	23	04.3	2.4	----	--------	---------	KM 30----------	----------
14	14	02	44.0	2.6	13	19°33'	155°58'	7 km NW of Kealakekua	Felt in Kona
18	09	22	19.5	2.6	----	--------	---------	KM 30----------	----------
19	00	48	32.5	2.5	3	19°20.8'	155°03.1'	8 km WSW of Kalapana	----------
19	03	51	51.0	2.0	3	19°19.7'	155°05.9'	10 km ESE of Makaopuhi	----------
19	21	39	10.0	2.2	3	19°18.8'	155°04.3'	14 km ESE of Makaopuhi	----------
20	06	04	04.0	2.8	3	19°40.8'	155°53.9'	18 km NNE of Kealakekua	Felt in Kona
20	14	07	13.0	3.4	< 3	19°25'	156°01'	17 km SW of Kealakekua	Felt in Kona
21	09	58	35.5	2.2	13	19°07.5'	155°29.7'	12 km NE of Naalehu	----------
21	20	49	32.3	2.7	3	19°12.8'	155°35.0'	17 km N. of Naalehu	----------
22	14	08	13.5	2.5	3	19°13.6'	155°33.3'	18 km NNE of Naalehu	----------
26	00	44	50.0	2.9	3	19°18.9'	155°11.8'	8 km SSW of Makaopuhi	Felt at Volcano
26	10	20	39.6	2.9	3	19°21.8'	155°04.9'	12 km E. of Makaopuhi	Felt in Hilo
28	05	32	16.7	2.5	----	--------	---------	KM 30----------	----------
28	06	27	15.9	3.2	----	--------	---------	Kaoiki----------	Felt near Pahala
28	15	33	53.0	2.5	3	19°17.8'	155°06.1'	12 km SE of Makaopuhi	----------
30	01	26	42.3	2.5	3	19°19.4'	155°08.0'	8 km SE of Makaopuhi	----------
30	04	23	08.0	2.8	3	19°27.4'	155°57.8'	8 km SW of Kealakekua	----------
May 2	17	55	33.5	2.4	8	19°16.8'	155°11.8'	10 km SSW of Makaopuhi	----------
3	02	40	58.5	3.1	8	19°20.2'	155°05.2'	10 km ESE of Makaopuhi	----------
4	01	41	23.0	2.9	3	19°27.0'	155°58.2'	9 km SW of Kealakekua	----------
7	22	58	54.0	2.3	5	19°18.0'	155°15.5'	9 km S. of Ahua seismometer.	----------
8	03	44	42.0	2.2	3	19°13.2'	155°15.2'	18 km S. of Ahua seismometer.	----------
8	13	36	20.0	2.7	13	18°54'	155°30'	22 km SSE of Naalehu	----------
9	07	56	32.5	2.6	----	--------	--------	Kaoiki----------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, April, May, and June 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
May 9	15	53	23.0	2.6	----	--------	---------	KM 30----------	----------
9	18	40	13.3	2.6	30	19°22.2'	155°19.8'	7 km NE of Desert seismometer.	----------
10	11	03	48.0	2.7	35	19°26.8'	156°02.2'	15 km SW of Kealakekua	----------
11	03	45	51.3	2.5	----	--------	---------	KM 30----------	----------
11	06	39	25.5	2.1	----	--------	---------	KM 30----------	----------
11	11	46	39.5	2.6	----	--------	---------	Kaoiki----------	----------
11	16	19	06.2	2.1	----	--------	---------	KM 30----------	----------
11	21	00	11.0	2.4	8	19°16.3'	155°09.2'	5 km ENE of Apua Point	----------
11	22	42	01.7	2.6	----	--------	---------	Kaoiki----------	----------
12	20	14	56.0	2.2	----	--------	---------	Kaoiki----------	----------
14	02	28	51.1	2.3	5	19°19.0'	155°09.6'	7 km SSE of Makaopuhi	----------
14	10	13	12.5	2.0	----	--------	---------	KM 30----------	----------
14	16	05	02.9	2.3	10	19°23.9'	155°15.8'	2 km N. of Ahua seismometer.	----------
15	05	49	17.5	2.4	3	19°19.0'	155°06.9'	10 km SE of Makaopuhi	----------
16	09	48	46.3	3.0	----	--------	---------	Kaoiki----------	Felt in the Kilauea Summit region.
16	18	18	22.7	2.5	3	19°21.6'	155°08.0'	6 km E. of Makaopuhi	----------
18	03	47	19.0	2.7	3	19°22.8'	155°45.5'	23 km SE of Kealakekua	----------
18	07	32	56.5	2.9	----	--------	---------	KM 30----------	Felt near Pahala
18	11	00	11.5	2.8	13	20°03.5'	155°32.1'	15 km ENE of Kamuela seismograph.	----------
18	11	02	34.3	2.6	13	20°03.5'	155°32.1'	15 km ENE of Kamuela seismograph.	----------
20	23	43	59.0	2.0	----	--------	---------	KM 30----------	----------
22	11	51	23.3	3.0	8	19°32.2'	155°37.2'	7 km NW of North Bay seismometer.	----------
22	14	21	29.2	2.7	13	19°29'	156°17'	40 km WSW of Kealakekua	----------
23	21	23	19.0	2.8	13	20°07.0'	155°50.4'	18 km NW of Kamuela seismograph.	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, April, May, and June 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
May 24	05	05	56.0	3.2	3	19°15.0'	155°24.4'	11 km SSW of Desert seismometer.	Felt----------
24	05	28	00.5	2.6	3	19°10.9'	155°22.9'	18 km SSW of Desert seismometer.	----------
24	07	15	27.7	2.2	3	19°15.1'	155°23.1'	12 km S. of Desert seismometer.	----------
27	15	01	45.5	2.4	13	19°53.8'	155°29.0'	28 km SE of Kamuela seismograph.	Felt in Kamuela
28	04	06	01.5	3.4	13	20°05.9'	155°50.3'	18 km WNW of Kamuela seismograph.	Felt in Kamuela and Kohala.
29	05	04	56.6	2.3	3	--------	--------	Kaoiki----------	----------
30	20	57	56.5	2.2	5	19°32.0'	154°52.9'	5 km NW of Kapoho---	Felt in Kapoho----
31	03	20	26.3	2.5	10	19°15.8'	155°06.5'	10 km E. of Apua Point.	----------
June 1	03	14	43.0	2.7	10	20°05.8'	155°50.8'	17 km WNW of Kamuela	----------
2	00	16	06.0	2.4	----	--------	--------	KM 30----------	----------
2	21	05	37.2	2.5	40	19°54.3'	155°10.1'	10 km NW of Pepeekeo	----------
4	08	34	31.9	4.0	45	19°26.8'	155°16.8'	4 km NE of Uwekahuna seismometer.	Felt Island-wide
4	12	52	16.7	2.5	----	--------	--------	Kaoiki----------	----------
4	13	22	30.0	3.8	8	19°19.2'	155°05.2'	12 km ESE of Makaopuhi seismometer.	Felt in Hilo------
6	19	31	24.3	2.8	8	19°51.9'	155°44.8'	10 km W. of Waikii----	----------
6	20	04	03.3	2.4	----	--------	--------	Kaoiki----------	----------
8	03	36	14.4	2.5	8	19°02.8'	155°27.6'	14 km E. of Naalehu	----------
8	12	00	50.5	4.1	8	19°37.8'	155°25.1'	15 km NNW of Mauna Loa seismometer.	Felt Island-wide
9	02	15	07.1	2.8	8	19°22.6'	155°06.2'	9 km E. of Makaopuhi seismometer.	----------
10	05	04	28.5	2.5	13	19°20.2'	155°06.7'	5 km SE of Maiaopuhi seismometer.	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, April, May, and June 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
June 10	07	13	32.4	2.6	----	--------	--------	KM 30----------	----------
10	09	05	16.5	2.7	8	19°17.4'	155°11.4'	9 km S. of Makaopuhi seismometer.	----------
10	22	45	34.9	2.0	10	19°24.5'	155°05.6'	11 km NE of Makaopuhi seismometer.	----------
11	14	10	37.7	2.3	35	19°12.7'	155°31.9'	6 km WNW of Pahala	----------
14	05	05	38.5	2.2	----	--------	--------	KM 30----------	----------
14	10	58	22.0	2.4	8	19°10.8'	155°31.9'	14 km NNW of Naalehu	----------
14	11	23	14.4	2.7	----	--------	--------	Kaoiki----------	----------
14	16	38	15.2	2.6	8	19°18.9'	155°11.6'	5 km SSW of Makaopuhi seismometer.	----------
15	03	25	31.6	2.7	10	19°16.7'	155°08.1'	11 km SSE of Makaopuhi seismometer.	----------
16	12	04	40.7	3.1	13	18°54.0'	155°35.6'	18 km S. of Naalehu	----------
17	00	48	20.0	2.0	3	19°27.1'	155°46.2'	17 km SE of Kealakekua	----------
17	14	13	31.3	3.0	3	19°28.0'	155°50.6'	10 km SE of Kealakekua	Felt in Kona-----
18	05	07	58.8	3.2	50	19°45.0'	155°05.2'	4 km N. of Hilo-------	----------
19	04	14	43.6	2.5	25	19°12.2'	155°18.6'	18 km SE of Desert seismometer.	----------
20	18	14	28.7	2.6	----	--------	--------	Kaoiki----------	----------
21	05	23	10.3	2.1	10	19°19.0'	155°07.0'	10 km SE of Makaopuhi seismometer.	----------
21	11	23	34.3	2.6	8	19°43'	156°10'	12 km E. of Keahole Point.	----------
22	17	30	32.8	2.9	----	--------	--------	Kaoiki----------	Felt in Pahala----
26	14	34	36.0	2.6	3	19°43.0'	155°41.9'	33 km NE of Kealakekua	----------
26	15	36	33.5	2.9	3	19°15.5'	155°11.4'	1 km SE of Apua Point	----------
26	18	56	08.1	2.1	10	19°18.1'	155°10.9'	7 km S. of Makaopuhi seismometer.	----------
26	20	52	54.1	2.7	10	19°18.7'	155°11.4'	6 km SSW of Makaopuhi seismometer.	----------

April 11

M	Z	iP	01:13:19.7 c
A	Z	iP	19.5 c
U	Z	iP	19.6 c
Pa	Z	iP	20.9 c
NB	Z	eP	20.0 c
Hi	Z	eP	22.4 c

C&GS card 33-64:
01:04:30.2
29.0° S., 178.9° W.
Kermadec Islands
h about 302 km
Magnitude 5.3 (CGS).

April 12

M	Z	iP	11:20:40.8 c
A	Z	iP	40.3 c
D	Z	iP	11:20:39.6 c
MP	Z	eP	40.1 c
U	Z	eP	40.3 c
Pa	Z	eP	42 c
NB	Z	iP	40.3 c
Hi	Z	iP	42.9 c
Ke	Z	iP	39.5 c
Ha	Z	iP	46.7 c

C&GS card 36-64:
11:10:54.8
33.9° S., 179.8° W.
Kermadec Islands
h about 89 km
Magnitude 5.4 (CGS).

April 13

M	Z	eP	08:54:49.3 d
A	Z	eP	50.0 d
D	Z	eP	49.3 d

C&GS card 33-64:
08:45:24.6
22.3° N., 142.1° E.
Bonin Islands region
h about 309 km
Magnitude 5.1 (CGS).

April 13

M	Z	iP	11:38:34.0 d
A	Z	iP	34.3 d

C&GS card 33-64:
11:26:52.1

April 13--Continued

C&GS card--Continued
6.9° N., 126.6° E.
Near east coast of Mindanao,
Philippine Islands
h about 110 km.

April 14

M	Z	iP	16:31:53.6 d

C&GS card 35-64:
16:18:54
8.6° S., 117.3° E.
Sumbawa Island region
h about 58 km
Magnitude 5.3 (CGS).

April 16

M	Z	eP	01:14:23.8 c

C&GS card 35-64:
01:04:34.5
37.0° N., 142.7° E.
Off East coast of Honshu, Japan
h about 38 km
Magnitude 5.1 (CGS).

April 16

U	PEZ	eR	14:00:46

C&GS card 35-64:
13:43:08.9
52.1° N., 169.4° W.
Fox Islands, Aleutian Islands
h about 33 km
Magnitude 4.9 (CGS).

April 16

M	Z	eP	14:14:59.4 d
D	Z	eP	58.4 d
Na	Z	eP	56.3 d

C&GS card 35-64:
14:05:14.9
7.0° S., 155.7° E.
Solomon Islands
Felt: Kieta & Omori
h about 78 km
Magnitude 5.4 (CGS).

April 17, 1964

M	Z	iP	06:09:27.4 d
D	Z	iP	26.6 d
Pa	Z	eP	29.4 d
NB	Z	iP	26.9 d
Hi	Z	iP	29.7 d
Na	Z	eP	24.5 d
Ke	Z	iP	24.7 d
Ke	**Z**	**Tmax**	**07:08:08**

C&GS card 35-64:
06:00:00.2
6.6° S., 154.9° E.
Solomon Islands
Felt: Buin & Omori
h about 85 km
Magnitude 5.4 (CGS),
6.4 (HVO).

April 19

U	PEZ	ePS	14:41:10
U	PEZ	eSS	14:47:24
U	PEZ	eR	14:03:18

C&GS card 35-64:
14:12:21.9
60.5° S., 58.3° S.
Near South Shetland Islands
h about 33 km
Magnitude 5.4 (CGS).

April 22

M	Z	iP	20:09:09.9 d
A	Z	eP	09.5 d
NB	Z	iP	08.7 d
Ha	Z	iP	12.3 d

C&GS card 36-64:
20:00:22.8
15.5° S., 167.5° E.
New Hebrides Islands
h about 123 km
Magnitude 5.0 (CGS).

April 23

M	Z	iP	03:44:26.8 c
A	Z	iP	26.6 c
D	Z	iP	25.7 c
U	Z	iP	26.5 c
Pa	Z	eP	28.5 c
NB	Z	iP	25.6 c
Hi	Z	iP	28.5 c

April 23--Continued

Ke	Z	iP	23.3 c
U	PEZ	iPP	03:47:33
U	PEZ	iPPP	03:49:28
U	PEZ	iS	03:54:11
U	PEZ	iSS	03:59:08
U	PEZ	iSSS	04:02:38
U	PEN	iG	04:04:19
U	PEZ	iR	04:07:16

C&GS card 36-64:
03:32:50.3
5.3° S., 134.0° E.
Aru Islands region
h about 33 km
Felt: Darwin, Australia
Magnitude 6.4 (CGS),
6.8 (HVO).

April 24

M	Z	eP	06:06:36.2 d
D	Z	eP	35.5 d
Pa	Z	eP	39.2 d
NB	Z	iP	36.1 d
Hi	Z	iP	38.7 d
Na	Z	iP	34.9 d
Ke	Z	eP	33.0 d
U	PEZ	i	06:07:06
U	PEN	iS	06:15:14
U	PEE	iG	06:22:26
U	PEZ	iR	06:25:14

C&GS card 39-64:
05:56:10.1
5.1° S., 144.2° E.
North-East New Guinea
h about 106 km
Slight damage at Hagne
Felt widely
Magnitude 6.5-6.75 (Brk),
6.3 (CGS), 7 (HVO).

April 24, 1964

M	Z	eP	14:50:50.1 c
A	Z	iP	49.6 c
D	Z	iP	50.0 c
U	Z	iP	49.9 c
NB	Z	iP	52.9 c
Hi	Z	eP	49.3 c

C&GS card 38-64:
14:40:28.3
13.3° N., 88.8° W.
Near coast of El Salvador
h about 158 km
Magnitude 6 (Pal), 5.1 (CGS).

April 27

U	PEN	ePS	07:09:38
U	PEE	eG	07:21:26
U	PEZ	eR	07:25:26

C&GS card 39-64:
06:44:25.1
60.1° S., 151.0° E.
Balleny Islands region
h about 33 km
Magnitude 5.0 (CGS), 6.0 (HVO).

April 28

M	Z	Tmax	13:12:50
A	Z	Tmax	51
D	Z	Tmax	51
U	Z	Tmax	35
Pa	Z	Tmax	25
NB	Z	Tmax	50
Hi	Z	Tmax	09

C&GS card 38-64:
12:21:25.6
59.0° N., 138.7° W.
Near coast of southeastern Alaska
h about 33 km
Magnitude 4.6 (CGS).

April 30

M	Z	eP	16:13:06.0 d
U	PEN	eS	16:21:11
U	PEN	eG	16:26:53
U	PEZ	eR	16:29:09
NB	Z	Tmax	17:14:09

C&GS card 42-64:
16:03:31.4
4.6° S., 153.2° E.
New Ireland region
h about 78 km
Felt: Londolovit, Rabaul
Magnitude 5.2 (CGS), 5.8 (HVO).

May 2

M	Z	iP	16:20:04.0 d
U	Z	eP	04.8 d
U	PEN	iS	16:27:25
U	PEN	iG	16:32:15
U	PEZ	iR	16:34:31

C&GS card 38-64:
16:11:00.2
45.5° N., 150.3° E.
Kurile Islands
h about 35 km
Magnitude 5.7 (CGS), 6.6 (HVO).

May 6

U	PEZ	eS	08:27:27
U	PEN	eG	08:31:51
U	PEZ	eR	08:33:59

C&GS card 38-64:
08:10:47.5
11.1° S., 162.2° E.
Solomon Islands
h about 40 km
Magnitude 5.1 (CGS), 5.6 (HVO).

May 7

M	Z	iP	08:08:15.7 c
A	Z	eP	17.6 c
D	Z	eP	15.9 c
U	Z	iP	16.5 d
Pa	Z	eP	17.0 c
NB	Z	iP	14.1 c
Hi	Z	eP	16.1 c
Na	Z	eP	15.6 d
Ke	Z	eP	12.0 c
Ha	Z	eP	08:08:07.3 c
U	PEE	iS	08:16:31
U	PEN	iG	08:22:47
U	PEZ	iR	08:24:51

C&GS card 40-64:
07:58:14.3
40.4° N., 139.0° E.
Off coast of northern Honshu, Japan.
Felt: Northern Honshu and Hokkaido.
h about 33 km
Magnitude 7 (Pas), 7 (Brk), 6.5-6.75 (Pal), 6.2 (CGS), 7.1 (HVO).

May 7

Ke	Z	iP	11:20:30.3 c

C&GS card 40-64:
11:11:04.9
30.6° N., 137.7° E.
Off south coast of Honshu, Japan
h about 469 km
Magnitude 5.1 (CGS).

May 7

M	Z	eP	20:22:50.0 d
U	PEN	iS	20:31:07
U	PEZ	eSS	20:35:03
U	PEN	iG	20:37:09
U	PEZ	iR	20:39:23

C&GS card 38-64:
20:12:49.3
40.5° N., 139.0° E.
Off west coast of Honshu, Japan
Minor damage in Akita Province
h about 33 km
Magnitude 5.9 (CGS), 6.5 (HVO).

May 8

U	PEZ	eS	23:52:59
U	PEZ	eR	23:56:17

C&GS card 38-64:
23:40:44.1
52.2° N., 169.5° W.
Adreanof Islands, Aleutian Islands
h about 20 km
Magnitude 5.2 (CGS).

May 9

M	Z	eP	02:09:16.3 c
U	PEZ	eR	02:17:59

C&GS card 40-64:
02:02:28.8
52.2° N., 169.6° W.
Adreanof Islands, Aleutian Islands
h about 25 km
Magnitude 5.1 (CGS).

May 10

M	Z	iP	05:49:29.6 c
D	Z	iP	29.8 c
U	Z	eP	30.1 c
NB	Z	iP	28.4 c
Hi	Z	eP	30.7 c
Ke	Z	iP	25.7 c

C&GS card 42-64:
05:39:42.6
29.0° N., 141.5° E.
Bonin Islands region
h about 62 km
Magnitude 4.75-5 (Brk), 5.3 (CGS).

May 10

Pa	Z	Tmax	14:29:53

C&GS card 42-64:
13:44:03
51.4° N., 129.2° W.
Vancouver Island region
h about 33 km
Magnitude 4.1 (CGS).

May 13

M	Z	eP	05:35:08.7 c
A	Z	iP	08.6 c
U	Z	eP	08.8 c
Ke	Z	eP	05.0 c
U	PEN	iS	05:43:05
U	PEZ	iR	05:52:27

C&GS card 44-64:
05:25:26.1
32.8° S., 178.3° W.
Kermadec Islands region
h about 33 km
Magnitude 5.3 (CGS), 6.6 (HVO).

May 15

U	PEE	iS	11:08:44
U	PEN	eG	11:15:37
U	PEZ	iR	11:17:33

C&GS card 43-64:
10:50:21
3.5° S., 149.1° E.
Bismark Sea
h about 44 km
Magnitude 4.7 (CGS), 5.9 (HVO).

May 16,

A	Z	eP	16:17:28.5 c
U	PEE	iS	16:25:27
U	PEZ	eR	16:34:29

C&GS card 44-64:
16:07:46.2
32.8° S., 178.3° W.
Kermadec Islands region
h about 33 km
Magnitude 6.0 (Pas), 5.4 (CGS), 6 (HVO).

May 17

U	PEZ	ePS	19:53:59
U	PEZ	eSS	19:58:51
U	PEN	eG	20:08:07
U	PEZ	eR	20:13:33

C&GS card 45-64:
19:26:20.6
35.2° N., 35.9° W.
North Atlantic Ocean
h about 33 km
Magnitude 6.5 (Pas), 5.75-6 (Brk), 6-6.25 (Pal), 5.6 (CGS), 6.4 (HVO).

May 18

M	Z	eP	14:20:26.3 c

C&GS card 43-64:
14:12:10.1
21.2° S., 174.5° W.
Tonga Islands region
h about 33 km
Magnitude 4.5 (Brk), 5.6 (CGS).

May 19

A	Z	eP	23:15:34.5 c
U	PEE	iS	23:25:15
U	PEZ	eSS	23:30:07
U	PEN	eG	23:35:39
U	PEZ	eR	23:38:39

C&GS card 43-64:
23:03:41.8
0.7° S., 80.2° W.
Near coast of Ecuador
h about 54 km
Magnitude 5.5 (Pal), 5.25-5.5 (Brk), 5.4 (CGS), 6.1 (HVO).

May 20

M	Z	eP	06:12:09.9 c
D	Z	eP	08.9 c
U	Z	iP	09.8 c
Hi	Z	eP	12.6 c
Ke	Z	eP	06.2 c

C&GS card 43-64:
06:01:14.8
2.7° S., 139.3° E.
Near north coast of western New Guinea
h about 61 km
Magnitude 5.8 (CGS).

May 23

M	Z	iP	11:31:58.1 c
D	Z	iP	58.0 c
U	Z	eP	58.3 c
Pa	Z	eP	59.8 c
NB	Z	iP	56.9 c
Ke	Z	iP	54.5 c

C&GS card 43-64:
11:22:33.3
28.6° N., 139.4° E.
Bonin Islands region
h about 409 km
Magnitude 5.1 (CGS).

May 24

U	PEZ	eR	10:57:15

C&GS card 43-64:
10:31:24.1
34.3° N., 141.1° E.
Near east coast of Honshu, Japan
h about 33 km
Magnitude 5.2 (CGS).

May 26

M	Z	iP	09:50:27.3 c
A	Z	iP	27.8 c
D	Z	iP	26.8 c
MP	Z	iP	28.3 c
U	Z	iP	27.5 c

C&GS card 43-64:
09:40:57.9
16.5° N., 145.9° E.
Mariana Islands region
h about 94 km
Magnitude 5.5 (CGS).

May 26, 1964

M	Z	iP'	11:18:06.0	d
A	Z	eP'	05.4	d
D	Z	eP'	05.6	d
MP	Z	iP'	04.9	d
U	Z	eP'	05.5	d
Na	Z	iP'	04.9	d
Ha	Z	iP'	07.7	d
U	PEZ	eP	11:14:53	c
U	PEZ	ipP	11:15:21	c
U	PEZ	iP'	11:18:09	
U	PEZ	ipP'	11:18:38	
U	PEZ	iPP	11:20:06	
U	PEZ	isPP	11:20:48	
U	PEZ	i	11:21:58	
U	PEZ	ePPP	11:22:56	
U	PEN	eSKKS	11:25:54	
U	PEN	eS	11:27:46	
U	PEN	i	11:29:36	
U	PEZ	iPS	11:30:18	
U	PEN	ipPS	11:30:42	
U	PEZ	isPS	11:30:54	
U	PEE	i	11:31:04	
U	PEE	iSPP	11:31:18	
U	PEZ	iSKKP	11:31:43	
U	PEZ	i	11:32:18	
U	PEZ	i	11:33:26	
U	PEE	i	11:34:48	
U	PEZ	i	11:35:23	
U	PEN	iSS	11:36:54	
U	PEN	isSS	11:37:46	
U	PEN	i	11:39:48	
U	PEE	i	11:40:38	
U	PEE	iSSS	11:42:00	
U	PEE	i	11:45:14	
U	PEZ	i	11:46:21	
U	PEZ	i	11:48:24	
U	PEZ	i	11:49:26	
U	PEN	iG	11:51:30	
U	PEN	i	11:54:48	
U	PEN	i	11:56:54	
U	PEZ	i	11:57:56	
U	PEZ	i	12:02:38	
U	PEN	i	12:04:23	
U	PEN	i	12:06:43	
U	PEN	i	12:10:48	
U	PEZ	i	12:13:00	

C&GS card 46-64:
10:59:12.3
56.2° S., 27.8° W.
Sandwich Islands

May 26--Continued

C&GS card--Continued

h about 120 km
Magnitude 7.5-7.75 (Pas), 7.5-7.75 (Brk), 7-7.25 (Pal), 7.6 (HVO).

May 29

M	Z	iP	19:10:13.3	c
A	Z	iP	12.7	c
MP	Z	iP	12.6	c
U	Z	iP	12.8	c

C&GS card 46-64:
19:01:57.0
26.1° S., 178.3° E.
Fiji Islands region
h about 613 km
Magnitude 4.1 (CGS).

May 30

M	Z	iP	14:40:33.0	c
U	Z	eP	33.6	c
NB	Z	eP	32.3	c
Hi	Z	eP	34.1	c
Na	Z	eP	33.7	c
Ha	Z	eP	24.0	c
U	PEE	iS	14:48:34	
U	PEZ	eSS	14:52:28	
U	PEZ	iR	14:57:04	

C&GS card 43-64:
14:30:45.3
36.2° N., 141.1° E.
Near east coast of Honshu, Japan.
h about 49 km
Magnitude 5.5-5.75 (Pal), 5.4 (CGS), 6.0 (HVO).

May 31

M	Z	eP	00:49:55.5	d
A	Z	eP	56.8	d
D	Z	eP	55.8	d
U	Z	eP	56.3	d
Pa	Z	eP	57.3	d
NB	Z	eP	54.3	d
Hi	Z	eP	55.9	d
Na	Z	eP	56.8	d
Ke	Z	eP	52.0	d
Ha	Z	iP	44.9	d

May 31, 1964--Continued

U	PEE	iS	00:57:27
U	PEZ	iSS	01:01:10
U	PEE	eG	01:02:38
U	PEZ	iR	01:04:50
Ha	Z	Tmax	01:46:07

C&GS card 43-64:
00:40:36.4
43.5° N., 146.8° E.
Kurile Islands
h about 48 km
Magnitude 6.5-6.75 (Pal), 6.3 (CGS), 7.2 (HVO).

June 6

M	Z	iP	19:18:02.2 c
A	Z	iP	00.4 c
D	Z	iP	00.6 c
U	Z	eP	00.7 c
Pa	Z	eP	19:17:59.5 c
NB	Z	iP	19:18:03.5 c
Hi	Z	eP	01.8 c
Na	Z	eP	01.7 c
Ha	Z	iP	11.1 c
M	Z	Tmax	20:23:56
A	Z	Tmax	57
D	Z	Tmax	56
U	Z	Tmax	54
Pa	Z	Tmax	35
NB	Z	Tmax	20:24:02
Na	Z	Tmax	20:23:44

C&GS card 46-64:
19:07:51.4
26.6° S., 114.4° W.
Easter Island region
h about 33 km
Magnitude 5.8 (CGS).

June 8

M	Z	iP	23:02:42.1 d
A	Z	eP	42.8 d
D	Z	iP	42.1 d
MP	Z	iP	23:02:43.3 d
U	Z	iP	42.5 d
Pa	Z	iP	44.6 d
NB	Z	iP	40.2 d
Hi	Z	eP	43.5 d
Na	Z	iP	40.7 d
Ke	Z	iP	37.8 d

June 8--Continued

C&GS card 46-64:
22:53:21.7
17.7° N., 145.7° E.
Mariana Islands
h about 163 km
Magnitude 5.4 (CGS).

June 10

M	Z	iP	18:39:56.5 d

C&GS card 50-64:
18:26:54.5
9.4° S., 117.6° E.
Sumbawa region
h about 33 km
Magnitude 5.0 (CGS).

June 10

M	Z	iP	22:28:21.9 d
A	Z	iP	22.1 d
D	Z	eP	21.4 d
MP	Z	iP	23.0 d
U	Z	eP	22.0 d
NB	Z	iP	20.7 d
Hi	Z	eP	23.9 d
Ke	Z	eP	19.9 d
Ha	Z	eP	16.7 d
U	PEZ	ipP	22:28:45
U	PEZ	isP	22:29:06
U	PEZ	i	22:51:38

C&GS card 49-64:
22:16:44.8
5.0° N., 127.4° E.
Talaud Islands region
Felt: Gen. Santos & Hinatuan, Philippines
h about 146 km
Magnitude 5.5 (CGS), 6.0 (HVO).

June 11

M	Z	iP	17:12:40.3 c

C&GS card 47-64:
17:01:48.5
2.0° S., 140.8° E.
Near north coast of New Guinea
h about 18 km.

June 11, 1964

M	Z	iP	18:41:57.4

C&GS card 47-64:
18:32:17.9
33.1° N., 137.6° E.
Near south coast of Honshu, Japan
h about 330 km
Magnitude 4.8 (CGS).

June 11

A	Z	Tmax	22:58:36
U	Z	Tmax	34
NB	Z	Tmax	53
Ha	Z	Tmax	22:57:59

C&GS card 50-64:
22:18:19.8
40.3° N., 126.5° W.
Off coast of northern California
h about 33 km
Magnitude 5.4 (CGS).

June 12

M	Z	iP	16:07:57.8 d
A	Z	iP	58.1 d
D	Z	eP	57.3 d
U	Z	eP	58.0 d

C&GS card 48-64:
15:56:21.3
11.4° N., 124.9° E.
Cebu, Philippine Islands
h about 183 km.
Magnitude 5.5 (CGS).

June 12

M	Z	iP	18:20:36.0 c
A	Z	iP	35.0 c
MP	Z	iP	35.1 c
U	Z	iP	35.1 c
Pa	Z	iP	36.1 c
NB	Z	iP	34.8 c
Ke	Z	iP	33.6 c
Ha	Z	iP	40.3 c

C&GS card 50-64:
18:12:20.5
26.5° S., 178.3° E.
South of Fiji Islands
h about 648 km
Magnitude 5.3 (CGS).

June 16

M	Z	iP	04:11:41.3 d
A	Z	iP	42.0 d
D	Z	iP	41.6 d
MP	Z	eP	42.4 d
U	Z	eP	41.9 d
Pa	Z	eP	43.0 d
NB	Z	iP	40.6 d
Hi	Z	eP	42.2 d
Ke	Z	eP	39.9 d
Ha	Z	iP	33.4 d
U	PEE	iS	04:19:45
U	PEZ	iSS	04:23:44
U	PEE	iG	04:26:06
U	PEZ	iR	04:28:22

C&GS card 51-64:
04:01:44.3
38.3° N., 139.1° E.
Near west coast of Honshu, Japan
h about 57 km
25 killed, many injured, and extensive property damage at Niigata. 7 foot tsunami along coastal areas
Magnitude 7.25-7.5 (Pas), 7.25 (Pal), 6.1 (CGS), 7.5 (HVO).

June 16

M	Z	iP	07:03:08.5 d
A	Z	eP	09.5 d
D	Z	iP	08.6 d
NB	Z	eP	07.8 d
Hi	Z	eP	09.7 d

C&GS card 51-64:
06:53:05.0
38.7° N., 139.0° E.
Near west coast of Honshu, Japan
h about 15 km
Magnitude 5.6 (CGS).

June 16

M	Z	iP	07:24:59.6 d
A	Z	iP	07:25:00.6 d
D	Z	iP	07:24:59.9 d
U	Z	iP	07:25:00.4 d
Pa	Z	eP	07:25:01.7 d
NB	Z	iP	07:24:59.2 d

C&GS card 51-64:
07:14:57.1
38.5° N., 139.2° E.

June 16, 1964--Continued

C&GS card--Continued
Near west coast of Honshu, Japan.
h about 16 km
Magnitude 5.9 (CGS).

June 22

M	Z	iP	03:12:42.4 d
A	Z	eP	43.3 d
D	Z	iP	42.3 d
U	Z	eP	43.0 d
NB	Z	eP	42.0 d
Ha	Z	iP	49.5 d
U	PEE	iS	03:20:04
U	PEZ	iR	03:27:22
Ke	Z	Tmax	04:07:55
NB	Z	Tmax	04:08:13
Ha	Z	Tmax	04:08:19

C&GS card 53-64:
03:03:37.9
10.4° S., 161.1° E.
Solomon Islands
h about 70 km
Magnitude 5.4 (CGS), 5.8 (HVO).

June 23

M	Z	iP	01:35:59.0 c
MP	Z	iP	59.7 c
U	Z	eP	59.3 c
Na	Z	iP	59.4 c
Hi	Z	iP	59.1 c
Ke	Z	iP	55.8 c
NB	Z	iP	58.7 c
Ha	Z	iP	49.1 c
U	PEN	iS	01:43:34
U	PEZ	iSS	01:47:23
U	PEN	iL	01:48:15
U	PEE	iG	01:48:30
U	PEZ	iR	01:50:50

C&GS card 53-64:
01:26:37.0
43.3° N., 146.1° E.
Kurile Islands
h about 77 km
Magnitude 7 (Pas), 6.75-7 (Brk), 6.75 (Pal), 6.2 (CGS), 7.0 (HVO).

June 28

Hi	Z	eP	13:01:31.9 d
Ke	Z	eP	27.1 d
U	PEN	iS	13:09:35
U	PEZ	eSS	13:13:29
U	PEN	iG	13:14:53
U	PEZ	iR	13:17:47
M	Z	Tmax	14:03:43
A	Z	Tmax	35
D	Z	Tmax	43
U	Z	Tmax	44
Ke	Z	Tmax	17
NB	Z	Tmax	46

C&GS card 53-64:
12:51:34.6
1.7° S., 149.6° E.
New Ireland region
h about 7 km
Magnitude 5.75-6 (Brk), 6.4 (CGS).

June 29

M	Z	iP	07:29:33.2 c
A	Z	iP	33.8 c
D	Z	iP	34.3 c
U	Z	eP	33.4 c
Pa	Z	iP	33.0 c
NB	Z	iP	34.1 c
Hi	Z	iP	31.5 c
Ke	Z	iP	33.5 c

C&GS card 53-64:
07:21:32.8
62.7° N., 152.0° W.
Southern Alaska
Felt: College, Alaska
h about 33 km
Magnitude 5.6 (CGS).

June 30

M	Z	iP	13:58:43.3 c
A	Z	eP	43.8 c
D	Z	eP	43.2 c
U	Z	eP	43.4 d
NB	Z	eP	40.9 c
Ke	Z	eP	40.1 c
Ha	Z	eP	48.8 c
U	PEE	epP	14:01:59
U	PEE	iS	14:09:03
U	PEE	iPPS	14:10:09

June 30, 1964--Continued

U	PEN	eSS	14:14:17
U	PEE	eSSS	14:18:09
U	PEN	iG	14:20:29
U	PEZ	iR	14:24:01

C&GS card 54-64:
13:46:21.6
0.8° S., 122.5° E.
Northern Celebes
h about 36 km
Magnitude 6.3 (CGS), 6.7 (HVO).

June 30

M	Z	iP	19:59:44.6 c
U	Z	eP	44.7 c

C&GS card 52-64:
19:47:22.5
0.0° N., 122.9° E.
Northern Celebes
h about 33 km
Magnitude 4.9 (CGS).

June 30

M	Z	iP	20:17:27.8 c
A	Z	iP	28.6 c
D	Z	iP	28.4 c
U	Z	eP	28.5 c
Pa	Z	eP	29.7 c
NB	Z	eP	26.9 c
Hi	Z	eP	28.2 c
Na	Z	eP	28.8 c
Ke	Z	eP	24.7 c

C&GS card 52-64:
20:08:28.5
46.6° N., 144.6° E.
Sea of Okhotsk
h about 383 km
Magnitude 5.5 (CGS).

Aftershocks of the Alaskan earthquake of March 28, 1964

April 1, 1964

U	Z	eP	00:08:58.6 c
Ke	Z	iP	58.8 c

C&GS card 32-64:
00:01:10.6
60.4° N., 146.4° W.
h about 10 km
Magnitude 4.9 (CGS).

April 1

U	Z	Tmax	04:10:47
Pa	Z	Tmax	40
Hi	Z	Tmax	11
Ha	Z	Tmax	04:09:02

C&GS card 34-64:
03:23:17.2
57.2° N., 151.3° W.
h about 25 km
Magnitude 5.25 (Pal), 5.1 (CGS).

April 1

Pa	Z	Tmax	05:36:20
Ha	Z	Tmax	05:34:45

C&GS card 32-64:
04:49:26
57.2° N., 151.4° W.
h about 20 km
Magnitude 4.8 (CGS).

April 1

U	Z	Tmax	06:24:22
Pa	Z	Tmax	23
Hi	Z	Tmax	03
Ha	Z	Tmax	06:22:56

C&GS card 32-64:
05:33:02.9
59.9° N., 146.0° W.
h about 15 km
Magnitude 4.5 (CGS).

April 1

Pa	Z	Tmax	14:42:01
Ha	Z	Tmax	14:40:29

C&GS card 32-64:
13:54:31.9
57.5° N., 151.3° W.
h about 20 km
Magnitude 4.9 (CGS).

April 1

NB	Z	Tmax	17:19:48
Ha	Z	Tmax	17:18:39

C&GS card 32-64:
16:29:09.0
59.7° N., 146.5° W.
h about 15 km
Magnitude 4.7 (CGS).

April 1

Pa	Z	Tmax	20:53:38
Ha	Z	Tmax	20:51:57

C&GS card 32-64:
20:07:24
56.6° N., 153.0° W.
h about 33 km
Magnitude 4.4 (CGS).

Aftershocks of the Alaskan earthquake of March 28, 1964

April 2, 1964

Pa	Z	Tmax	09:14:11

C&GS card 32-64:
08:27:13.5
56.6° N., 152.4° W.
h about 33 km
Magnitude 4.3 (CGS).

April 2

U	Z	Tmax	10:44:16
Pa	Z	Tmax	10:44:16
NB	Z	Tmax	10:44:03
Hi	Z	Tmax	10:43:48
Ha	Z	Tmax	10:42:46

C&GS card 32-64:
09:57:54.5
56.5° N., 152.8° W.
h about 20 km
Magnitude 4.9 (CGS).

April 2

Pa	Z	Tmax	10:56:07
Ha	Z	Tmax	10:54:41

C&GS card 32-64:
10:09:47.0
56.7° N., 152.6° W.
h about 33 km
Magnitude 4.2 (CGS).

April 2

M	Z	eP	11:48:49.1 c
Na	Z	eP	51.0 c
Ke	Z	iP	49.2 c
Pa	Z	Tmax	12:40:37
Hi	Z	Tmax	12:40:05

C&GS card 32-64:
11:41:10.7
58.8° N., 149.6° W.
h about 20 km
Magnitude 5.4 (CGS).

April 2

Pa	Z	Tmax	13:06:12
Ha	Z	Tmax	13:04:47

C&GS card 32-64:
12:19:09
56.3° N., 152.2° W.
h about 33 km
Magnitude 4.3 (CGS).

April 2

Pa	Z	Tmax	20:31:29
Ha	Z	Tmax	20:30:00

C&GS card 32-64:
19:40:19.9
59.6° N., 144.8° W.
h about 20 km
Magnitude 4.7 (CGS).

April 2

Pa	Z	Tmax	21:00:38
Ha	Z	Tmax	20:58:59

C&GS card 32-64:
20:09:42.0
59.8° N., 147.0° W.
h about 10 km
Magnitude 5.0 (CGS).

April 2

U	Z	Tmax	23:25:59
Pa	Z	Tmax	53
NB	Z	Tmax	52
Ke	Z	Tmax	42
Hi	Z	Tmax	29
Ha	Z	Tmax	23:24:23

C&GS card 34-64:
22:34:31.7
59.8° N., 144.3° W.
h about 20 km
Magnitude 4.75-5 (Brk), 5.75-6 (Pal), 5.0 (CGS).

April 3

U	Z	Tmax	09:30:10
Pa	Z	Tmax	09:29:56
NB	Z	Tmax	09:30:23
Hi	Z	Tmax	09:29:23
Ha	Z	Tmax	09:28:28

C&GS card 32-64:
08:38:42.8
59.6° N., 144.7° W.
h about 10 km
Magnitude 5.4 (CGS).

April 3

U	Z	Tmax	09:37:50
Pa	Z	Tmax	33
NB	Z	Tmax	54
Hi	Z	Tmax	17
Ha	Z	Tmax	09:36:36

C&GS card 34-64:
08:46:27
57.9° N., 150.5° W.
h about 15 km
Magnitude 5.5 (CGS).

April 3

M	Z	iP	22:41:35.6 d
U	Z	iP	36.0 d
Pa	Z	eP	35.0 d
NB	Z	iP	36.4 d
Ke	Z	iP	35.9 d
Ha	Z	eP	26.5 d
U	PEN	eS	22:48:14
U	PEE	eG	22:51:14
U	PEZ	eR	22:52:58
Pa	Z	Tmax	23:26:04
Ha	Z	Tmax	23:24:35

C&GS card 32-64:
22:33:42.2
61.6° N., 147.6° W.
h about 40 km
Magnitude 6 (Pas), 6.25-6.5 (Pal)
5.25 (Brk), 5.7 (CGS)
5.8 (HVO).

April 4

M	Z	iP	04:42:45.3 c
Pa	Z	eP	45.8 c
Hi	Z	eP	43.1 c

C&GS card 32-64:
04:34:56.9
60.3° N., 146.5° W.
h about 5 km
Magnitude 5.0 (CGS).

April 4

M	Z	iP	05:01:45.3 c
Pa	Z	eP	45.4 c
Hi	Z	eP	43.0 c
Na	Z	eP	49.1 c
Ke	Z	iP	45.6 c
Ha	Z	iP	35.5 c
U	PEZ	eS	05:08:02
U	PEZ	iR	05:12:36
M	Z	Tmax	05:44:48
U	Z	Tmax	05:45:13
Pa	Z	Tmax	05:44:44
NB	Z	Tmax	05:45:19
Hi	Z	Tmax	05:44:32
Ha	Z	Tmax	05:43:32

C&GS card 32-64:
04:54:01.7
60.1° N., 146.7° W.
h about 40 km
Magnitude 5.6 (CGS), 6.0 (HVO).

April 4

Pa	Z	Tmax	07:45:03
Ha	Z	Tmax	07:43:48

C&GS card 32-64:
06:53:25.9
60.4° N., 146.0° W.
h about 15 km
Magnitude 4.8 (CGS).

April 4, 1964

M	Z	eP	08:47:45.4 d
U	Z	eP	45.9 d
Na	Z	eP	48.1 d
U	PEN	eS	08:53:38
U	PEZ	iR	08:57:38
M	Z	Tmax	09:27:00
U	Z	Tmax	09:27:00
Pa	Z	Tmax	09:26:47
NB	Z	Tmax	09:26:53
Hi	Z	Tmax	09:26:27
Ha	Z	Tmax	09:25:28

C&GS card 32-64:
08:40:29.8
56.5° N., 152.6° W.
h about 15 km
Magnitude 6.0 (Pal), 5.3 (CGS).

April 4

M	Z	iP	09:18:08.6 d
U	Z	iP	09.2 d
NB	Z	eP	09.1 d
Hi	Z	iP	06.0 d
Na	Z	iP	13.1 d
Ke	Z	iP	09.0 d
Ha	Z	eP	58.2 d
M	Z	Tmax	09:57:37
U	Z	Tmax	33
Pa	Z	Tmax	34
NB	Z	Tmax	44
Hi	Z	Tmax	14
Ha	Z	Tmax	09:56:06

C&GS card 32-64:
09:10:55.1
56.9° N., 152.7° W.
h about 15 km
Magnitude 5.75-6 (Pal), 5.9 (CGS).

April 4

M	Z	Tmax	15:58:50
Pa	Z	Tmax	58
NB	Z	Tmax	15:59:29
Ha	Z	Tmax	15:57:39

C&GS card 32-64:
15:08:12.3

April 4--Continued

C&GS card--Continued

59.6° N., 146.9° W.
h about 15 km
Magnitude 4.7 (CGS).

April 4

U	Z	eP	17:53:15.8 c
Na	Z	eP	18.7 c
Hi	Z	eP	13.0 c
U	PEZ	iS	17:59:02
U	PEN	eG	18:01:22
U	PEZ	eR	18:02:50
M	Z	Tmax	18:32:28
U	Z	Tmax	23
Pa	Z	Tmax	22
NB	Z	Tmax	31
Hi	Z	Tmax	18:31:58
Ke	Z	Tmax	18:32:39
Ha	Z	Tmax	18:30:42

C&GS card 32-64:
17:46:08.6
56.3° N., 154.4° W.
h about 25 km
Magnitude 6.5 (Pas), 5.75-6
(Brk), 6.5-6.75 (Pal),
5.7 (CGS), 6.5 (HVO).

April 4, 1964

Hi	Z	iP	18:06:49.7 c
M	Z	Tmax	18:46:00
U	Z	Tmax	18:45:57
Pa	Z	Tmax	18:45:53
NB	Z	Tmax	18:46:00
Hi	Z	Tmax	18:45:40
Ha	Z	Tmax	18:44:37

C&GS card 34-64:
17:59:43.3
56.4° N., 154.5° W.
h about 25 km
Magnitude 5.25 (Brk), 6.5-6.75
(Pal), 5.5 (CGS).

Aftershocks of the Alaskan earthquake of March 28, 1964

April 4, 1964

Pa	Z	Tmax	23:08:00
Ha	Z	Tmax	23:06:47

C&GS card 32-64:
22:16:54.5
59.4° N., 145.2° W.
h about 10 km
Magnitude 5.5-5.75 (Pal), 5.1 (CGS).

April 5

M	Z	eP	01:29:20.6
U	PEZ	iS	01:35:14
U	PEZ	eR	01:38:42
M	Z	Tmax	02:08:08
U	Z	Tmax	02:08:24
Pa	Z	Tmax	09
NB	Z	Tmax	30
Hi	Z	Tmax	02:07:53
Ha	Z	Tmax	02:07:18

C&GS card 33-64:
01:22:13.3
56.2° N., 153.5° W.
h about 25 km
Magnitude 6-6.25 (Pal), 5.4 (CGS), 6.2 (HVO).

April 5

M	Z	Tmax	02:27:34
U	Z	Tmax	44
Pa	Z	Tmax	39
NB	Z	Tmax	02:28:02
Hi	Z	Tmax	02:27:13
Ha	Z	Tmax	02:26:05

C&GS card 33-64:
01:41:45.0
56.2° N., 153.3° W.
h about 35 km
Magnitude 5.75-6 (Pal), 5.2 (CGS).

April 5, 1964

M	Z	Tmax	08:36:13
U	Z	Tmax	06
Pa	Z	Tmax	05
NB	Z	Tmax	11
Hi	Z	Tmax	08:35:46
Ha	Z	Tmax	08:34:44

C&GS card 34-64:
07:44:51
60.0° N., 144.8° W.
h about 15 km
Magnitude 4.2 (CGS).

April 5

Pa	Z	Tmax	08:59:15
Ha	Z	Tmax	08:57:44

C&GS card 34-64:
08:13:12.4
56.9° N., 152.0° W.
h about 15 km
Magnitude 4.5 (CGS).

April 5

Pa	Z	Tmax	09:45:07
Ha	Z	Tmax	09:43:26

C&GS card 33-64:
08:59:02
56.2° N., 154.5° W.
h about 15 km
Magnitude 4.7 (CGS).

April 5

M	Z	Tmax	18:27:12
U	Z	Tmax	18:27:00
Pa	Z	Tmax	18:26:57
NB	Z	Tmax	18:27:09
Hi	Z	Tmax	18:26:40
Ha	Z	Tmax	18:25:32

C&GS card 33-64:
17:40:43.1
56.3° N., 152.9° W.
h about 10 km
Magnitude 4.9 (CGS).

Aftershocks of the Alaskan earthquake of March 28, 1964

April 5, 1964

M	Z	Tmax	18:33:26
U	Z	Tmax	25
Pa	Z	Tmax	20
NB	Z	Tmax	27
Hi	Z	Tmax	18:32:52
Ha	Z	Tmax	18:31:57

C&GS card 34-64:
17:42:07.4
59.6° N., 144.9° W.
h about 15 km
Magnitude 5.1 (CGS).

April 5

M	Z	iP	19:36:04.3 d
U	Z	iP	04.6 d
NB	Z	eP	04.4 d
Hi	Z	eP	02.0 d
Ke	Z	eP	04.2 d
M	Z	Tmax	20:19:31
U	Z	Tmax	20
Pa	Z	Tmax	12
Hi	Z	Tmax	20:18:58
Ha	Z	Tmax	20:18:13

C&GS card 33-64:
19:28:18.1
60.2° N., 146.7° W.
h about 15 km
Magnitude 5-5.25 (Brk), 5.5 (Pal), 5.8 (CGS).

April 6

M	Z	Tmax	02:42:34
U	Z	Tmax	02:42:34
Ha	Z	Tmax	02:41:08

C&GS card 33-64:
01:51:49
59.4° N., 146.8° W.
h about 15 km
Magnitude 4.3 (CGS).

April 6

Pa	Z	Tmax	09:54:24

C&GS card 34-64:
09:03:12.9
59.5° N., 145.3° W.
h about 15 km
Magnitude 4.4 (CGS).

April 6

M	Z	Tmax	11:33:48
U	Z	Tmax	57
Pa	Z	Tmax	54
NB	Z	Tmax	11:34:08
Hi	Z	Tmax	11:33:39
Ha	Z	Tmax	11:32:29

C&GS card 34-64:
10:42:36.3
59.9° N., 145.6° W.
h about 15 km
Magnitude 4.8 (CGS).

April 6

Pa	Z	Tmax	11:47:52

C&GS card 34-64:
10:56:29
59.8° N., 147.9° W.
h about 33 km
Magnitude 4.0 (CGS).

April 7

M	Z	eP	01:50:54.8 c
NB	Z	iP	54.7 c
Ke	Z	iP	54.3 c

C&GS card 33-64:
01:43:28.7
58.5° N., 154.5° W.
h about 30 km
Magnitude 5.1 (CGS).

Aftershocks of the Alaskan earthquake of March 28, 1964

April 7

M	Z	Tmax	06:53:00
U	Z	Tmax	17
Pa	Z	Tmax	10
NB	Z	Tmax	13
Hi	Z	Tmax	06:52:57

C&GS card 33-64:
06:02:00
60.0° N., 145.7° W.
h about 33 km
Magnitude 4.0 (CGS).

April 7

Pa	Z	Tmax	18:49:44
Hi	Z	Tmax	18:49:32
Ha	Z	Tmax	18:48:18

C&GS card 33-64:
18:02:24.7
57.3° N., 151.1° W.
Magnitude 4.8 (CGS).
h about 20 km.

April 8

M	Z	Tmax	20:24:03
U	Z	Tmax	16
Pa	Z	Tmax	03
NB	Z	Tmax	10
Hi	Z	Tmax	20:23:41
Ha	Z	Tmax	20:22:42

C&GS card 33-64:
19:33:19.0
59.6° N., 147.0° W.
h about 15 km
Magnitude 5.1 (CGS).

April 8

M	Z	eP	19:58:04.9 c
NB	Z	eP	05.3 c
Ke	Z	iP	05.2 c

C&GS card 34-64:
19:50:16.8
60.4° N., 145.9° W.
h about 10 km
Magnitude 5.25-5.5 (Pal), 5.3 (CGS).

April 9

Pa	z	eP	13:14:05.8 d
NB	Z	eP	07.7 d
Hi	Z	eP	04.5 d
Na	Z	eP	10.9 d
Ke	Z	eP	07.7 d
M	Z	Tmax	13:57:30
U	Z	Tmax	38
Pa	Z	Tmax	29
NB	Z	Tmax	32
Hi	Z	Tmax	15
Ha	Z	Tmax	13:56:15

C&GS card 34-64:
13:06:15.2
59.6° N., 146.1° W.
h about 15 km
Magnitude 5.5-5.75 (Pal),
5.1 (CGS).

April 9

Pa	Z	Tmax	14:08:51

C&GS card 34-64:
13:22:29.6
56.8° N., 152.0° W.
h about 33 km
Magnitude 4.7 (CGS).

April 9

Pa	Z	Tmax	15:05:59

C&GS card 34-64:
14:14:36.5
59.8° N., 146.0° W.
h about 10 km
Magnitude 4.3 (CGS).

April 10

M	Z	iP	01:15:27.7 c
A	Z	iP	28.4 c
U	Z	eP	27.9 c
NB	Z	eP	28.1 c
Hi	Z	eP	23.4 c
Ke	Z	iP	27.5 c
Ha	Z	iP	19.3 c

Aftershocks of the Alaskan earthquake of March 28, 1964

April 10, 1964--Continued

C&GS card 33-64:
01:08:00.2
58.4° N., 150.6° W.
h about 15 km
Magnitude 5-5.25 (Pal), 5.5 (CGS).

April 10

M	Z	eP	21:51:49.8 d
NB	Z	eP	49.9 d
Hi	Z	eP	47.5 d
Ke	Z	eP	49.9 d

C&GS card 34-64:
21:44:06.7
60.1° N., 153.7° W.
h about 10 km
Magnitude 5.5-5.75 (Pal),
5.6 (CGS).

April 11

Pa	Z	Tmax	08:24:49

C&GS card 35-64:
07:33:52
59.6° N., 144.8° W.
h about 33 km
Magnitude 4.4 (CGS).

April 11

Pa	Z	Tmax	10:10:06

C&GS card 35-64:
09:23:51.5
56.4° N., 152.2° W.
h about 33 km
Magnitude 4.6 (CGS).

April 11

Pa	Z	Tmax	12:27:31

C&GS card 35-64:
11:36:00.5
60.4° N., 146.4° W.
Magnitude 4.8 (CGS).
h about 15 km.

April 12

M	Z	eP	01:31:40.5 d
A	Z	eP	41.0 d
Hi	Z	iP	38.0 d
Ke	Z	eP	41.2
U	PEN	eS	01:37:34
U	PEE	eG	01:39:38
U	PEZ	iR	01:41:34
M	Z	Tmax	02:10:57
A	Z	Tmax	02:11:14
U	Z	Tmax	02:11:04
Pa	Z	Tmax	02:11:01
NB	Z	Tmax	02:10:59
Hi	Z	Tmax	02:10:45
Ha	Z	Tmax	02:08:30

C&GS card 35-64:
01:24:31.2
56.6° N., 152.2°.W.
h about 22 km
Magnitude 5.6 (CGS),
6.1 (HVO).

April 12

M	Z	Tmax	10:21:11
A	Z	Tmax	17
U	Z	Tmax	10:20:55
Pa	Z	Tmax	10:21:06
NB	Z	Tmax	10:21:12
Ha	Z	Tmax	10:19:46

C&GS card 35-64:
09:34:44.1
56.6° N., 152.1° W.
h about 20 km
Magnitude 5.1 (CGS).

April 12

M	Z	Tmax	13:23:48
A	Z	Tmax	52
U	Z	Tmax	45
Pa	Z	Tmax	43
NB	Z	Tmax	49
Ha	Z	Tmax	13:22:20

C&GS card 37-64:
12:36:23
56.4° N., 151.4° W.
h about 30 km
Magnitude 5.0 (CGS).

April 12, 1964

M	Z	Tmax	18:13:33
A	Z	Tmax	40
U	Z	Tmax	28
Pa	Z	Tmax	26
NB	Z	Tmax	13
Ha	Z	Tmax	18:12:08

C&GS card 35-64:
17:22:02.2
60.2° N., 145.6° W.
h about 20 km
Magnitude 5.0 (CGS).

April 13

M	Z	eP	12:33:24 c
U	PEZ	eS	12:39:52
U	PEE	eG	12:42:34
U	PEZ	iR	12:44:22
M	Z	Tmax	13:17:10
A	Z	Tmax	13:17:05
U	Z	Tmax	13:17:04
Pa	Z	Tmax	13:16:47
NB	Z	Tmax	13:17:15
Hi	Z	Tmax	13:17:05
Ha	Z	Tmax	13:15:28

C&GS card 44-64:
12:25:36
59.4° N., 143.9° W.
h about 40 km
Magnitude 4.9 (CGS).

April 13

M	Z	eP	14:12:17.3 d
M	Z	Tmax	14:52:40
A	Z	Tmax	39
D	Z	Tmax	44
U	Z	Tmax	38
Pa	Z	Tmax	30
NB	Z	Tmax	13
Hi	Z	Tmax	14
Ha	Z	Tmax	14:51:08

C&GS card 36-64:
14:05:00.0
57.6° N., 151.2° W.
h about 25 km
Magnitude 4.75 (Brk), 5-5.25 (Pal), 5.5 (CGS).

April 13

M	Z	Tmax	17:00:37
A	Z	Tmax	39
U	Z	Tmax	35
Pa	Z	Tmax	28
NB	Z	Tmax	38
Hi	Z	Tmax	07
Ha	Z	Tmax	16:58:48

C&GS card 35-64:
16:14:06.3
56.6° N., 152.1° W.
h about 33 km
Magnitude 5.1 (CGS).

April 13

M	Z	iP	21:32:49.9 c
A	Z	iP	50.2 c
D	Z	iP	50.5 c
U	Z	iP	49.8 c
NB	Z	iP	49.7 c
Ke	Z	eP	49.3 c

April 13, 1964--Continued

C&GS card 35-64:
21:25:33.0
57.5° N., 153.9° W.
h about 30 km
Felt: Kodiak
Magnitude 5.5 (CGS).

April 13

M	Z	Tmax	22:34:43
A	Z	Tmax	47
U	Z	Tmax	46
Pa	Z	Tmax	31
Ha	Z	Tmax	22:33:21

C&GS card 35-64:
21:43:16.5
59.4° N., 143.1° W.
h about 33 km
Magnitude 5.1 (CGS).

April 14

M	Z	Tmax	23:20:52
A	Z	Tmax	50
D	Z	Tmax	49
U	Z	Tmax	51
NB	Z	Tmax	33
Ha	Z	Tmax	23:19:27

C&GS card 35-64:
22:29:31.1
59.9° N., 145.6° W.
h about 23 km
Magnitude 4.5 (CGS).

April 14

M	Z	eP	23:02:51.9 c
A	Z	eP	52.4 c
D	Z	iP	53.0 c
U	Z	iP	52.8 c
NB	Z	iP	52.5 c
Hi	Z	eP	49.3 c
Na	Z	iP	55.8 c
Ha	Z	eP	42.2 c
U	PEZ	eS	23:08:38
U	PEE	eG	23:11:22
U	PEZ	eR	23:12:58

C&GS card 35-64:
22:55:31.3
58.0° N., 152.6° W.
h about 30 km
Magnitude 5.4 (CGS), 5.5 (HVO).

April 15

M	Z	eP	15:37:54.9 c
D	Z	eP	56.1 c
U	Z	eP	55.4 c
Ke	Z	eP	54.4 c
U	PEZ	eS	15:43:46
U	PEE	eG	15:46:02
U	PEZ	iR	15:47:34
M	Z	Tmax	16:17:09
A	Z	Tmax	16
D	Z	Tmax	07
U	Z	Tmax	05
Pa	Z	Tmax	16:16:58
NB	Z	Tmax	16:17:35
Hi	Z	Tmax	16:16:39
Ke	Z	Tmax	16:17:20
Ha	Z	Tmax	16:15:12

C&GS card 35-64:
15:30:47.1
56.5° N., 154.4° W.
h about 35 km
Magnitude 5.5 (CGS), 5.9 (HVO).

April 16, 1964

M	Z	Tmax	08:28:17
U	Z	Tmax	23
Ha	Z	Tmax	08:27:00

C&GS card 35-64:
07:37:35.8
59.6° N., 146.9° W.
h about 33 km
Magnitude 4.3 (CGS).

April 16

M	Z	iP	19:34:04.9 c
A	Z	iP	05.8 c
D	Z	iP	05.9 c
U	Z	iP	05.1 c
Pa	Z	iP	04.1 c
NB	Z	eP	04.2 c
Hi	Z	eP	02.5 c
Na	Z	iP	09.9 c
Ke	Z	eP	04.5 c
Ha	Z	eP	19:33:56.1 c
U	PEZ	ePP	19:35:26
U	PEZ	iS	19:39:50
U	PEE	iG	19:41:58
U	PEZ	iR	19:43:38
M	Z	Tmax	20:13:06
A	Z	Tmax	20
D	Z	Tmax	30
U	Z	Tmax	20:13:20
Pa	Z	Tmax	12
NB	Z	Tmax	38
Hi	Z	Tmax	20:12:55
Ke	Z	Tmax	20:12:59
Ha	Z	Tmax	20:11:31

C&GS card 35-64:
19:26:57.4
56.4° N., 152.9° W.
h about 30 km
Magnitude 5.5 (CGS), 6.2 (HVO).

April 17

Pa	Z	Tmax	04:55:08
Ha	Z	Tmax	04:53:54

C&GS card 35-64:
04:03:55.9
59.6° N., 144.7° W.
h about 20 km
Magnitude 4.9 (CGS).

April 17

Pa	Z	Tmax	05:08:04
Ha	Z	Tmax	05:06:52

C&GS card 35-64:
04:16:59.4
59.6° N., 144.7° W.
h about 33 km
Magnitude 4.9 (CGS).

April 17

M	Z	eP	04:56:40.1 c
D	Z	eP	41.2 c
Ke	Z	eP	39.7 c
U	PEZ	eS	04:02:26
U	PEE	eG	04:04:34
U	PEZ	iR	04:06:26
M	Z	Tmax	05:35:42
A	Z	Tmax	05:36:00
D	Z	Tmax	05:35:48
U	Z	Tmax	05:35:46
Pa	Z	Tmax	05:35:46
NB	Z	Tmax	05:36:11
Hi	Z	Tmax	05:35:30
Ha	Z	Tmax	05:34:19

C&GS card 35-64:
04:49:30.5
56.4° N., 152.9° W.
h about 25 km
Magnitude 5.3 (CGS), 5.7 (HVO).

April 17

M	Z	iP	09:16:28.6 c
D	Z	iP	29.7 c
Ke	Z	eP	28.3 c
M	Z	Tmax	09:56:52
A	Z	Tmax	09:56:53
D	Z	Tmax	59
U	Z	Tmax	51
Pa	Z	Tmax	50
NB	Z	Tmax	24
Hi	Z	Tmax	34
Ha	Z	Tmax	09:55:30

C&GS card 35-64:
09:09:07.8
57.7° N., 151.4° W.
h about 20 km
Magnitude 5.4 (CGS).

April 17, 1964

M	Z	Tmax	12:39:58
A	Z	Tmax	12:40:04
D	Z	Tmax	12:40:03
U	Z	Tmax	12:39:49
Pa	Z	Tmax	55
NB	Z	Tmax	58
Hi	Z	Tmax	29
Ha	Z	Tmax	12:38:35

C&GS card 35-64:
11:48:44.7
60.0° N., 145.5° W.
h about 33 km
Magnitude 4.4 (CGS).

April 18

M	Z	Tmax	20:54:30
A	Z	Tmax	24
U	Z	Tmax	34
Pa	Z	Tmax	12
Hi	Z	Tmax	20:53:46
Ha	Z	Tmax	20:52:34

C&GS card 35-64:
20:08:19.7
56.1° N., 153.7° W.
h about 15 km
Magnitude 4.9 (CGS).

April 18

M	Z	Tmax	21:01:54
A	Z	Tmax	21:02:12
U	Z	Tmax	21:01:59
Pa	Z	Tmax	21:02:00
NB	Z	Tmax	21:01:28
Hi	Z	Tmax	21:01:39
Ha	Z	Tmax	21:00:31

C&GS card 35-64:
20:16:16.3
56.1° N., 153.7° W.
h about 30 km
Magnitude 4.9 (CGS).

April 20

M	Z	Tmax	04:26:02
A	Z	Tmax	00
U	Z	Tmax	03
Pa	Z	Tmax	04:25:54
NB	Z	Tmax	04:26:26

April 20--Continued

Hi	Z	Tmax	04:25:40

C&GS card 35-64:
03:34:45.1
59.7° N., 144.6° W.
h about 30 km
Magnitude 4.7 (CGS).

April 20

M	Z	eP	12:04:34.3 c
A	Z	eP	35.0 c
U	Z	eP	34.5 c
Pa	Z	eP	34.2 c
NB	Z	eP	34.7 c
Na	Z	eP	37.0 c
Ke	Z	eP	34.1 c
U	PEZ	eS	12:10:54
U	PEE	iG	12:14:14
U	PEZ	eR	12:15:56
M	Z	Tmax	12:48:56
U	Z	Tmax	47
Pa	Z	Tmax	55
NB	Z	Tmax	46

C&GS card 37-64:
11:56:41.6
61.4° N., 147.3° W.
h about 30 km
Magnitude 6.5 (Pas), 6.75 (Brk), 6-6.25 (Pal), 5.7 (CGS), 5.8 (HVO).

April 21

M	Z	iP	05:09:27.4 c
A	Z	iP	28.0 c
D	Z	iP	28.3 c
U	Z	eP	27.5 c
NB	Z	eP	27.6 c
Ke	Z	iP	27.5 c
U	PEZ	eR	05:20:58

C&GS card 36-64:
05:01:35.7
61.5° N., 147.4° W.
h about 40 km
Felt: Anchorage
Magnitude 6 (Pas), 4.75-5 (Brk), 5.4 (CGS), 5.5 (HVO).

April 24, 1964

M	Z	Tmax	04:42:07
A	Z	Tmax	07
U	Z	Tmax	04
NB	Z	Tmax	31

C&GS card 38-64:
03:51:05.0
59.5° N., 144.5° W.
h about 33 km
Magnitude 5.2 (CGS).

April 25

M	Z	Tmax	07:52:26
A	Z	Tmax	29
U	Z	Tmax	25
NB	Z	Tmax	39

C&GS card 41-64:
07:01:20
59.8° N., 145.3° W.
h about 33 km
Magnitude 3.8 (CGS).

April 25

M	Z	Tmax	10:34:37
A	Z	Tmax	45
D	Z	Tmax	30
U	Z	Tmax	36
Pa	Z	Tmax	30
NB	Z	Tmax	57
Hi	Z	Tmax	16
Ke	Z	Tmax	21
Ha	Z	Tmax	10:33:04

C&GS card 38-64:
09:43:30.7
59.9° N., 144.9° W.
h about 30 km
Magnitude 5.0 (CGS).

May 1

M	Z	Tmax	04:32:09
A	Z	Tmax	11
D	Z	Tmax	14
U	Z	Tmax	09
Pa	Z	Tmax	03
NB	Z	Tmax	20
Hi	Z	Tmax	04:31:47
Ha	Z	Tmax	04:30:43

May 1--Continued

C&GS card 46-64:
03:40:36.2
59.7° N., 144.1° W.
h about 20 km
Magnitude 4.4 (CGS).

May 1

M	Z	iP	06:09:41.6
U	PEZ	eR	06:21:09

C&GS card 38-64:
06:01:55.4
60.5° N., 145.6° W.
h about 20 km
Magnitude 5.4 (CGS).

May 2

M	Z	Tmax	10:53:05
A	Z	Tmax	04
U	Z	Tmax	12
NB	Z	Tmax	08
Ha	Z	Tmax	10:51:45

C&GS card 41-64:
10:02:42
59.4° N., 146.5° W.
h about 33 km
Magnitude 4.3 (CGS).

May 6

D	Z	eP	15:33:48.6 d
U	Z	eP	48.4 d
U	PEN	eS	15:39:43
U	PEE	eG	15:42:15
U	PEZ	eR	15:43:54
M	Z	Tmax	16:13:09
A	Z	Tmax	16
D	Z	Tmax	29
U	Z	Tmax	16:12:59
Pa	Z	Tmax	16:13:04
NB	Z	Tmax	16:13:21
Hi	Z	Tmax	16:12:44
Ha	Z	Tmax	16:11:39

C&GS card 38-64:
15:26:35.5
56.7° N., 152.1° W.
h about 15 km
Magnitude 5.4 (CGS), 5.4 (HVO).

May 8

Ha	Z	Tmax	10:13:20

C&GS card 38-64:
09:23:33.1
59.4° N., 145.4° W.
h about 20 km
Magnitude 4.5 (CGS).

May 8

M	Z	eP	16:28:59.1 c
U	PEE	eS	16:34:47
U	PEZ	iR	16:38:51
M	Z	Tmax	17:07:59
A	Z	Tmax	17:08:15
D	Z	Tmax	17:08:21
U	Z	Tmax	17:08:21
Pa	Z	Tmax	17:07:59
NB	Z	Tmax	17:08:15
Hi	Z	Tmax	17:07:42

C&GS card 38-64:
16:21:49.8
56.7° N., 154.0° W.
h about 25 km
Magnitude 5.3 (CGS), 5.7 (HVO).

May 8

M	Z	eP	21:42:31.5 d
U	PEZ	eR	21:53:23
M	Z	Tmax	22:26:54
U	Z	Tmax	22:26:53

C&GS card 38-64:
21:34:40.6
60.8° N., 143.6° W.
h about 35 km
Magnitude 5.4 (CGS).

May 12

M	Z	iP	18:23:54.8 c
A	Z	iP	57.1 c
Ke	Z	iP	56.5 c
U	PEZ	eS	18:29:43
U	PEE	iG	18:32:09
U	PEZ	iR	18:33:47
M	Z	Tmax	19:03:20
A	Z	Tmax	23
U	Z	Tmax	10
Pa	Z	Tmax	19:03:14
NB	Z	Tmax	23
Hi	Z	Tmax	19:02:56

May 12--Continued

Ha	Z	Tmax	19:01:51

C&GS card 42-64:
18:16:41.9
56.6° N., 152.4° W.
h about 10 km
Magnitude 5.5-5.75 (Brk),
6-6.25 (Pal),
5.3 (CGS), 6.0 (HVO).

May 14

M	Z	Tmax	15:10:25
A	Z	Tmax	31
U	Z	Tmax	22
Pa	Z	Tmax	19
NB	Z	Tmax	32
Hi	Z	Tmax	07
Ha	Z	Tmax	15:09:15

C&GS card 42-64:
14:19:05
59.7° N., 144.4° W.
h about 33 km
Magnitude 4.5 (CGS).

May 16

M	Z	Tmax	15:32:36
A	Z	Tmax	15:32:37
U	Z	Tmax	35
Ha	Z	Tmax	15:30:59

C&GS CARD 40-64:
14:44:54
57.6° N., 151.0° W.
h about 33 km
Magnitude 5.4 (CGS).

May 17

M	Z	eP	00:57:57.3 c
U	PEN	eS	01:04:19
U	PEN	eG	01:07:29
M	Z	Tmax	01:41:49
A	Z	Tmax	01:42:04
D	Z	Tmax	01:41:59
U	Z	Tmax	01:41:55
Ha	Z	Tmax	01:40:20

C&GS card 43-64:
00:50:17.9
59.4° N., 142.7° W.

Aftershocks of the Alaskan earthquake of March 28, 1964

May 17 --Continued

C&GS card--Continued
h about 35 km
Magnitude 5.75 (Pas), 6-6.25 (Brk), 6.25-6.5 (Pal), 5.1 (CGS).

May 18

M	Z	Tmax	14:38:19
A	Z	Tmax	31
D	Z	Tmax	25
U	Z	Tmax	19
Pa	Z	Tmax	20
NB	Z	Tmax	40
Ha	Z	Tmax	14:36:31

C&GS card 43-64:
13:47:22.7
59.6° N., 145.0° W.
h about 20 km
Magnitude 4.6 (CGS).

May 19

M	Z	eP	15:44:45 c
M	Z	Tmax	16:24:23
A	Z	Tmax	31
U	Z	Tmax	23
NB	Z	Tmax	28
Hi	Z	Tmax	16:23:54

C&GS card 43-64:
15:37:35.9
57.0° N., 152.8° W.
h about 25 km
Magnitude 4.9 (CGS).

May 21

M	Z	eP	15:43:34.0 d
A	Z	eP	34.5 d
U	Z	eP	34.1 d
NB	Z	eP	33.5 d
U	PEN	eG	15:52:33
U	PEZ	eR	15:54:18

C&GS card 45-64:
15:36:01.5
59.0° N., 153.5° W.
h about 15 km
Magnitude 5.75-6 (Brk), 5.3 (CGS).

May 28

M	Z	iP	16:25:29.7 c
A	Z	iP	30.2 c
D	Z	iP	30.7 c
MP	Z	iP	30.1 c
U	Z	iP	29.7 c
Ke	Z	eP	29.5 c

C&GS card 43-64:
16:18:04.2
58.3° N., 156.0° W.
h about 25 km
Magnitude 5.4 (CGS).

May 29

M	Z	iP	10:25:21.2 d
A	Z	iP	21.7 d
D	Z	iP	22.1 d
MP	Z	iP	21.8 d
U	Z	iP	21.5 d
NB	Z	eP	21.7 d
Hi	Z	iP	18.4 d
Ke	Z	eP	20.9 d
Ha	Z	iP	11.5 d
U	PEZ	iR	10:36:19
M	Z	Tmax	11:08:48
A	Z	Tmax	48
D	Z	Tmax	54
MP	Z	Tmax	35
U	Z	Tmax	54
Pa	Z	Tmax	51
NB	Z	Tmax	50
Hi	Z	Tmax	17
Ha	Z	Tmax	11:07:19

C&GS card 43-64:
10:17:34.5
60.2° N., 146.3° W.
h about 5 km
Magnitude 5.5 (Pal), 5.6 (CGS), 5.8 (HVO).

Aftershocks of the Alaskan earthquake of March 28, 1964

May 30

M	Z	eP	03:25:46.0 c
A	Z	eP	46.6 c
D	Z	eP	47.0 c

C&GS card 43-64:
03:18:08.3
59.5° N., 148.5° W.
Magnitude 4.25-4.5 (Pal), 5.5 (CGS).

May 30

Ha	Z	Tmax	23:19:31

C&GS card 43-64:
22:34:33.3
56.6° N., 152.3° W.
h about 15 km
Magnitude 4.7 (CGS).

June 2

M	Z	eP	16:17:05.7 c
A	Z	eP	06.2 c
M	Z	Tmax	17:00:44
A	Z	Tmax	50
U	Z	Tmax	36
Pa	Z	Tmax	25
NB	Z	Tmax	53
Hi	Z	Tmax	16
Ha	Z	Tmax	16:59:10

C&GS card 45-64:
16:09:23.5
59.7° N., 144.4° W.
h about 15 km
Magnitude 4.75 (Brk), 5.1 (CGS).

June 2

M	Z	Tmax	17:20:59
A	Z	Tmax	17:21:02
D	Z	Tmax	17:21:02
U	Z	Tmax	17:20:56
Pa	Z	Tmax	17:20:51
NB	Z	Tmax	17:21:00
Hi	Z	Tmax	17:20:29
Ha	Z	Tmax	17:19:30

C&GS card 45-64:
16:29:41.5
59.7° N., 144.2° W.
h about 10 km
Magnitude 4.8 (CGS).

June 3

M	Z	Tmax	14:54:53
A	Z	Tmax	14:54:57
D	Z	Tmax	14:55:09
MP	Z	Tmax	14:54:55
U	Z	Tmax	14:55:01
Pa	Z	Tmax	14:54:49
NB	Z	Tmax	14:55:11
Hi	Z	Tmax	14:54:33
Ha	Z	Tmax	14:53:38

C&GS card 43-64:
14:03:42.4
59.9° N., 143.9° W.
h about 20 km
Magnitude 5.1 (CGS).

June 5

M	Z	iP	09:58:22.5 c
D	Z	eP	23.4 c
U	Z	eP	22.6 c
Ke	Z	iP	22.6 c

C&GS card 45-64:
09:50:35.0
60.4° N., 146.0° W.
h about 15 km
Magnitude 5.2 (CGS).

June 5

M	Z	iP	22:14:17.9 c
A	Z	iP	18.5 c
D	Z	iP	19.0 c
U	Z	iP	18.1 c
Pa	Z	iP	17.2 c
NB	Z	iP	18.2 c
Hi	Z	iP	15.3 c
Na	Z	iP	21.6 c
Ke	Z	iP	17.5 c
Ha	Z	eP	07.7 c

C&GS card 45-64:
22:06:53.0
58.1° N., 152.1° W.
h about 15 km
Magnitude 5.0 (CGS).

Table 5.--Distant earthquakes--Continued

Aftershocks of the Alaskan earthquake of March 28, 1964

June 10, 1964			
M	Z	eP	23:32:37.6 c
C&GS card 47-64:			
23:25:09.1			
59.1° N., 153.8° W.			
h about 33 km			
Magnitude 5.1 (CGS).			
June 28			
M	Z	iP	19:16:29.5 c
A	Z	iP	30.4 c
D	Z	iP	30.7 c
U	Z	iP	29.8 c
Pa	Z	eP	28.6 c
NB	Z	eP	30.1 c
Hi	Z	eP	27.3 c
Ke	Z	iP	29.4 c
C&GS card 52-64:			
19:09:05.4			
58.3° N., 150.2° W.			
h about 23 km			
Magnitude 5.5 (CGS).			

During the quarter "felt reports" were either phoned or mailed in by the following people to whom we wish to express our gratitude for these and other instances of cooperation.

Kilauea summit area

Mrs. V. Hanson
Mrs. W. Gorder
Mr. and Mrs. C. Wentworth
Mrs. W. Mist
Mr. G. Kojima
Mr. R. Koyanagi
Miss M. English
Miss L. Yong
Mrs. O. Duncan
Mr. and Mrs. A. Yamamoto
Mrs. K. Okamoto

North Hawaii

Mrs. E. Lindsey
Mrs. P. Richards
Mrs. R. Edlund
Kohala Police Station
Mrs. A. Paiva
Dr. F. Tabrah

Hilo region

Mrs. T. Crabb
Mrs. H. Lewis
Mr. and Mrs. R. Baldwin
Mr. C, Shoemaker
Mr. Y. Kojima
Miss E. Patten
Mr. C. Okamura
Mrs. T. Indledue
Mr. J. Bryan

Puna

Mr. H. Warner
Mrs. D. Isbell
Mrs. C. Guerino
Keaau Police Station

Kau

Mrs. A. Paiva
Rev. D. Thompson

Kona region

Mr. H. Nelson
Miss A. Greenwell
Mr. M. Sutherland
Mrs. R. Apple
Miss N. Wallace

Central Hawaii

Pohakuloa Military trainees

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

SUMMARY 35

July August, and September, 1964

By

Willie T. Kinoshita, Arnold T. Okamura

and Robert Y. Koyanagi

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

SUMMARY 35

July August, and September, 1964

By

Willie T. Kinoshita, Arnold T. Okamura
and Robert Y. Koyanagi

OBSERVATORY STAFF

Geology

H. A. Powers (Scientist-in-Charge)
D. L. Peck

Geophysics

R. W. Decker (June 29-Dec. 20)
D. P. Hill
W. T. Kinoshita
George Kojima
R. Y. Koyanagi
A. T. Okamura

Geochemistry

R. T. Okamura
T. L. Wright

Support

E. T. Endo
J. C. Forbes
W. H. Francis
B. J. Loucks
Akira Yamamoto

Contents

Illustrations

Tables

Chronological summary

Most conspicuous during the third quarter of 1964 were the increase in sulfurous fuming from Halemaumau and the step-up in rate of inflation of Kilauea summit which was indicated by both the short-base tiltmeter and the net of long-base tiltmeters. The number of felt earthquakes increased (43 during the quarter), but the total daily counts of quakes remained very low.

During July the short-base tiltmeter indicated slight but erratic inflation of Kilauea. A flurry of small earthquakes from the Kaoiki fault on July 16 lasted 3 hours. Two relatively large quakes were felt during July: one magnitude 4.5 earthquake from a shallow focus beneath the southeast flank of Kilauea was felt throughout eastern Hawaii on the 1st, and another magnitude 4.5 quake, offshore, west of Mauna Loa, was felt islandwide on the 17th.

In the first half of August the summit tilting accelerated to a rate sufficient to increase the elevation of Uwekahuna a tenth of an inch per day. The number of shallow quakes originating in the Kilauea caldera area increased to more than 100 per day, and tremor was conspicuous by its absence. On August 26 one deep magnitude 4.5 quake under Kilauea and another of the same magnitude off the northwest coast of Hawaii were felt islandwide. The daily count of local caldera quakes decreased on August 16 and remained low for the remainder of the quarter.

There was increased seismic activity near Pahoa on the lower east rift of Kilauea during the first half of September. An average of 25 small shallow earthquakes per day was recorded by the Pahoa seismograph. Several larger quakes with magnitudes of from 3.5 to 4 were felt strongly in the Puna region; a dozen smaller ones were felt only near Pahoa. This local activity was monitored on several occasions by a portable seismograph.

Inflation of the summit area continued at a lower rate during September, and no evidence suggesting movement of magma into the lower east rift zone was recorded.

An earthquake of magnitude 4.9 was felt throughout the island just after midnight on the morning of September 18. It originated at about 5-km depth on the southeast flank of Kilauea and was followed by about 50 smaller quakes, 2 of which were felt locally, during the next 24 hours.

Seismic profiles.--During August, Observatory personnel participated with the Branch of Crustal Studies in recording seismic-refraction profiles along the northeast, southeast, and west coasts of the triangular-shaped island of Hawaii. Shots were fired at 10-km intervals from the U.S. Coast Guard Cutter Cape Small, Lt. Lloyd commanding, and were recorded along each coast by five refraction units spaced approximately at 25-km intervals.

Interpretation of the seismograms by D. P. Hill indicates that the crust is about 16 km thick under the west flanks of Mauna Loa and Hualalai, and 11 km thick under the northeast and southeast flanks of Kilauea. The crust has an intermediate thickness along the northeast flanks of Mauna Kea and the Kohala Mountains. The velocity of P waves in the upper crust increases with depth from 2.0 to as much as 6.0 km per sec.; velocities in the upper crust are generally lower on the flanks of Kilauea than on the flanks of the other volcanoes. Clearly recorded arrivals indicate that a layer with velocities of from 6.9 to 7.3 km per sec. forms the lowermost 4-8 km of the crust under each of the coasts. The velocity of P_n under each of the coasts is about 8.2 km per sec. Anomalously high crustal velocities are associated with the major rift zones extending from the five volcanoes that form the island.

Crustal Studies participants in the Hawaii refraction program were Wayne Jackson, David Stuart, Benton Tibbetts, and Jack Clark.

Puna leveling.--A 50-mile-long network of bench marks established in 1958 across part of the active east rift zone of Kilauea volcano in the Puna area was releveled during the second half of 1964. The level lines, which follow the road network, form one large triangle which encompasses a smaller triangle, thus affording three loop closures. These were at 0.075, 0.060, and 0.015 foot, and the survey was well within 3d-order allowable error. The rift zone is crossed in three places and paralleled roughly for several miles by the level lines. Spur lines were run to the Kupapau tide gage and to the Kokoolau triangulation station along the Honolulu Landing road.

Uplift of 0.3 foot has taken place across the rift zone along the Pahoa-Kaimu line. The zone of uplift is 7 miles wide, its apex asymmetric to the north. A small graben half a mile wide and 0.3 foot deep indents the apex. The swelling is probably related to the east rift eruption of September 1961, during which much more magma moved from beneath the summit region into the rift zone than was erupted along the rift.

The Pahoa-Pohoiki crossing of the rift shows a broad region of subsidence having a maximum depression of 0.2 foot. The line paralleling the rift zone near Kapoho shows a collapse of 0.2-0.4 foot, and the road along the shore between Kapoho and Pohoiki appears to have subsided about 0.1 foot. This general area of collapse along the rift zone east of Pahoa probably was formed during the 1960 Kapoho eruption.

Three stations north of the Kapoho graben along the Honolulu Landing road show a sharp uplift of 0.5 foot, which decreases rapidly to less than 0.1 foot within a distance of $1\frac{1}{2}$ miles. This uplift suggests that some vertical movement took place on the north side of the Koae fault immediately preceding and during the Kapoho eruption in 1960. The disturbed zone in the Honolulu Landing-Pohoiki region of the rift zone is about 6 miles wide.

New bench marks set in areas covered by the 1960 flows can be compared roughly with nearby but buried 1958 bench marks. This comparison provides a thickness profile for the 1960 flows which fill the Kapoho graben beneath the present Pohoiki-Honolulu Landing road. The maximum thickness exceeds 70 feet 0.7 mile north of the Kapoho road intersection without allowing for subsidence of the graben during the eruption.

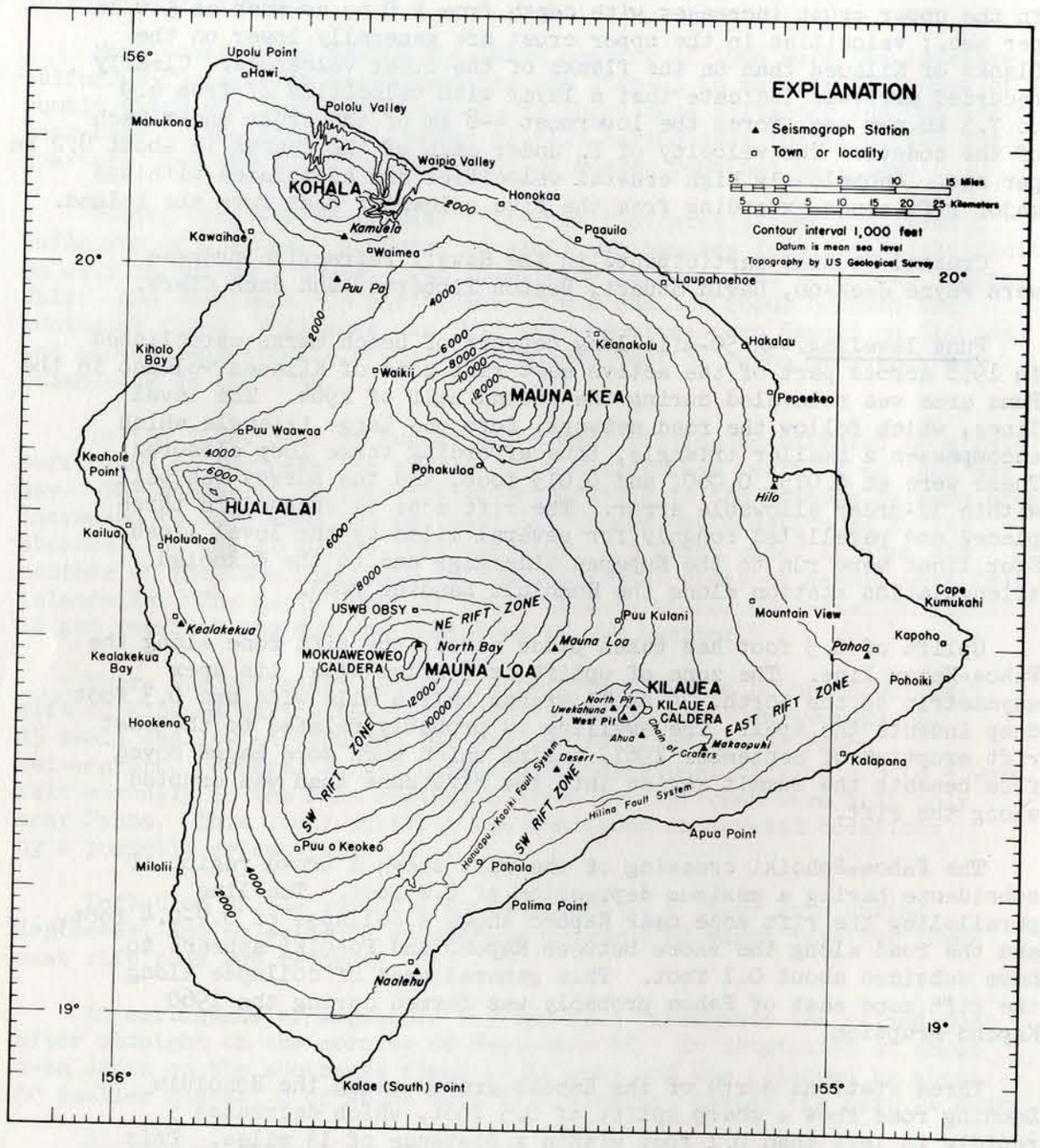

Figure 1.--Map of the island of Hawaii showing localities mentioned in the text and seismograph stations operated by the U.S. Geological Survey. Epicenters of local earthquakes are given in terms of geographic coordinates, which are indicated at the edges of the map.

Organization of the leveling fieldwork and analysis of the results were done by R. W. Decker, who was on sabbatical leave from Dartmouth College.

Tilting of the ground around Kilauea caldera.--Tilting of the ground around the summit of Kilauea is monitored daily by a short-base water-tube tiltmeter in Uwekahuna Vault, and at irregular intervals it is measured on a regional scale by means of a network of field tilt-bases and a portable water-tube tiltmeter. The attitude of the ground surface at each tilt-base is reported in terms of north-south and east-west tilt coordinates. Both coordinates at each station were arbitrarily set equal to 500 when measurements were begun. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface; that is, to a relative subsidence toward the north and east. A one-unit change in coordinate corresponds to a tilting of 1 microradian (1 mm per km) in the direction indicated.

Table 1.--Tilt coordinates at Uwekahuna Vault, July, August, and September, 1964

Date	N-S	E-W	Date	N-S	E-W
July 5	468	504	Sept. 6	477	488
12	469	504	13	478	486
19	470	502	20	480	482
26	472	502	27	480	479
Aug. 2	471	501			
9	471	499			
16	473	495			
23	474	495			
30	476	490			

Table 2.--Tilt coordinates and changes at bases around Kilauea caldera. (See fig. 2)

Tilt Base	Date (1964)	Tilt coordinates		Rate (10^{-6} rad/mo) and direction of tilting since last reading		Date of last reading (1964)
		N-S	E-W			
Uwekahuna	Aug. 27	469.6	477.2	5.7	N. 40.7° W.	Apr. 29
Tree Molds	28	441.0	508.1	2.1	N. 19.7° W.	May 1
Sand Spit	Sept. 1	872.6	742.9	8.5	N. 46.7° W.	1
Kalihipaa	Aug. 27	330.6	383.9	1.9	S. 00.8° E.	Apr. 27
Keamoku	28	505.6	577.3	4.3	N. 56.2° W.	28
Ahua Kamokukolau	26	584.3	528.5	9.5	S. 6.0° W.	May 1
Kipuka Nene	Sept. 1	482.6	508.3	0.8	S. 32.3° W.	Apr. 27
Hilina Pali	Not occupied this epoch					
Kapapala Ranch	Aug. 24	493.9	504.0	0.4	S. 25.1° E.	Apr. 28

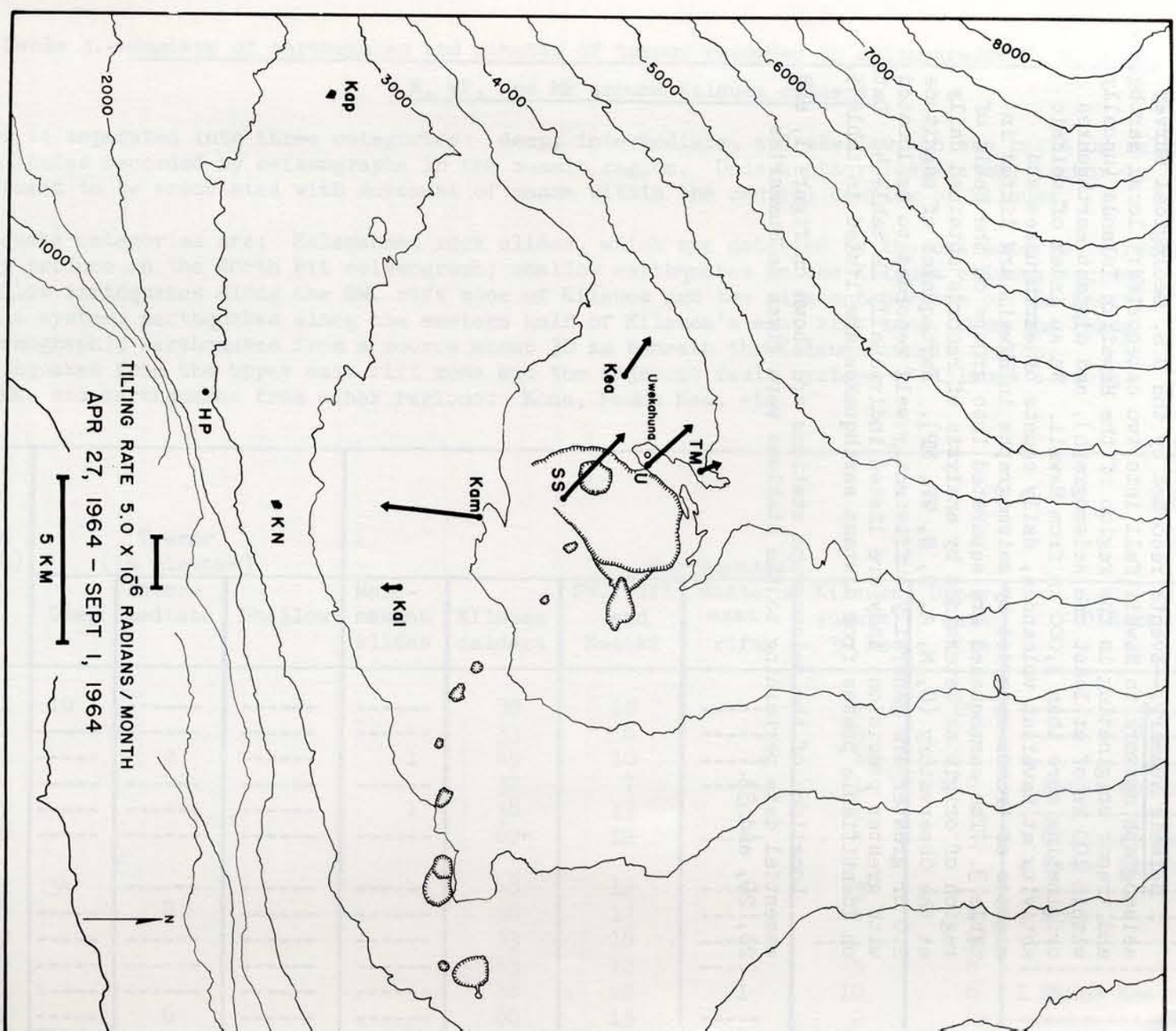

Figure 2.--Tilting of the ground around Kilauea caldera, April 27 to September 1, 1964. The vector depicting tilting at a given tilt base points in the direction of maximum relative subsidence and has a length proportional to the rate of tilting during the measurement interval. Closed circles represent field tilt bases; open circles, short-base water-tube tiltmeters.

Seismic summary.--Events recorded by the U.S. Geological Survey seismograph network in Hawaii fall into two categories: local earthquakes and tremor originating in the region of the Hawaiian Islands (usually within 100 km of at least one seismograph), and distant earthquakes originating more than 3,000 km from Hawaii. As an index of seismic activity at Hawaiian volcanoes, daily counts of earthquakes and minutes of tremor recorded by seismographs in Hawaii are listed in table 3. The earthquakes are separated into groups on the basis of region of origin as determined by analysis of records obtained daily at the Observatory (U, M, A, D, N, WP, MP). Earthquakes of magnitude 2.0 or greater are generally sufficiently well recorded to be located with greater precision; they are listed individually in table 4. Data on identifiable phases from distant earthquakes are listed in table 5.

Locations of the seismograph stations are shown on figure 1, and essential data pertaining to the stations were given in Summaries 25, 29, and 33.

s of tremor recorded on seismographs U, M, A, D,

N, WP, and MP around Kilauea caldera

, intermediate, and shallow, on the basis of relative
mit region. Unless otherwise stated, tremor is
ma within the central complex of Kilauea.

es, which are detected by the characteristic record
llow earthquakes in the Kilauea caldera region;
Kilauea and the adjacent portion of the Kaoiki
lf of Kilauea's east rift zone (from the Pahoa
30 km beneath the Kilauea summit region;
the adjacent fault systems of Kilauea's south
ona, Mauna Kea, etc.

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera

Tremor is separated into three categories: deep, intermediate, and shallow, on the basis of relative amplitudes recorded by seismographs in the summit region. Unless otherwise stated, tremor is presumed to be associated with movement of magma within the central complex of Kilauea.

Earthquake categories are: Halemaumau rock slides, which are detected by the characteristic record they produce on the North Pit seismograph; shallow earthquakes in the Kilauea caldera region; shallow earthquakes along the SW. rift zone of Kilauea and the adjacent portion of the Kaoiki fault system; earthquakes along the eastern half of Kilauea's east rift zone (from the Pahoa seismograph); earthquakes from a source about 30 km beneath the Kilauea summit region; earthquakes from the upper east rift zone and the adjacent fault systems of Kilauea's south flank, and earthquakes from other regions: Kona, Mauna Kea, etc.

Date (1964)	Tremor (in minutes)			Earthquakes								Others
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	
July 1	10	------	------	------	30	10	-----	2	21	----------
2	-----	------	------	------	33	6	-----	3	2	----------
3	-----	2	------	1	49	10	-----	4	----	----------
4	-----	------	------	------	32	7	-----	1	2	1 Mauna Kea region
5	-----	------	------	1	38	13	2	1	?	----------
6	-----	------	------	------	62+	12	----	4	3+	1 Offshore Maui
										1 Mauna Kea region
7	34	------	------	------	48	12	-----	3	-----	----------
8	----	8	------	------	56	13	-----	4	4+	1 Kona----------
9	-----	------	------	------	33	18	-----	-----	4?	----------
10	-----	------	------	------	43	12	-----	5	6	----------
11	-----	------	------	------	38	22	-----	10	6	1 Mauna Kea region
12	----	6	------	------	66	15	-----	2	4+	----------

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	Others
July 13	-----	5	-----	-----	38	13	-----	11	5	-----
14	-----	3	-----	-----	42	6	-----	5	3	-----
15	32	-----	-----	-----	47	34	-----	2	3?	-----
16	-----	-----	-----	-----	49	43	-----	-----	2	-----
17	4	-----	-----	-----	43	11	-----	2	1	1 Hualalai region
18	-----	-----	-----	-----	50	14	-----	4	6	1 Mauna Kea region 1 Kohala region
19	-----	-----	-----	-----	53+	7	-----	1	7	1 Mauna Kea region
20	-----	-----	-----	-----	47	6	-----	9	3	-----
21	-----	-----	-----	-----	45	10	-----	6	2	-----
22	-----	-----	-----	-----	43	24	-----	-----	2	-----
23	-----	3	-----	2	100	21	-----	1	-----	-----
24	-----	4	-----	-----	95+	28	-----	3	4+	-----
25	-----	-----	-----	-----	70	13	-----	3	?	-----
26	-----	-----	-----	-----	60	34	-----	14	2+	1 Mauna Loa region
27	5	-----	-----	-----	37	10	-----	6	-----	2 Hualalai region
28	-----	-----	-----	-----	25+	20	-----	4	-----	1 Kona
29	-----	5	-----	-----	25	12	-----	9	-----	1 Mauna Kea region
30	-----	-----	-----	-----	36	17	-----	1	2	1 Hualalai region
31	-----	5	-----	-----	40	12	9	4	1	-----
Aug. 1	8	-----	-----	-----	33	16	-----	3	4	1 Kona 1 Hualalai region
2	13	-----	-----	-----	32	9	-----	2	2	-----
3	-----	-----	-----	-----	20	5	-----	3	1	1 Mauna Loa region
4	-----	-----	-----	-----	57	5?	-----	1	?	1 Kona
5	-----	-----	-----	-----	53	4	-----	1	-----	1 Mauna Loa region
6	-----	-----	-----	-----	55	12	-----	3	2	-----
7	39	-----	-----	-----	100	5	-----	-----	5	1 Kona 1 Offshore Maui
8	-----	-----	-----	-----	85	10	-----	1	-----	-----
9	-----	-----	-----	-----	100	3	-----	-----	3	-----
10	4	-----	-----	-----	65	3	-----	1	1	-----
11	-----	-----	-----	-----	85	7	-----	4	4	-----
12	-----	5	-----	-----	116	16	-----	3	3	-----
13	-----	-----	-----	-----	111	6	-----	1	6	-----
14	-----	-----	-----	1	90	6	-----	-----	5	-----
15	-----	-----	9	-----	104	8	-----	3	3	-----
16	-----	13	-----	1	80	8	-----	-----	4	-----
17	-----	-----	-----	-----	60	4	-----	-----	4	-----
18	-----	-----	-----	-----	50	5	-----	2	-----	-----
19	-----	-----	-----	-----	28	6	-----	2	12	1 Kawaihae
20	-----	2	-----	-----	30	9	-----	1	5	-----
21	-----	-----	-----	-----	29	6	-----	4	6	-----
22	-----	-----	-----	-----	30	6	-----	1	3	-----
23	48	-----	-----	-----	37	6	1	2	2	-----
24	-----	-----	-----	-----	45	10	-----	1	-----	-----
25	12	-----	-----	-----	47	6	-----	3	-----	1 Mauna Kea region
26	-----	-----	-----	-----	58	2	-----	3	7	1 Maui 1 Kohala region 1 Mauna Kea region
27	-----	-----	-----	-----	80	4	2	-----	2	1 Mauna Kea region
28	-----	9	-----	-----	61	11	4	2	2	1 Mauna Loa region
29	-----	-----	-----	-----	83	13	26	1	3	1 Kona
30	-----	-----	-----	-----	65	7	63	2	5	-----
31	-----	-----	-----	-----	60	17	23	-----	5	1 Mauna Kea region
Sept. 1	-----	-----	-----	-----	80+	8	23	4	-----	-----
2	-----	-----	-----	-----	65	9	16	-----	3	-----
3	-----	5	-----	-----	60	12	10	2	3+	1 Kona 1 Mauna Loa
4	7	-----	-----	-----	39	19	15	1	13	-----
5	-----	-----	-----	-----	56	19	11	10	10	-----
6	-----	-----	-----	-----	66	16	24	4	13	-----
7	11	-----	-----	-----	30	24	34	4	2+	1 Mauna Loa 2 Kona
8	16	-----	-----	-----	74	17	9	8	5	-----
9	11	-----	-----	-----	?	22	11	6	?	-----
10	4	-----	-----	-----	51	6	11	2	3	-----

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	Others
Sept. 11	----	-----	-----	------	45	7	18	4	----	----------
12	----	-----	-----	------	47	21	92	2	12	----------
13	----	-----	-----	------	65+	9	43	2	2	----------
14	----	-----	-----	------	50	25	37	2	5	1 Kona
15	----	4	-----	------	62	9	25	5	2	1 Kona
16	----	-----	-----	------	54	10	27	3	3	----------
17	----	-----	-----	------	45+	10	34	4	85+	----------
18	----	-----	2	------	62	15	7	3	12+	1 Offshore Puna
19	----	-----	-----	------	62	11	8	3	10	1 Mauna Kea region
20	----	-----	-----	------	68	6	8	2	4	1 Mauna Kea region
21	----	-----	-----	------	63	6	2	------	3	----------
22	----	-----	-----	------	54	12	4	2	3	1 Mauna Kea region
23	----	-----	-----	------	48	8	-----	1	1	----------
24	----	-----	-----	------	58	9	5	3	12	----------
25	2	-----	-----	------	88	4+	4	16	2	----------
26	----	-----	-----	------	98	14	-----	9	6	----------
27	----	-----	-----	------	90	6	-----	------	2	----------
28	----	-----	-----	------	49	4	-----	2	4	----------
29	----	-----	-----	------	63	4	-----	------	2	----------
30	----	-----	-----	------	48	4	-----	------	6	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, July, August, and September, 1964

Entries for a given quake are: date, origin time (Hawaiian Standard Time), magnitude, depth, epicenter, and felt report. All earthquakes of magnitude 2.5 and larger, as well as many favorably located smaller ones, occurring on or near the island of Hawaii are included in the list.

In the following list, some origin times are followed only by "KM 30" and a statement of magnitude. These are all members of a continuing family of quakes noted also in other Summaries. The best mean focus for this group is beneath Halemaumau at a depth of 30 km (19°24.1' N., 155°17.1' W.).

In the following list a number of quakes are described as "Upper east rift" (see Summary 28). Further statistical study of this group which occurred in the swarm periods during July 1 to 6 and August 3 to 4 gives a mean epicenter 19°21.5' N., 155°14' W. about 2 km south of Aloi Crater at near-surface depth.

In Summary 24, "Kaoiki" was introduced as a symbol for listing any of a family of quakes with mean focus 19°24' N., 155°24' W., h=3 to 8 km. This symbol is used in the following list.

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
July 1	10	43	09.5	4.5	5	19°18.8'	155°06.9'	10 km SE. of Makaopuhi seismometer.	Felt in Hilo, Kilauea summit, and Puna regions.
1	10	46	49.0	2.8	5	19°18.8'	155°06.9'	10 km SE. of Makaopuhi seismometer.	----------
1	13	44	55.2	2.3	30	19°23.7'	155°18.8'	4 km SW. of Uwekahuna seismometer.	----------
2	04	19	31.0	2.4	30	19°23.8'	155°17.7'	4 km S. of Uwekahuna seismometer.	----------
3	15	03	13.0	2.2	5	19°18.2'	155°05.5'	13 km SE. of Makaopuhi seismometer.	----------
4	06	39	19.5	2.3	8	19°57.2'	155°21.9'	15 km WSW. of Laupahoehoe	----------
5	05	25	10.4	2.7	30	19°22.3'	155°19.2'	6 km W. of Ahua seismometer.	----------
7	05	40	18.0	2.3	13	20°01.5'	155°19.2'	8 km ESE. of Paauilo	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, July, August, and September, 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
July 8	08	56	48.0	2.3	8	19°36.0'	155°45.8'	20 km NE. of Kealakekua	----------
11	11	45	53.6	2.3	8	19°58.9'	155°10.1'	8 km ESE. of Laupahoehoe	----------
12	13	26	23.7	2.3	5	19°18.8'	155°07.8'	9 km SE. of Makaopuhi seismometer.	----------
15	18	48	03.0	3.2	10	19°19.0'	155°07.2'	9 km SE. of Makaopuhi seismometer.	Felt at Kilauea summit.
17	13	10	56.4	4.5	13	19°53.5'	155°59.2'	43 km NNW. of Kealakekua	Felt islandwide
18	14	31	10.1	2.9	13	19°50.8'	155°34.2'	24 km SSE. of Kamuela---	Felt in Waikii
18	18	51	22.3	2.7	13	20°14.6'	155°38.8'	25 km N. of Kamuela-----	----------
19	04	36	31.0	2.4	13	19°53.3'	155°33.2'	21 km SE. of Kamuela----	----------
19	09	26	11.4	2.9	45	19°12.2'	155°12.7'	20 km SSE. of Ahua seismometer.	----------
19	23	55	45.5	2.0	---	--------	--------	Kaoiki----------	----------
25	01	28	38.1	2.4	8	19°17.2'	155°07.9'	12 km SSE. of Makaopuhi seismometer.	----------
26	16	56	52.1	2.5	3	19°14.7'	155°37.9'	20 km NNW. of Naalehu	----------
27	07	04	22.0	2.7	3	19°40.2'	155°41.8'	31 km NE. of Kealakekua	----------
27	19	41	08.5	2.3	8	19°57.3'	155°49.1'	7 km SW. of Kamuela	----------
27	23	47	59.0	2.3	---	--------	--------	Kaoiki----------	----------
28	04	39	52.4	2.9	8	19°22.0'	155°59.0'	18 km SSW. of Kealakekua	----------
28	18	05	50.2	3.5	25	19°25.5'	155°15.6'	3 km E. of Uwekahuna seismometer.	Felt Kilauea summit.
28	18	06	50.5	2.6	25	19°23.8'	155°17.5'	2 km S. of Uwekahuna seismometer.	----------
29	07	49	03.1	2.7	8	19°51.8'	155°36.8'	20 km SSE. of Kamuela	----------
29	14	33	40.3	2.1	---	--------	--------	KM 30----------	----------
30	07	55	03.4	2.5	---	--------	--------	KM 30----------	----------
30	17	31	11.0	2.6	8	19°57.3'	155°51.6'	20 km SW. of Kamuela---	----------
31	11	33	45.0	2.4	3	19°27.3'	154°55.5'	6 km SSE. of Pahoa-----	----------
Aug. 1	03	46	27.8	2.8	8	19°41.7'	155°52.8'	21 km NNE. of Kealakekua	----------
1	11	07	32.6	3.0	8	19°18.9'	155°54.9'	23 km S. of Kealakekua--	----------
1	15	35	10.0	2.5	---	--------	--------	Kaoiki----------	----------
1	15	36	15.0	2.0	---	--------	--------	Kaoiki----------	----------
3	10	36	08.7	3.5	8	19°11.9'	155°33.5'	15 km NNE. of Naalehu---	Felt in Pahala, Naalehu, and Kealakekua.
Aug. 3	15	39	28.4	2.4	---	-------	--------	KM 30----------	Felt at Kilauea summit.
4	01	38	50.0	2.5	3	19°31.7'	155°48.8'	12 km ENE. of Kealakekua	----------
4	20	14	29.4	2.1	---	--------	--------	KM 30----------	----------
5	03	12	19.5	2.4	8	19°11.4'	155°35.5'	14 km N. of Naalehu-----	----------
6	16	51	43.5	2.1	---	--------	--------	Kaoiki----------	----------
7	04	56	15.0	2.7	< 3	19°26.8'	155°46.2'	18 km ESE. of Kealakekua	----------
7	10	56	24.0	2.5	---	--------	--------	Kaoiki----------	Felt in Pahala
7	20	45	09.0	2.9	13	21°01'	155°15'	105 km ENE. of Haleakala Maui.	----------
9	10	17	15.5	2.2	3	19°13.8'	155°13.2'	5 km SSW. of Apua Point	----------
9	10	20	06.1	2.2	13	19°16.2'	155°11.7'	11 km SSW. of Makaopuhi seismometer.	----------
11	15	09	20.5	2.2	---	--------	--------	KM 30----------	Felt in Pahala
11	15	14	05.9	2.5	30	19°21.4'	155°18.7'	6 km WSW. of Ahua seismometer.	Felt in Pahala
13	06	27	38.9	4.5	30	19°30.0'	155°16.2'	8 km NNE. of Uwekahuna seismometer.	Felt islandwide
14	10	51	08.5	2.8	8	19°23.2'	155°29.1'	12 km WNW. of Desert seismometer.	Felt in Pahala
15	18	15	55.5	2.4	8	19°20.0'	154°48.0'	25 km SE. of Pahoa	----------
16	14	09	05.0	2.1	5	19°20.5'	155°04.2'	13 km ESE. of Makaopuhi seismometer.	----------
16	15	58	34.1	2.9	5	19°22.8'	155°30.7'	14 km WNW. of Desert seismometer.	Felt at Kilauea summit.
19	04	50	15.5	3.3	12	20°03.8'	155°55.2'	10 km WNW. of Kawaihae	----------
20	23	09	45.4	2.4	---	--------	--------	KM 30----------	----------
23	09	24	53.0	2.7	3	19°15.2'	155°14.8'	14 km S. of Ahua seismometer.	----------
24	17	30	33.0	2.0	---	--------	--------	Kaoiki----------	----------
25	03	02	09.0	2.5	3	19°55.5'	155°34.5'	18 km SE. of Kamuela	----------
25	21	31	01.0	2.7	43	19°13.3'	155°18.8'	15 km SSE. of Desert seismometer.	----------
26	08	30	45.5	4.4	12	20°14'	156°09'	33 km WSW. of Upolu Point.	Felt in Hilo, Kamuela, Kealakekua Honokaa, and Kohala.
26	19	35	29.7	2.7	8	20°00.0'	155°26.5'	10 km SSE. of Honokaa	----------
27	14	22	10.8	2.8	5	19°26.5'	154°52.8'	9 km SE. of Pahoa	Felt in Kapoho
27	17	42	56.5	2.6	8	19°59.5'	155°49.8'	16 km WSW. of Kamuela	----------
27	21	26	07.9	2.4	8	19°15.3'	155°08.8'	13 km SSE. of Makaopuhi	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, July, August, and September, 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
Aug. 28	21	10	16.5	2.2	8	19°14.2'	155°29.2'	4 km NNW. of Pahala	Felt in Pahala
29	11	07	55.7	2.4	13	19°38'	156°15'	38 km WNW. of Kealakekua	----------
30	12	20	05.1	2.8	8	19°25.8'	154°59.0'	8 km SSW. of Pahoa------	Felt in Pahoa
30	12	22	55.2	2.1	8	19°25.8'	154°59.0'	8 km SSW. of Pahoa------	Felt in Pahoa
31	07	57	47.0	3.2	5	19°27.1'	154°56.1'	5 km SSE. of Pahoa------	Felt in Pahoa, Kapoho.
31	13	25	27.5	3.3	---	--------	---------	Kaoiki----------	Felt in Pahala
31	21	57	34.0	2.6	8	20°01.6'	155°32.1'	18 km E. of Kamuela-----	Felt in Kamuela
Sept. 1	06	39	13.5	3.7	5	19°27.1'	154°56.1'	5 km SSE. of Pahoa------	Felt in Pahoa, Kilauea summit, Kapoho.
1	21	57	29.0	2.0	5	19°27.1'	154°56.1'	5 km SSE. of Pahoa------	----------
2	02	11	49.0	2.0	5	19°27.1'	154°56.1'	5 km SSE. of Pahoa------	Felt in Pahoa----
2	02	58	03.0	2.4	3	19°26.9'	154.56.0'	7 km SSE. of Pahoa------	----------
2	04	03	20.0	2.6	3	19°26.8'	154.56.0'	7 km SSE. of Pahoa------	----------
2	06	14	55.0	2.2	8	19°14.8'	155°30.0'	17 km SW. of Desert seismometer.	----------
3	00	57	59.8	2.5	3	19°32.3'	155°40.3'	12 km WNW. of North Bay seismometer.	----------
3	01	43	32.5	2.5	8	19°28.5'	155°52.0'	7 km SE. of Kealakekua	----------
3	05	46	19.5	2.7	5	19°28.2'	154°54.8'	5 km SE. of Pahoa------	Felt in Kapoho, Pahoa.
3	18	36	22.9	2.0	8	19°18.9'	155°07.3'	9 km SE. of Makaopuhi seismometer.	----------
3	19	50	58.0	2.0	---	--------	---------	Kaoiki----------	----------
5	01	26	00.0	2.6	10	19°19.0'	155°10.6'	5 km S. of Makaopuhi seismometer.	----------
6	03	09	48.5	2.5	5	19°27.2'	154°54.7'	5 km SE. of Pahoa------	----------
6	07	39	46.6	2.0	8	19°20.0'	155°03.4'	14 km ESE. of Makaopuhi seismometer.	----------
6	08	33	17.7	2.4	3	19°27.0'	154°52.9'	9 km SE. of Pahoa -----	Felt in Pahoa
7	03	35	24.7	2.7	8	19°26.2'	155°36.2'	7 km SSW. of North Bay seismometer.	----------
7	06	10	39.9	2.8	3	19°26.7'	154°53.8'	8 km SE. of Pahoa------	Felt in Pahoa
7	06	13	01.7	3.0	3	19°26.7'	154°53.8'	8 km SE. of Pahoa------	Felt in Pahoa

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, July, August, and September, 1964--Continued

Date (1964)	Time			Magnitude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
Sept. 7	14	19	26.1	2.5	8	19°30.0'	155°48.6'	12 km ESE. of Kealakekua	----------
7	17	17	34.3	2.3	3	19°30.0'	155°43.0'	22 km E. of Kealakekua	----------
7	19	42	27.6	2.7	---	--------	--------	Kaoiki----------	Felt at Kilauea summit.
8	08	26	40.4	2.5	---	--------	--------	Kaoiki----------	Felt in Pahala
8	14	19	16.0	2.2	---	--------	--------	Kaoiki----------	Felt in Pahala
9	17	42	49.5	2.8	30	19°22.5'	155°20.0'	8 km NE. of Desert seismometer.	----------
9	22	17	31.8	2.4	---	--------	--------	Kaoiki----------	Felt in Pahala
10	11	09	24.4	2.4	5	19°27.7'	154°55.5'	5 km SSE. of Pahoa------	Felt in Pahoa
12	21	27	34.0	2.7	< 3	19°27.7'	154°55.7'	5 km SSE. of Pahoa------	Felt in Kapoho
13	03	39	24.0	2.7	< 3	19°26.8'	154°55.9'	7 km SSE. of Pahoa------	----------
14	06	02	12.0	3.8	3	19°26.5'	154°56.2'	7 km SSE. of Pahoa------	Felt at Kilauea summit, Hilo, Pahoa.
14	19	21	42.5	2.5	3	19°27.5'	154°54.8'	6 km SE. of Pahoa------	----------
15	04	18	34.0	2.1	---	--------	--------	Kaoiki----------	----------
16	06	04	41.8	3.3	8	19°20.1'	155°04.8'	13 km ESE. of Makaopuhi seismometer.	Felt in Hilo, Pahoa, Kalapana.
16	18	34	03.3	2.4	3	19°25.9'	154°55.8'	8 km SSE. of Pahoa------	----------
18	00	25	29.1	4.9	5	19°18.9'	155°06.9'	9 km SE. of Makaopuhi seismometer.	Felt islandwide
18	02	07	56.8	3.6	5	19°17.9'	155°07.3'	10 km SE. of Makaopuhi seismometer.	Felt in Hilo, Kilauea summit.
18	02	21	40.0	2.5	3	19°19.1'	155°06.8'	10 km SE. of Makaopuhi seismometer.	----------
18	08	01	27.2	3.2	3	19°18.2'	155°07.5'	3 km SE. of Makaopuhi seismometer.	Felt in Pahala, Kilauea summit, Pahoa.

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, July, August, and September, 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
Sept. 18	06	56	50.3	2.3	8	19°08.0'	154°56.5'	30 km SE. of Apua Point	
19	09	54	12.4	2.3	----	----	----	KM 30----------	
19	12	06	40.2	2.1	5	19°27.2'	154°56.2'	5 km SSE. of Pahoa----	
19	23	07	50.3	2.2	13	19°54.5'	155°22.1'	17 km SW. of Laupahoehoe	
20	02	17	36.0	2.3	13	19°52.5'	155°22.7'	18 km SW. of Laupahoehoe	
21	15	34	00.1	2.0	----	----	----	Kaoiki----------	
21	15	58	34.0	2.0	----	----	----	Kaoiki----------	
22	06	34	28.5	2.7	13	19°55.9'	155°34.5'	15 km SE. of Kamuela---	Felt in Kamuela
22	11	50	43.6	2.3	8	19°17.8'	155°06.9'	12 km SE. of Makaopuhi seismometer.	
24	16	47	42.0	2.6	3	19°21.2'	155°02.0'	17 km E. of Makaopuhi seismometer.	
26	00	36	27.5	3.4	25	19°22.1'	155°19.0'	9 km NE. of Desert seismometer.	Felt at Kilauea summit, Pahala, Hilo.
26	17	15	08.3	2.2	5	19°22.2'	155°25.0'	5 km NW. of Desert seismometer.	

Table 5.--Distant earthquakes

Times are reported in Greenwich Civil Time which is 10 hours faster than Hawaiian Standard Time. A "c" following the time of P indicates compressional first motion; a "d" indicates dilatational first motion. Station symbols, locations, and instrumentation are presented in Summary 33 . Magnitudes calculated from the Hawaii seismograms are followed by (HVO). Location of epicenter, origin times, and focal depths, and magnitudes reported by other institutions are taken from "Preliminary Determination of Epicenters" published by the U.S. Coast and Geodetic Survey.

July 1, 1964

M	Z	eP	13:45:05.9 c
A	Z	eP	05.8 c
N	Z	eP	06.4 c
MP	Z	eP	07.4 c

C&GS card 56-64:
13:33:10
1.8° N., 127.1° E.
Molucca Passage
h about 33 km
Magnitude 4.5 (CGS).

July 2

M	Z	Tmax	07:19:09
A	Z	Tmax	23
D	Z	Tmax	23
N	Z	Tmax	21
MP	Z	Tmax	14
U	Z	Tmax	08
Hi	Z	Tmax	07:18:50
NB	Z	Tmax	07:19:12
Ha	Z	Tmax	07:17:10

C&GS card 54-64:
06:35:18
53.4° N., 167.8° W.
Fox Islands, Aleutian Islands
h about 45 km
Magnitude 4.75-5 (Pal)
4.8 (CGS).

July 4

M	Z	iP	10:59:22.2 c
D	Z	iP	22.4 c
WP	Z	iP	23.0 c
MP	Z	eP	23.5 c
U	Z	iP	23.1 c
Pa	Z	eP	24.4 c

July 4--Continued

Hi	Z	eP	24.4 c
Ke	Z	iP	18.6 c
Ha	Z	eP	16.8 d
NB	Z	iP	21.2 c

C&GS card 53-64:
10:49:28.8
11.7° N., 144.5° E.
Mariana Islands
h about 33 km
Magnitude 6.0 (CGS).

July 5

U	PEZ	eP	19:15:47 c
Na	Z	iP	50.0 c
NB	Z	eP	49.9 c
U	PEZ	iS	19:22:03
U	PEE	eG	19:25:27
U	PEZ	eR	19:26:59

C&GS card 53-64:
19:07:57.8
26.2° N., 110.2° W.
Gulf of California
h about 29 km
Magnitude 5.75-6 (Brk),
6-6.25 (Pal), 6.0 (CGS),
6.4 (HVO).

July 5

M	Z	eP	23:45:07.1 d
NB	Z	eP	06.1 d
U	PEE	iS	23:52:31
U	PEN	eG	23:57:23
U	PEZ	eR	23:59:39

C&GS card 53-64:
23:36:01.5

July 5, 1964--Continued
C&GS card 53-64:--Continued
44.8° N., 149.6° E.
Kurile Islands
h about 54 km
Magnitude 6.25 (Pas), 6-6.25 (Pal), 5.5 (CGS), 6.5 (HVO).

July 6

U	PEZ	eP	02:22:23	c
Hi	Z	eP	21.5	c
NB	Z	eP	24.3	c
U	PEZ	iS	02:28:47	
U	PEN	eG	02:32:05	
U	PEZ	iR	02:33:15	

C&GS card 55-64:
02:14:36.0
26.2° N., 110.4° W.
Gulf of California
h about 33 km
Magnitude 6-6.25 (Brk), 6-6.25 (Pal), 5.4 (CGS), and 6.8 (HVO).

July 6

M	Z	eP	07:31:11.8	d
A	Z	eP	10.8	d
D	Z	eP	11.7	d
MP	Z	eP	10.5	d
Pa	Z	iP	07.8	d
Na	Z	iP	13.4	d
Hi	Z	iP	09.4	d
Ke	Z	eP	14.6	d
Ha	Z	iP	16.7	c
NB	Z	iP	13.5	d
U	PEZ	iS	07:38:36	
U	PEN	iG	07:44:11	

C&GS card 53-64:
07:22:11.7
18.3° N., 100.4° W.
Guerrero, Mex.
More than 30 killed, many injured and considerable property damage in Guerrero.
h about 100 km
Magnitude 6.75-7 (Pas),

July 6--Continued
C&GS card--Continued
Magnitude--Continued
6.75-7 (Brk), 7.25-7.5 (Pal), 6.3 (CGS), 7.2 (HVO).

July 6

U	PEZ	eR	20:13:55	

C&GS card 57-64:
19:50:42.1
21.2° S., 173.8° E.
New Hebrides Islands region
h about 22 km
Magnitude 4.8 (CGS).

July 7

M	Z	iP	07:47:10.6	d
A	Z	iP	10.0	d
D	Z	eP	09.4	d

C&GS card 54-64:
07:39:04.2
23.6° S., 179.9° W.
Fiji Islands region
h about 462 km
Magnitude 5.5 (CGS).

July 7

M	Z	Tmax	14:26:40	
A	Z	Tmax	19	
U	Z	Tmax	35	
Pa	Z	Tmax	11	
Hi	Z	Tmax	04	
Ha	Z	Tmax	14:25:59	

C&GS card 53-64:
13:44:40
43.4° N., 127.2° W.
Off coast of Oregon
h about 7 km
Magnitude 5.7 (CGS).

July 8, 1964

M	Z	eP	07:57:35.0	d
A	Z	eP	36.0	d
D	Z	eP	34.8	d
U	Z	iP	35.9	d
Ke	Z	iP	32.3	d

C&GS card 54-64:
07:45:48.6
3.2° N., 128.4° E.
Molucca Passage
h about 50 km
Magnitude 5.5 (CGS).

July 8

M	Z	eP	12:07:19.7	c
A	Z	eP	19.9	c
D	Z	eP	19.1	c
Pa	Z	eP	21.7	c
Na	Z	iP	18.2	c
Hi	Z	eP	21.7	d
NB	Z	iP	19.5	c
U	PEN	iS	12:17:01	
U	PEN	iG	12:27:39	

C&GS card 53-64:
11:55:39
5.5° S., 129.8° E.
Banda Sea
h about 165 km
Magnitude 6.5 (CGS).

July 9

U	Z	iP	11:30:34.1	d
Pa	Z	eP	35.5	d
Na	Z	iP	31.8	d
Hi	Z	iP	36.3	d
Ka	Z	eP	36.0	d
Ke	Z	iP	32.9	d
Ha	Z	eP	40.8	c
U	PEZ	iS	11:37:24	
U	PEE	iSS	11:40:53	
U	PEN	iG	11:41:23	
U	PEZ	iR	11:43:29	

C&GS card 58-64:
11:22:05.4
23.3° S., 175.7° W.

July 9--Continued

C&GS card--Continued

Tonga Islands
h about 43 km
Magnitude 5.5-5.75 (Brk), 5.7 (CGS), 6.1 (HVO).

July 9

M	Z	iP	16:48:36.0	d
A	Z	iP	35.9	d
D	Z	iP	35.2	d
U	Z	iP	35.9	d
Na	Z	eP	33.6	d
Ka	Z	eP	37.0	d
Ke	Z	iP	34.4	c
NB	Z	eP	35.3	d
U	PEZ	ipP	16:49:01	d
U	PEZ	isP	16:49:18	d
U	PEZ	iPP	16:50:32	
U	PEZ	iPPP	16:51:35	
U	PEE	iS	16:55:42	
U	PEE	isS	16:56:35	
U	PEE	eScS	16:58:00	
U	PEE	iSS	16:59:21	
U	PEN	iG	17:00:25	
U	PEZ	i	17:03:01	
Ke	Z	Tmax	17:42:47	

C&GS card 57-64:
16:39:49.3
15.5° S., 167.6° E.
New Hebrides Islands
h about 121 km
Magnitude 7.5 (Pas), 7.5-7.75 (Brk), 6.6 (CGS), 7.1 (HVO).

July 11

M	Z	Tmax	10:35:11	
A	Z	Tmax	13	
D	Z	Tmax	25	
MP	Z	Tmax	07	
U	Z	Tmax	06	
Pa	Z	Tmax	07	
Ka	Z	Tmax	10:34:36	
Ha	Z	Tmax	10:33:57	

July 11--Continued

C&GS card 56-64:
09:44:18.7
59.7° N., 146.1° W.
Alaska aftershock
h about 33 km
Magnitude 5 (Pal), 5.3 (CGS).

July 11

M	Z	iP	20:33:19.3 d
D	Z	iP	20.5 d
U	Z	eP	19.5 d
Ke	Z	iP	19.3 d
U	PEZ	eS	20:39:39
U	PEZ	eR	20:44:07
M	Z	Tmax	21:17:00
D	Z	Tmax	21:17:07
MP	Z	Tmax	21:16:57
U	Z	Tmax	21:16:52
Pa	Z	Tmax	21:16:35
Hi	Z	Tmax	21:16:39
Ka	Z	Tmax	21:16:09
Ha	Z	Tmax	21:15:13
NB	Z	Tmax	21:17:00

C&GS card 56-64:
20:25:40.3
59.7° N., 146.2° W.
Alaska aftershock
h about 40 km
Magnitude 5-5.25 (Brk), 5.5-5.75 (Pal), 5.6 (CGS), 5.7 (HVO).

July 12

M	Z	eP	01:55:28.8 c
D	Z	eP	29.3 c
Pa	Z	eP	30.6 c
Na	Z	iP	29.2 c
Hi	Z	eP	28.7 c
Ke	Z	iP	25.2 c
Ha	Z	iP	18.9 c
NB	Z	eP	28.2 c
U	PEE	eS	02:03:47
U	PEE	eL	02:10:19
U	PEZ	eR	02:12:09

C&GS card 55-64:

July 12--Continued

C&GS card--Continued
01:45:25.6
38.6° N., 139.2° E.
Near west coast of Honshu, Japan
h about 13 km
Magnitude 5.25-5.5 (Pal), 6.0 (CGS).

July 13

Pa	Z	Tmax	07:28:36
NB	Z	Tmax	07:28:45

C&GS card 56-64:
06:47:54
44.7° N., 129.9° W.
Off coast of Oregon
h about 33 km
Magnitude 5.5 (CGS).

July 18

M	Z	iP	12:57:58.7 c
A	Z	iP	58.7 c
D	Z	eP	58.2 c
U	Z	eP	58.8 c
Na	Z	eP	57.5 c
Hi	Z	eP	12:58:00.5 c
Ke	Z	eP	57:55.8 c
NB	Z	eP	57:58.0 c

C&GS card 61-64:
12:45:47.7
0.2° N., 123.5° E.
Northern Celebes
h about 97 km
Magnitude 5.8 (CGS).

July 20

U	PEZ	eR	19:09:18

C&GS card 59-64:
18:49:43.5
19.8° N., 109.0° W.
Revilla Gigedo Islands region
h about 33 km
Magnitude 4.5-4.75 (Brk), 5 (Pal), 5.1 (CGS).

July 21, 1964

U	PEZ	eR	01:28:45

C&GS card 59-64:
01:09:25.8
19.8° N., 108.8° W.
Off coast of Jalisco, Mex.
h about 31 km
Magnitude 4.75-5 (Brk), 4.9 (CGS).

July 21

M	Z	iP	03:57:34.3 c
MP	Z	eP	33.7 c
Hi	Z	eP	36.5 c
Ke	Z	eP	32.0 c
U	PEE	iS	04:04:34

C&GS card 59-64:
03:48:59.1
26.0° S., 178.0° W.
Fiji Islands region
h about 222 km
Magnitude 6.5 (Pas), 5.25-5.5 (Brk), 5.8 (CGS).

July 21

A	Z	iP	13:25:08.2 c
D	Z	eP	07.7 c
MP	Z	eP	08.6 c

C&GS card 59-64:
13:13:00.2
11.5° N., 121.9° E.
Panay, Philippine Islands
h about 34 km

July 24

M	Z	iP	06:59:42.0 d
A	Z	eP	43.4 d
U	PEZ	iPP	07:01:41
U	PEE	iS	07:06:53
U	PEN	eG	07:11:13
U	PEZ	iR	07:13:13

C&GS card 60-64:
06:50:52.8
46.9° N., 153.9° E.

July 24--Continued

C&GS card--Continued
Kurile Islands
h about 33 km
Magnitude 6 (Pas), 6 (Brk), 5.9 (CGS), 6.3 (HVO).

July 24

M	Z	iP	08:21:30.3
A	Z	eP	31.4
D	Z	eP	30.6
U	PEZ	iPP	08:23:23
U	PEE	iS	08:28:39
U	PEZ	iSS	08:32:17
U	PEN	iG	08:33:08
U	PEZ	iR	08:34:48

C&GS card 59-64:
08:12:40.0
47.2° N., 153.8° E.
Kurile Islands
h about 33 km
Magnitude 6.5 (Pas), 5.9 (CGS), 6.9 (HVO).

July 24

M	Z	eP	11:04:41.5 d

C&GS card 59-64:
10:54:52.5
13.1° N., 145.0° E.
Mariana Islands
Felt: Guam
h about 43 km
Magnitude 5.6 (CGS).

July 24

M	Z	eP	13:34:26.5 d
A	Z	iP	27.4 d
U	PEE	eS	13:41:21
U	PEE	eL	13:45:41
U	PEN	eR	13:47:52

C&GS card 59-64:
13:25:18.3
47.0° N., 153.7° E.
Kurile Islands

July 24--Continued

C&GS card--Continued
h about 33 km
Magnitude 5.75-6 (Brk),
5.7 (CGS), 5.7 (HVO).

July 24

M	Z	iP	13:57:19.9 d
A	Z	eP	19.6 d
D	Z	eP	18.8 d
U	Z	eP	19.7 d
Na	Z	iP	16.8 d
U	PEZ	eR	14:11:23

C&GS card 59-64:
13:47:48.6
6.6° S., 154.8° E.
Solomon Islands
h about 62 km
Magnitude 5.6 (CGS).

July 24

M	Z	iP	17:11:49.4 c
U	PEE	iS	17:18:53
U	PEE	eSS	17:22:19
U	PEN	iG	17:23:17
U	PEZ	iR	17:25:21

C&GS card 59-64:
17:02:49.2
47.1° N., 153.6° E.
Kurile Islands
h about 33 km
Magnitude 6.5 (Pas), 6 (Brk),
5.8 (CGS), 6.4 (HVO).

July 25

Hi	Z	eP	19:44:29.1 d
U	PEZ	eS	19:54:51
U	PEZ	eSS	20:01:59
U	PEZ	eR	20:14:15
M	Z	Tmax	21:29:05
A	Z	Tmax	21:28:55
D	Z	Tmax	21:29:04
Pa	Z	Tmax	21:28:38
Na	Z	Tmax	21:29:03

C&GS card 59-64:
19:31:07.0

July 25--Continued

C&GS card--Continued
27.9° S., 70.9° W.
Northern Chile
Felt: Copiapo and Vallenar
h about 26 km
Magnitude 6.5 (Pas), 6 (Brk),
6.1 (CGS).

July 25

M	Z	iP	21:41:23.2 d
U	Z	eP	24.0 d

C&GS card 59-64:
21:29:33.2
2.9° N., 128.2° E.
North of Halmahera
h about 22 km
Magnitude 5.1 (CGS).

July 28

U	PEZ	eR	19:21:40

C&GS card 59-64:
18:40:04.3
51.2° S., 139.0° E.
About 1000 km. SW. of
of Tasmania.
h about 33 km
Magnitude 5.3 (CGS).

July 30

A	Z	eP	05:26:54.5 d
D	Z	eP	55.1 d
MP	Z	iP	53.9 d
U	Z	iP	54.6 d
U	PEZ	eS	05:35:51
U	PEZ	eR	05:46:59

C&GS card 59-64:
05:16:03.3
11.1° N., 86.2° W.
Near west coast of Costa Rica
Felt: Balboa Heights C. Z.
h about 42 km
Magnitude 5.75-6 (Pal), 5.7
(CGS), 5.7 (HVO).

July 31, 1964

U	PEZ	iP	06:02:22 c
Hi	Z	eP	25.2 c
U	PEE	eS	06:10:28
U	PEN	iG	06:17:12
U	PEZ	eR	06:19:40

C&GS card 61-64:
05:52:18.8
6.1° S., 149.4° E.
New Britain
h about 63 km
Magnitude 5.9 (CGS),
6.9 (HVO).

August 2

M	Z	Tmax	03:49:44
A	Z	Tmax	47
D	Z	Tmax	48
MP	Z	Tmax	43
U	Z	Tmax	40
Pa	Z	Tmax	43
Hi	Z	Tmax	22

C&GS card 61-64:
03:04:16.9
56.1° N., 156.1° W.
Alaska aftershock
h about 33 km
Magnitude 5.6 (CGS).

August 2

M	Z	eP	08:43:24.9 c
Ke	Z	eP	24.9 c
U	PEE	iG	08:51:34

C&GS card 60-64:
08:36:16.9
56.2° N., 149.9° W.
Alaska aftershock
h about 31 km
Magnitude 6 (Pas), 4.75-5 (Brk),
5.25 (Pal), 5.4 (CGS).

August 4

M	Z	eP	17:33:23.7 c
A	Z	eP	24.9 c
D	Z	eP	24.4 c
Pa	Z	iP	25.6 c
Ke	Z	eP	20.4 c
NB	Z	eP	23.0 c
U	PEZ	eR	17:47:20

C&GS card 60-64:
17:24:29.2
46.5° N., 151.1° E.
Kurile Islands
h about 101 km
Magnitude 5.5-5.75 (Brk),
5.9 (CGS), 5.7 (HVO).

August 5

M	Z	iP	11:15:21.8 c
A	Z	iP	21.1 c
D	Z	iP	21.1 c
MP	Z	iP	21.2 c
U	Z	eP	21.4 c
Pa	Z	eP	21.3 c
Hi	Z	iP	24.9 c
NB	Z	eP	21.8 c

C&GS card 63-64:
11:06:02.6
32.1° S., 179.8° E.
S. of Kermadec Islands
h about 235 km
Magnitude 6.75 (Pas), 5.5
(Brk), 5.8 (CGS).

August 5

U	PEZ	eS	22:47:30
U	PEZ	ePS	22:49:14
U	PEZ	iSS	22:54:28
U	PEZ	iR	23:07:17

C&GS card 62-64:
22:23:13.0
41.1° S., 74.9° W.
Off coast of southern Chile
h about 33 km
Magnitude 6.75 (Pas), 6.5 (Brk),
6.1 (CGS).

August 6

M	Z	eP	18:31:58.0 d
A	Z	eP	58.5 d
D	Z	iP	59.0 d
M		Tmax	19:11:15
A		Tmax	11
D		Tmax	22
MP		Tmax	19
U		Tmax	20
Hi		Tmax	19:10:48
Ha		Tmax	19:09:43
NB		Tmax	19:11:19

C&GS card 60-64:
18:24:50.5
56.9° N., 152.1° W.
Alaska aftershock
h about 39 km
Magnitude 5.6 (CGS).

August 7

M	Z	Tmax	06:23:47
A	Z	Tmax	51
MP	Z	Tmax	42
U	Z	Tmax	48
Pa	Z	Tmax	50
Hi	Z	Tmax	22
Ka	Z	Tmax	01
Ha	Z	Tmax	06:22:24
NB	Z	Tmax	06:24:02

C&GS card 60-64:
05:37:25.1
56.8° N., 152.3° W.
Alaska aftershock
h about 33 km
Magnitude 5.2 (CGS).

August 7

Ha	Z	Tmax	07:50:38

C&GS card 63-64:
07:08:07
54.4° N., 164.4° W.
Unimak Island region
h about 33 km
Magnitude 4.6 (CGS).

August 7

M	Z	Tmax	09:22:56
A	Z	Tmax	54
D	Z	Tmax	52
MP	Z	Tmax	48
U	Z	Tmax	46
Pa	Z	Tmax	16
Ke	Z	Tmax	46
NB	Z	Tmax	38

No C&GS preliminary listing

August 8

M	Z	eP	15:09:29.1 c
A	Z	eP	30.5 c
D	Z	eP	29.3 c
U	Z	eP	30.0 c
Hi	Z	iP	30.8 c
NB	Z	eP	28.3 c

C&GS card 60-64:
14:59:41.2
31.7° N., 140.2° E.
South of Honshu, Japan
h about 110 km
Magnitude 5.7 (CGS).

August 8

M	Z	eP	15:55:47.0 c
A	Z	iP	46.3 c
D	Z	eP	47.0 c
U	Z	eP	46.5 c
Hi	Z	eP	45.1 c

C&GS card 61-64:
15:45:10.9
12.5° N., 87.8° W.
Off west coast of Nicaragua
Felt: San Salvador
h about 63 km
Magnitude 5.8 (CGS).

August 12

M	Z	eP	07:00:33.0 c
D	Z	eP	34.6 c
MP	Z	iP	35.2 c
Hi	Z	eP	33.7 c
Ke	Z	eP	30.3 c
NB	Z	eP	33.0 c

C&GS card 63-64:
06:51:49.9
48.9° N., 153.7° E.
Kurile Islands
h about 127 km
Magnitude 5.6 (CGS).

August 13

M	Z	eP	00:40:13.7 d
D	Z	eP	12.7 d
MP	Z	eP	13.3 d
U	Z	eP	13.8 d
Na	Z	eP	09.3 d
Ke	Z	eP	09.8 d
NB	Z	iP	12.9 d
U	PEZ	iPcP	00:41:31
U	PEE	eS	00:47:24
U	PEZ	esS	00:49:32

C&GS card 65-64:
00:31:14.1
5.4° S., 154.3° E.
Solomon Islands
h about 383 km
Magnitude 6.0 (CGS).

August 18

U	PEZ	eP	04:58:09 c
U	PEE	eS	05:09:25
U	PEZ	ePS	05:10:27
U	PEZ	eSS	05:15:33
U	PEZ	eR	05:27:17

C&GS card 64-64:
04:44:58.0
26.4° S., 71.5° W.
Off coast of northern Chile
h about 8 km
Magnitude 6 (Brk), 6.4 (CGS), 6.4 (HVO).

August 24

M	Z	iP	17:38:23.1 d
A	Z	iP	23.2 d
MP	Z	iP	23.9 d
U	Z	iP	23.2 d

C&GS card 66-64:
17:26:15.1
0.2° N., 123.8° E.
Northern Celebes
h about 127 km
Magnitude 5.4 (CGS).

August 24

M	Z	eP	22:04:21.6 c
A	Z	eP	22.1 c
D	Z	eP	23.1 c
MP	Z	eP	22.1 c
NB	Z	eP	21.3 c
U	PEZ	eR	22:14:41

C&GS card 67-64:
21:56:54.2
58.4° N., 150.3° W.
Gulf of Alaska
h about 22 km
Magnitude 5.8 (CGS), 5.4 (HVO).

August 25

M	Z	iP	13:58:21.0 d
A	Z	eP	21.6 d
D	Z	eP	21.6 d
U	Z	eP	21.1 d
Pa	Z	eP	21.1 d
Na	Z	eP	23.1 d
Hi	Z	eP	19.8 d
Ka	Z	eP	17.9 d
Ke	Z	iP	19.8 d
Ha	Z	iP	12.6 c
NB	Z	eP	22.0 d
U	PEN	iS	14:07:33
U	PEE	iG	14:15:11
U	PEZ	eR	14:18:41

August 25--Continued

C&GS card 66-64:
13:47:20.6
78.2° N., 126.6° E.
East of Severnaya Zemlya
h about 50 km
Magnitude 6.25-6.5 (Pas), 6.5 (Brk), 6.1 (CGS), 6.8 (HVO).

September 4

M	Z	eP	10:45:58.4	d
A	Z	eP	58.4	d
D	Z	eP	57.9	d
Ke	Z	eP	56.2	d
U	PEZ	eS	10:55:41	
U	PEZ	eR	11:08:29	

C&GS card 70-64:
10:34:13.1
4.0° S., 131.4° E.
West New Guinea region
h about 33 km
Magnitude 5.5-5.75 (Brk), 5.9 (CGS), 6.1 (HVO).

September 5

M	Z	iP	02:26:20.2	c
A	Z	iP	19.5	c
U	Z	iP	19.8	c
Ke	Z	iP	18.6	c
NB	Z	iP	19.3	c

C&GS card 70-64:
02:17:14.4
32.2° S., 179.5° E.
South of Kermadec Islands
h about 397 km
Magnitude 4.6 (CGS).

September 5

M	Z	eP	03:03:25.6	d
A	Z	eP	24.8	d
D	Z	eP	23.9	d
U	Z	eP	25.4	d
Na	Z	iP	22.2	d
Hi	Z	eP	28.1	d

September 5 --Continued

U	PEZ	eS	03:11:14
U	PEZ	iSS	03:15:17
U	PEN	eG	03:16:53
U	PEZ	iR	03:19:01
Ke	Z	Tmax	04:02:26
Ha	Z	Tmax	26
NB	Z	Tmax	58

C&GS card 69-64:
02:53:50.6
5.8° S., 154.0° E.
Solomon Islands
h about 69 km
Magnitude 6.4 (CGS), 6.3 (HVO).

September 6

M	Z	eP	18:51:29
U	PEN	eG	19:06:41
U	PEZ	eR	19:09:41

C&GS card 73-64:
18:41:01.8
10.0° N., 140.2° E.
West Caroline Islands
h about 33 km
Magnitude 5.1 (CGS), 5.7 (HVO).

September 12

M	Z	eP	12:53:43.4	c
A	Z	eP	43.9	c
D	Z	eP	42.9	c
Pa	Z	iP	45.6	c
Na	Z	iP	41.0	c
Hi	Z	iP	45.7	c
Ka	Z	iP	42.5	c
Ke	Z	iP	40.2	c
Ha	Z	iP	40.9	c
NB	Z	eP	42.3	c
U	PEE	eS	13:02:21	
U	PEN	eG	13:09:41	
U	PEZ	eR	13:12:23	

C&GS card 72-64:
12:43:19.0
4.4° S., 144.0° E.
Near north coast of New Guinea

September 12--Continued

C&GS card--Continued
h about 120 km
Magnitude 6.5 (Pas), 6.25-6.5 (Brk), 6.3 (CGS), 6.1 (HVO).

September 12

M	Z	eP	15:26:42.4	d
A	Z	iP	42.2	d
Na	Z	iP	39.1	d
Hi	Z	iP	44.6	d
Ka	Z	eP	45.1	d
Ke	Z	eP	40.2	d
Ha	Z	eP	46.8	d
NB	Z	iP	41.9	d

C&GS card 71-64:
15:19:22.3
17.4° S., 179.9° W.
Fiji Islands region
h about 561 km
Magnitude 4.25-4.5 (Brk), 5.8 (CGS).

September 12

M	Z	eP	22:18:56.4	c
A	Z	iP	55.4	c
D	Z	iP	55.0	c
U	Z	iP	55.6	c
Hi	Z	eP	56.8	c
Ke	Z	eP	53.7	c
NB	Z	eP	22:18:50.0	c
U	PEZ	ePP	22:22:05	
U	PEE	iS	22:28:55	
U	PEN	iPPS	22:29:59	
U	PEZ	iSS	22:33:54	
U	PEZ	eSS	22:37:19	
U	PEN	iG	22:39:21	
U	PEZ	iR	22:42:36	

C&GS card 72-64:
22:07:03.2
49.1° S., 164.2° E.
Auckland Islands region
h about 33 km
Magnitude 7.5 (Pas), 7.5 (Brk), 6.9 (CGS), 6.7 (HVO).

September 14

A	Z	iP	10:24:54.2	c
MP	Z	iP	54.2	c
Hi	Z	iP	51.1	c
Ka	Z	eP	48.3	c
Ke	Z	eP	52.8	c
NB	Z	iP	53.6	c

C&GS card 72-64:
10:17:46.6
56.7° N., 157.4° W.
Alaska Peninsula
h about 61 km
Magnitude 5.7 (CGS).

September 14

M	Z	eP	13:43:31.6	c
A	Z	eP	29.1	c
D	Z	eP	30.7	c
U	Z	eP	30.1	c

C&GS card 72-64:
13:33:33.7
15.0° N., 93.2° W.
Near coast of Chiapas, Mex.
Felt: Western El Salvador
h about 64 km
Magnitude 4.9 (CGS).

September 15

M	Z	iP	05:49:58.7	d
A	Z	eP	58.7	d
U	Z	iP	58.9	d

C&GS card 72-64:
05:37:45.4
0.1° S., 124.6° E.
Molucca Sea
h about 33 km
Magnitude 5.3 (CGS).

September 15

U	PEZ	iPP	15:48:11	d
U	PEZ	ePS	15:57:24	
U	PEE	eSS	16:03:50	
U	PEN	iG	16:14:05	

September 15, 1964--Continued

U	PEZ	eR	16:19:06	

C&GS card 73-64:
15:29:32.2
8.9° N., 93.1° E.
Nicobar Islands region
h about 37 km
Magnitude 5.5 (Pal),
6.2 (CGS).

September 16

M	Z	iP	01:58:17.4	d
A	Z	eP	18.1	d
D	Z	iP	18.4	d
Ha	Z	eP	10.5	d
U	PEZ	eS	02:04:21	
U	PEZ	eR	02:09:13	
M	Z	Tmax	02:41:36	
A	Z	Tmax	35	
D	Z	Tmax	37	
U	Z	Tmax	33	
Pa	Z	Tmax	34	
Ha	Z	Tmax	02:40:11	
NB	Z	Tmax	02:41:39	

C&GS card 74-64:
01:50:33.9
60.0° N., 147.1° W.
Gulf of Alaska
h about 29 km
Magnitude 5.75 (Pas),
5.75-6 (Pal),
5.5 (CGS),
5.8 (HVO).

September 21

M	Z	eP	04:31:01.9	d
A	Z	eP	01.1	d
U	Z	iP	01.5	d
Hi	Z	iP	04.9	d
Ke	Z	iP	00.3	d
Ha	Z	iP	07.2	d
NB	Z	iP	01.6	d

C&GS card 74-64:
04:23:19.7
21.8° S., 179.6° W.
Fiji Islands region

September 21--Continued

C&GS card--Continued

h about 609 km
Magnitude 5.4 (CGS).

September 23

M	Z	eP	05:06:36.5	c
A	Z	eP	37.3	c
D	Z	eP	37.6	c
U	Z	eP	37.0	c

C&GS card 76-64:
04:59:47.4
53.6° N., 163.9° W.
Unimak Island region
h about 29 km
Magnitude 5-5.5 (Brk),
5.5 (CGS).

September 24

M	Z	Tmax	14:41:29
A	Z	Tmax	17
MP	Z	Tmax	16
U	Z	Tmax	17
Pa	Z	Tmax	01
Ha	Z	Tmax	14:40:47

C&GS card 76-64:
13:59:36.8
43.5° N., 127.5° W.
Off coast of Oregon
h about 14 km.

September 27

U	Z	eP	15:58:09.7
U	PEZ	eR	16:07:53
M	Z	Tmax	16:37:41
A	Z	Tmax	31
MP	Z	Tmax	30
U	Z	Tmax	31
Pa	Z	Tmax	22
Ka	Z	Tmax	16:36:50
Ha	Z	Tmax	16:35:56
NB	Z	Tmax	16:37:31

September 27, 1964--Continued

C&GS card 76-64:
15:50:54.7
56.6° N., 152.0° W.
Kodiak Island region
h about 27 km
Magnitude 5.25 (Brk),
5.4 (CGS),
5.5 (HVO).

September 28

M	Z	Tmax	16:25:00
A	Z	Tmax	16:24:51
MP	Z	Tmax	53
U	Z	Tmax	53
Pa	Z	Tmax	39
Hi	Z	Tmax	23
Ha	Z	Tmax	20
NB	Z	Tmax	16:25:12

C&GS card 76-64:
15:43:13.6
43.5° N., 127.1° W.
Off coast of Oregon
h about 33 km
Magnitude 4.8 (CGS).

During the quarter "felt reports" were either phoned or mailed in by the following persons and agencies, to whom we wish to express our gratitude for these and other instances of cooperation:

Kilauea summit area

Mrs. V. Hansen
Mrs. M. Gorder
Mr. B. Loucks
Mr. and Mrs. C. Wentworth
Mr. and Mrs. W. Mist
Mr. R. Koyanagi
Miss M. English
Mr. and Mrs. G. Yong
Mr. and Mrs. A. Yamamoto

North Hawaii

Mrs. E. Lindsey
Mrs. P. Richards
Mrs. R. Eklund
Mrs. A. Paiva
Dr. F. Tabrah
Geotech seismic station
Mr. Yuen
Mrs. E. Christianson
Mrs. E. Fergustrom
Mrs. Vredenburg,
Mrs. A. Walker

Hilo region

Mrs. T. Crabb
Mrs. H. Lewis
Mr. and Mrs. R. Baldwin
Mr. C. Shoemaker
Miss E. Patten
Mr. C. Okamura
Mrs. T. Ingledue
Mrs. M. Shaeffer
Mrs. M. Veriato
Mr. B. B. Blackwood
Mr. E. Endo
Mr. S. Ho
Civil Defense Office
Mr. H. Pierce
Mr. J. Bryan
Miss M. Tulley
Mrs. A. Elliot
Mr. A. Green

Puna

Mr. H. Warner
Mrs. C. Guerino
Mrs. Ruthven
Miss Y. Kimura
Mr. G. Hay
Mrs. H. Hoopai
Mr. Edwards
Mrs. Kongo Kimura
Mrs. Kimiko Kimura
Mr. and Mrs. Takahashi
Mr. R. Williamson

Kau

Mrs. A. Paiva
Rev. D. Thompson
Mrs. Billings
Mr. Hunter
Mrs. Ashton
Mrs. Carvalho

Kona region

Miss A. Greenwell
Mr. M. Sutherland
Mr. R. Apple
Miss N. Wallace
Mr. E. Glass
Mr. Johnston

Central Hawaii

Pohakuloa Military Camp
Mauna Loa Observatory
Kulani Honor Camp

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HAWAIIAN VOLCANO OBSERVATORY

SUMMARY 36

October, November, and December, 1964

By

Robert Y. Koyanagi, Arnold T. Okamura,
Willie T. Kinoshita, and Howard A. Powers

OBSERVATORY STAFF

Geology

H. A. Powers (Scientist-in-Charge)
D. L. Peck
R. W. Decker (July-Dec. 1964)

Geophysics

D. P. Hill
W. T. Kinoshita
George Kojima
R. Y. Koyanagi
A. T. Okamura

Geochemistry

R. T. Okamura
T. L. Wright

Support

E. T. Endo
J. C. Forbes
W. H. Francis
B. J. Loucks
Akira Yamamoto
Yukie Kimura

Contents

Illustrations

Tables

Chronological summary

Relative quiet reigned throughout the fourth quarter of 1964. Modest net inflation was registered for the period.

A few felt quakes were scattered through October, including one of magnitude 5.5 located offshore 83 km southwest of Milolii in South Kona. A spurt of inflationary tilt between October 17 and November 6 was indicated on the short-base tiltmeter. Total seismicity was very low.

October 20 marked the beginning of a month of increase in tremor; several minutes of short bursts and a few spasms of half-hour duration were recorded almost daily. A swarm of deep Kilauea quakes occurred on October 28-29; about 60 shocks were recorded, the largest of magnitude 3.5. Tilt drifted erratically during this time and until December 27. During November 11 through 14 a flurry of small shallow earthquakes took place along the lower east rift of Kilauea. More than 50 shocks were recorded at Pahoa, 3 of which were mildly felt near Kapoho.

An earthquake of magnitude near 5 occurred on December 2 at 22:29. It was reported felt on Oahu and Maui, as well as throughout Hawaii. It originated from a seismically active zone 30 km beneath Kilauea summit. An aftershock from the same source with magnitude 4 was felt on Hawaii on December 3 at 07:56 and a swarm of more than 300 smaller shocks from the same source, ranging in magnitude from 0.5 to 2.5, continued during the week following. Eight other felt quakes from various source areas were scattered through December. Scattered bursts of tremor continued and totaled nearly 700 minutes during December.

The lava lake in Alae Crater solidified completely by early October, as indicated by temperature gradient and releveling. All level stations on the lake showed subsidence after the end of September for the first time; stations above the liquid rose during each relevel period so long as any liquid remained. Twelve core holes were completed, and the drilling equipment was removed from the crater on December 16.

A level line and a loop of closure were established on the upper 5 miles of slope to the north edge of Mokuaweoweo caldera on Mauna Loa. Releveling of this line and loop will yield a measure of summit inflation and deflation. It is logistically impossible to operate the water-level tiltmeter surveys around the remote summit of the big volcano.

R. W. Decker returned to Dartmouth College in December after completing 6 months of special studies of a program for monitoring structural events at Kilauea.

Mr. Rodrigo Saenz R., a scientist from the government of Costa Rica, has joined the staff at the Hawaiian Volcano Observatory to learn methods of study that have proved useful here. Mr. Saenz will conduct monitoring studies of Cost Rican volcanoes when he returns to Costa Rica.

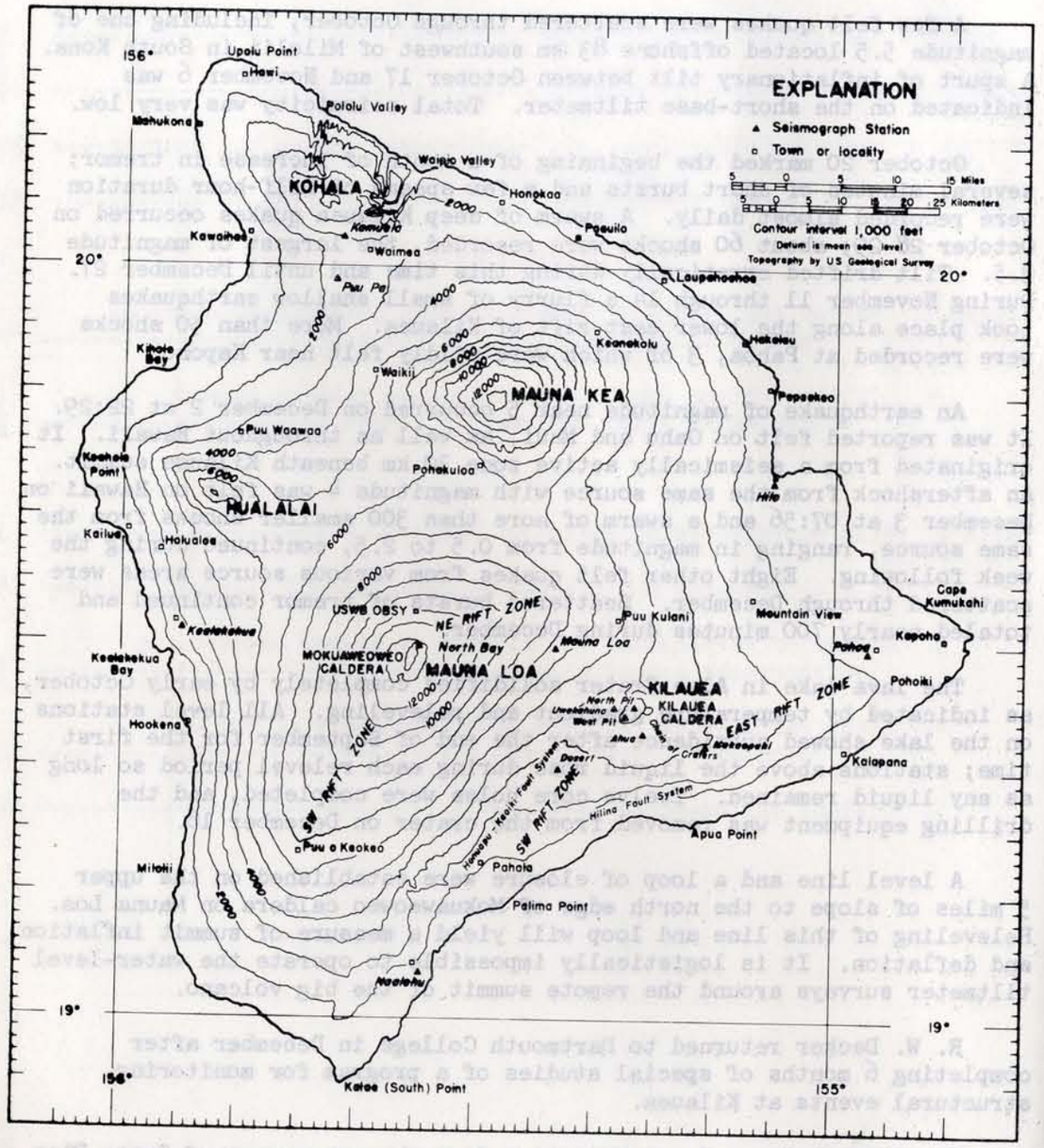

Figure 1.--Map of the island of Hawaii showing seismograph stations operated by the Geological Survey and localities mentioned in the text. Epicenters of local earthquakes are given in terms of geographic coordinates, which are indicated at the edges of the map.

Tilting of the ground around Kilauea caldera.--Tilting of the ground around the summit of Kilauea is monitored daily by a short-base water-tube tiltmeter in Uwekahuna Vault, and at irregular intervals it is measured on a regional scale by means of a network of field tilt bases and a portable water-tube tiltmeter. The attitude of the ground surface at each tilt base is reported in terms of north-south and east-west tilt coordinates. Both coordinates at each station were set equal to 500 when measurements at that station were begun. Increasing tilt coordinates correspond to northward and eastward tilting of the earth's surface; that is, to a relative subsidence toward the north and east. A one-unit change in coordinate corresponds to a tilting of 1 microradian (1 mm per km) in the direction indicated.

Table 1.--Tilt coordinates at Uwekahuna Vault, October, November, and December, 1964

Date	N-S	E-W	Date	N-S	E-W
Oct. 4	482	476	Dec. 6	482	470
11	482	478	13	483	467
18	482	476	20	483	465
25	484	472	27	483	465
Nov. 1	486	472			
8	487	465			
15	483	467			
22	481	467			
29	482	470			

Table 2.--Tilt coordinates and changes at bases around Kilauea caldera (fig. 2).

Tilt Base	Date (1964)	Tilt coordinates		Rate (10^{-6} rad/mo) and direction of tilting since last reading		Date of last reading (1964)
		N-S	E-W			
Uwekahuna	Dec. 10	488.5	455.5	8.2	N. 49.0° W.	Aug. 27
Tree Molds	Dec. 7	451.6	512.7	3.4	N. 23.5° W.	Aug. 28
Sand Spit	Dec. 11	893.2	717.4	9.6	N. 51.1° W.	Sept. 1
Kalihipaa	Dec. 8	320.4	381.3	3.1	S. 19.3° E.	Aug. 27
Keamoku	Dec. 11	506.1	563.5	3.9	N. 87.8° W.	Aug. 26
Ahua Kamokukolau	Dec. 10	540.7	523.0	12.5	S. 7.2° W.	Aug. 26
Kipuka Nene	Dec. 14	480.4	506.8	0.7	S. 34.3° W.	Sept. 1
Hilina Pali	Dec. 7	498.0	494.4	0.5	S. 88.5° W.	Apr. 30
Kapapala Ranch	Dec. 9	493.6	505.9	0.6	S. 81.5° E.	Aug. 24
Mehana	Dec. 10	547.4	552.8	2.2	N. 28.9° E.	Sept. 2

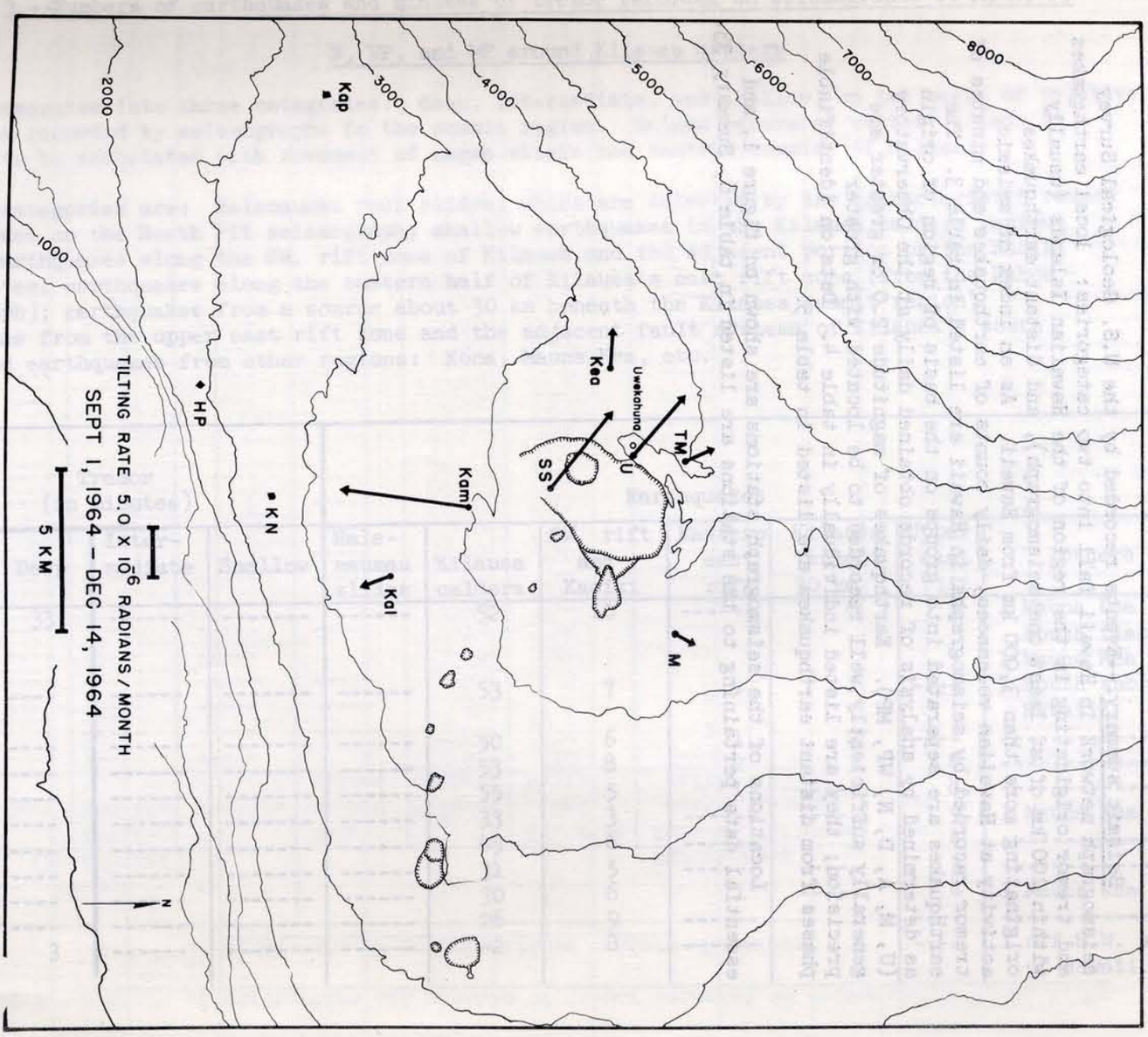

Figure 2.--Tilting of the ground around Kilauea caldera, Sept. 1-Dec. 14, 1964. The vector depicting tilting at a given tilt base points in the direction of maximum relative subsidence and has a length proportional to the rate of tilting during the measurement interval. Closed circles represent field tilt bases; open circles, short-base water-tube tiltmeters.

Seismic summary.--Events recorded by the U.S. Geological Survey seismograph network in Hawaii fall into two categories: local earthquakes and tremor originating in the region of the Hawaiian Islands (usually within 100 km of at least one seismograph), and distant earthquakes originating more than 3,000 km from Hawaii. As an index of seismic activity at Hawaiian volcanoes, daily counts of earthquakes and minutes of tremor recorded by seismographs in Hawaii are listed in table 3. The earthquakes are separated into groups on the basis of region of origin as determined by analysis of records obtained daily at the Observatory (U, M, A, D, N, WP, MP). Earthquakes of magnitude 2.0 or greater are generally sufficiently well recorded to be located with greater precision; they are listed individually in table 4. Data on identifiable phases from distant earthquakes are listed in table 5.

Locations of the seismograph stations are shown on figure 1, and essential data pertaining to the stations are listed in table 6, Summary 33.

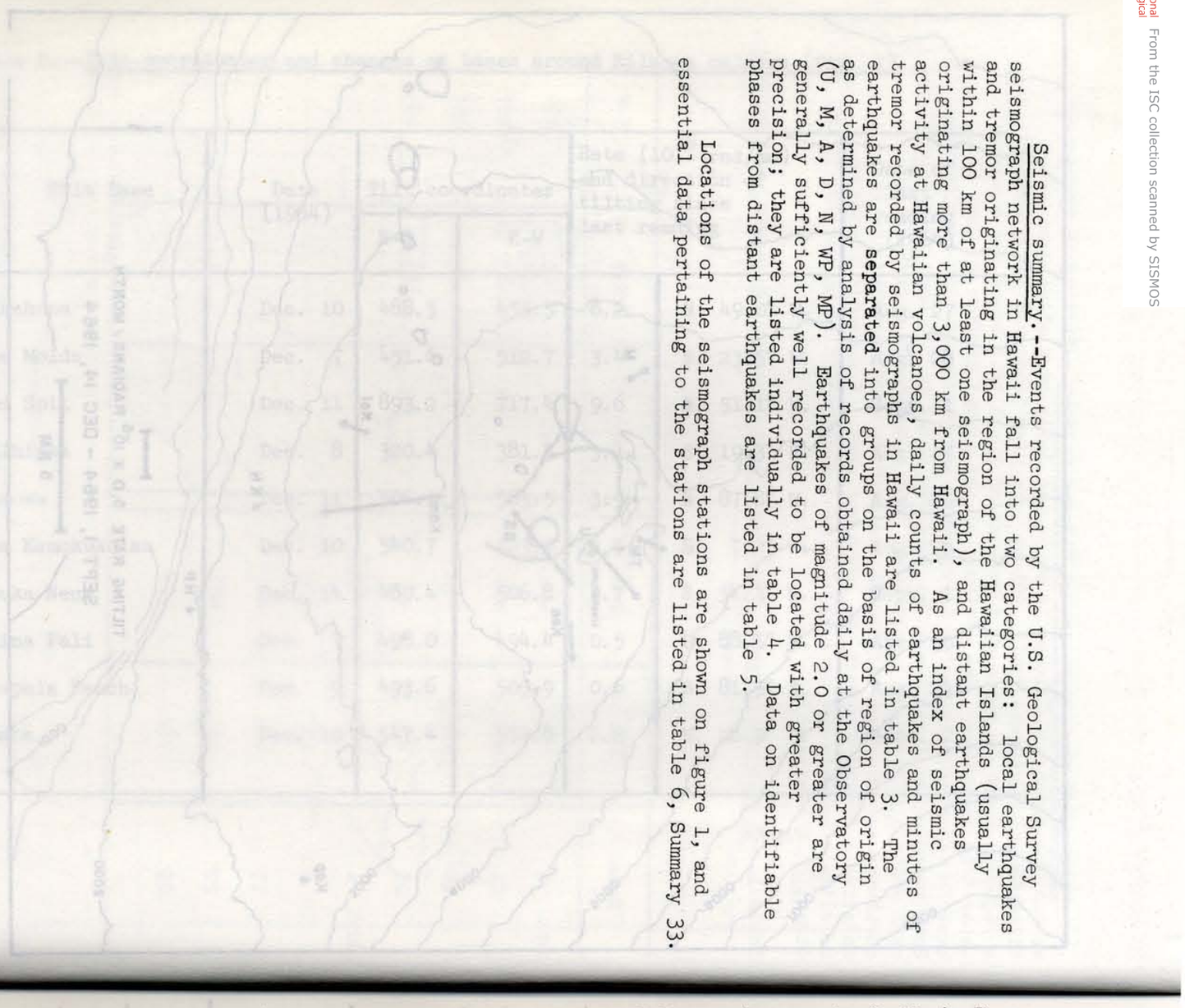

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera

Tremor is separated into three categories: deep, intermediate, and shallow, on the basis of relative amplitudes recorded by seismographs in the summit region. Unless otherwise stated, tremor is presumed to be associated with movement of magma within the central complex of Kilauea.

Earthquake categories are: Halemaumau rock slides, which are detected by the characteristic record they produce on the North Pit seismograph; shallow earthquakes in the Kilauea caldera region; shallow earthquakes along the SW. rift zone of Kilauea and the adjacent portion of the Kaoiki fault system; earthquakes along the eastern half of Kilauea's east rift zone (from the Pahoa seismograph); earthquakes from a source about 30 km beneath the Kilauea summit region; earthquakes from the upper east rift zone and the adjacent fault systems of Kilauea's south flank, and earthquakes from other regions: Kona, Mauna Kea, etc.

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	Others
Oct. 1	33	------	-------	------	52	10	------	6	3	1 Mauna Loa south flank. 1 Mauna Kea
2	----	------	-------	------	53	7	4	1	----	1 South shore of Hawaii.
3	----	------	-------	------	50	6	1	2	----	----------
4	----	------	-------	------	53	8	2	3	6	----------
5	----	------	-------	------	55	5	1	-----	8	----------
6	----	------	-------	------	33	3	------	-----	9	1 Mauna Kea region
7	----	------	-------	------	45	6	------	1	4	----------
8	----	------	-------	------	31	5	------	-----	3	----------
9	----	------	-------	------	30	6	1	-----	4	1 Mauna Kea
10	----	------	-------	------	26	9	------	1	----	----------
11	3	------	-------	------	42	8	------	3	----	1 off S.W. shore of Hawaii.

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Intermediate	Shallow	Halemaumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	Others
Oct. 12	----	-----	-----	1	62	10	----	2	----	1 Kona----------
13	9	-----	-----	-----	60	7	1	2	4	----------
14	----	-----	-----	-----	54	6	1	4	6	1 Kona----------
15	----	-----	-----	-----	65	5	1	-----	6	----------
16	----	-----	-----	1	68	22	----	4	14	----------
17	----	-----	-----	-----	73	16	----	2	11	----------
18	----	-----	-----	1	76	10	----	-----	----	----------
19	----	-----	-----	-----	87	10	----	-----	----	----------
20	31	-----	-----	-----	65	10	----	3	6	----------
21	----	14	2	-----	110	10	----	5	3	----------
22	----	16	7	-----	70	11	----	8	5+	----------
23	----	8+	-----	-----	75	12	----	6	6+	1 off south shore of Hawaii.
24	----	15+	-----	-----	43	14	----	-----	3	----------
25	----	27	-----	-----	65	11	----	5	6+	----------
26	----	21	-----	-----	75	6	----	4	8	1 Kona----------
27	6	-----	-----	-----	95	10	1	8	4	1 Kona----------
28	25	-----	-----	-----	60	12	----	32	----	----------
29	±25	-----	-----	-----	68	7	----	27	3	1 off south shore Hawaii.
30	35	-----	-----	-----	95	16	----	8+	6	----------
31	----	54	-----	-----	70	20	1	7	3	1 Mauna Loa S. flank
Nov. 1	55	-----	8	-----	40	4	----	6	10	2 Mauna Kea
2	25	24	-----	-----	54	5	4	3	3	----------
3	25	-----	-----	-----	43	5	2	2	3	----------
4	11	21	-----	-----	45	15	----	4	3	1 Kona 1 Mauna Loa
5	----	15	-----	-----	65	10	1	3	3	----------
6	8	-----	7	-----	38+	5+	1	2	4	----------
7	----	9	-----	-----	35	4+	1	2+	----	----------
Nov. 8	7	----	-----	------	38	8	3	3	----	----------
9	----	6	-----	------	40	9	5	----	6	1 off south shore
10	----	17	3	------	58	8	15	2	----	----------
11	----	42	15	------	40	13	17	10	----	----------
12	----	----	-----	------	50	15	34	5	5	1 Kona----------
13	----	----	-----	------	35	13	16	3	----	----------
14	----	----	-----	------	30	22+	8	1+	1	----------
15	18	----	10	1	43	11	10	2	6	----------
16	----	6	-----	------	56	18	3	3	2	----------
17	----	----	2	------	43	11	4	8	3	1 East flank Mauna Kea.
18	----	----	-----	------	66	25	2	1	5	----------
19	----	----	-----	------	80	13	1	----	3	----------
20	----	3	-----	------	58	15	----	3	2	1 offshore Kona
21	----	----	-----	------	70	10	----	7	4	----------
22	----	9	-----	------	45	9	----	8	3	----------
23	----	----	65	2	130+	11	----	7	4	----------
24	----	----	-----	------	70	13	----	13	6	1 Kona
25	----	----	-----	------	60	7	----	4	5	1 Mauna Kea
26	----	----	-----	------	72	12	3	4	3	1 Mauna Loa
27	----	----	-----	------	65	9	----	5	3	1 Kona
28	12	----	-----	------	65	10	----	4	4	----------
29	30	----	-----	------	63	17	----	5	2	1 Mauna Loa
30	124	----	-----	------	54+	8	----	1	3	----------
Dec. 1	----	61	-----	------	25	10	----	3	4	----------
2	----	----	5	------	48+	20	----	210+	4	----------
3	----	----	-----	------	33	10	----	46	4	1 Kona
4	----	115+	-----	1	90+	16	8	31	38+	2 Mauna Loa 1 Kona
5	----	46±	-----	------	70	13	1	22	4	----------
6	----	85+	-----	1	80+	19	----	12	16+	----------
7	----	47	-----	------	45	9	1	7	5	1 Mauna Loa 1 Kona
8	----	----	-----	------	48	8	3	3	4	----------
9	----	----	-----	------	85	15	2	21	31	----------
10	----	2	-----	------	58	6	----	3	3	----------
11	----	----	-----	------	63	11	7	6	17	1 Mauna Kea 1 Kohala
12	----	9	3	------	38	17	----	4	7	3 Mauna Loa
13	----	----	-----	------	30	10	3	8	20	1 Kona 1 Mauna Kea 1 Mauna Loa

Table 3.--Numbers of earthquakes and minutes of tremor recorded on seismographs U, M, A, D, N, WP, and MP around Kilauea caldera--Continued

Date (1964)	Tremor (in minutes)			Earthquakes						
	Deep	Inter-mediate	Shallow	Hale-maumau slides	Kilauea caldera	SW. rift and Kaoiki	Eastern east rift	Kilauea summit 30 km	Upper east rift	Others
Dec. 14	----	-----	3	------	30	10	2	4	7	1 Hilo 1 Kona
15	----	-----	10	4	65±	14	----	2	3	----------
16	----	-----	------	2	68	11	1	2	7	1 Kona
17	----	-----	7	------	61	6	----	2	9	1 Mauna Kea
18	----	33	8	------	25	11	----	1	7	1 Kohala
19	----	-----	3	------	25	(?)	2	2(?)	1	----------
20	9	11	------	------	45+	1+	----	2+	2+	----------
21	----	-----	3	1	40	6	----	1	----	----------
22	----	12	------	------	50	3	4	2	3	----------
23	----	-----	------	------	75	6	1	14	12	----------
24	----	-----	15±	------	94	13	----	4	5	----------
25	----	4	------	------	115+	8	3	5	2	1 Mauna Loa
26	3	-----	------	------	98	8(?)	----	5	----	----------
27	----	7+	------	------	114+	14	3	2	4	1 Kona
28	2	-----	------	1	91	9	2	3	4	----------
29	3(?)	-----	------	------	122	11	----	4	5	----------
30	----	4+	------	------	125+	4	1	4	13	----------
31	30	-----	------	------	148	6(?)	2	1	4	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, October, November, and December, 1964

Entries for a given quake are: date, origin time (Hawaiian Standard Time), magnitude, depth, epicenter, and felt report. All earthquakes of magnitude 2.5 and larger, as well as many favorably located smaller ones, occurring on or near the island of Hawaii are included in the list.

In the following list, some origin times are followed only by "KM 30" and a statement of magnitude. These are all members of a continuing family of quakes noted also in other Summaries. The best mean focus for this group is beneath Halemaumau at a depth of 30 km (19°24.1' N., 155°17.1' W.).

The mean focus of the magnitude 6.1 Kaoiki fault system earthquake of June 27, 1962, and its aftershocks is 19°24' N., 155°25' W., at a depth of 3-8 km. This focus has been abbreviated "Kaoiki."

Date (1964)	Time			Magni-tude	Depth (km)	Epicenter			Felt Report
	h	m	s			Lat. N.	Long. W.	Description	
Oct. 1	15	09	32.2	3.3	8	19°12.0'	155°35.0'	15 km N. of Naalehu	Pahala and Naalehu----
1	17	18	06.0	2.4	13	19°59.4'	155°17.7'	7 km W. of Laupahoehoe	----------
2	08	59	33.2	2.5	3	19°11.8'	155°27.9'	2 km ESE. of Pahala	----------
6	06	39	37.4	2.1	8	19°18.9'	155°12.8'	8 km SW. of Makaopuhi seismometer.	----------
6	14	35	34.4	2.0	8	19°16.8'	155°13.7'	11 km SW. of Makaopuhi seismometer.	----------
6	18	26	39.5	2.0	3	19°23.5'	155°05.2'	12 km ENE. of Makaopuhi seismometer.	----------
6	02	48	42.0	2.4	8	19°57.3'	155°48.5'	16 km SW. of Kamuela	----------
7	09	36	10.0	2.0	3	19°24.3'	155°04.1'	13 km ENE. of Makaopuhi seismometer.	----------
8	06	56	29.0	2.2	---	--------	---------	KM 30----------	----------
9	05	41	58.5	2.0	3	19°17.4'	155°10.3'	5 km NE. of Apua Point	----------
9	23	31	14.0	2.0	8	19°51.1'	155°33.8'	24 km SSE. of Kamuela	----------
11	00	06	42.8	5.5	13	18°47'	156°37'	83 km SW. of Milolii	Hawaii, Maui, Oahu
12	01	48	11.7	3.0	---	--------	---------	KM 30----------	Volcano----------
12	22	15	46.0	2.0	8	19°36.2'	155°49.8'	14 km NE. of Kealakekua	----------
14	08	43	55.0	3.4	---	--------	---------	KM 30----------	Pahala, Puna, Volcano, and Hilo.
14	22	19	13.5	2.0	8	19°23.2'	155°49.2'	18 km SE. of Kealakekua	----------
16	01	07	53.0	2.1	3	19°21.3'	155°03.0'	14 km E. of Makaopuhi seismometer.	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, October, November, and December, 1964--Continued

Date (1964)	Time h	m	s	Magnitude	Depth (km)	Epicenter Lat. N.	Long. W.	Description	Felt Report
Oct. 17	16	20	17.2	3.7	5	19°19.8'	155°05.7'	11 km ESE. of Makaopuhi seismometer.	Volcano, Paauil Hilo.
20	11	38	22.3	3.3	---	--------	---------	KM 30----------	Volcano, Pahala
22	11	45	37.4	2.8	45	19°13.8'	155°18.8'	15 km SE. of Desert seismometer.	----------
23	06	58	49.3	2.6	8	19°19.9'	154°59.5'	3 km SW. of Kalapana	----------
23	19	13	26.6	3.6	30	19°01.1'	155°24.8'	20 km ESE. of Naalehu	Pahala and Naal...
25	23	53	35.4	2.4	35	19°11.4'	155°08.5'	20 km SSE. of Makaopuhi seismometer.	----------
26	23	27	05.0	2.3	3	19°22.0'	155°53.8'	2 km SSE. of Hookena	----------
27	09	55	59.0	3.7	---	--------	---------	KM 30----------	Volcano
27	20	15	38.0	2.3	---	--------	---------	KM 30----------	----------
27	20	58	59.0	3.2	8	19°23.2'	155°49.4'	9 km E. of Hookena	----------
28	14	50	58.7	2.0	---	--------	---------	KM 30----------	----------
29	00	55	59.6	2.2	---	--------	---------	KM 30----------	----------
29	03	00	00.3	2.4	---	--------	---------	KM 30----------	----------
29	06	06	14.3	2.0	---	--------	---------	KM 30----------	----------
29	10	19	46.9	2.4	30	19°01.1'	155°29.8'	11 km ESE. of Naalehu	----------
29	16	10	58.7	2.9	---	--------	---------	KM 30----------	----------
29	16	47	50.1	2.0	---	--------	---------	KM 30----------	----------
30	18	26	14.2	2.2	10	19°17.8'	155°09.6'	9 km SSE. of Makaopuhi seismometer.	----------
30	19	18	02.9	2.0	8	19°23.6'	154°59.0'	12 km SW. of Pahoa	----------
31	05	35	48.5	2.9	8	19°11.0'	155°39.0'	14 km NNW. of Naalehu	----------
31	11	23	27.7	2.5	10	19°18.3'	155°10.2'	7 km S. of Makaopuhi seismometer.	----------
Nov. 1	00	41	50.1	2.5	3	19°55.0'	155°40.0'	16 km SSE. of Kamuela	----------
1	17	54	32.8	2.5	3	19°53.0'	155°36.2'	20 km SE. of Kamuela	----------
4	11	47	46.7	2.1	15	19°21.7'	155°28.0'	9 km WNW. of Desert seismometer.	----------
4	13	45	28.3	2.7	5	19°30.0'	155°42.8'	22 km E. of Kealakekua	----------
4	21	18	53.1	3.2	---	--------	---------	Kaoiki----------	Pahala----------
5	04	44	48.9	2.1	---	--------	---------	Kaoiki----------	----------
5	06	16	47.5	2.6	5	19°25.1'	155°01.1'	11 km SW. of Pahoa----	Pahoa----------
Nov. 6	05	27	37.9	2.5	----	--------	---------	KM 30----------	Pahoa----------
7	22	46	20.3	2.0	----	--------	---------	KM 30----------	----------
9	13	47	17.4	2.3	5	19°17.0'	155°01.1'	9 km SW. of Kalapana	----------
10	06	26	25.5	2.0	3	19°25.0'	155°04.0'	14 km ENE. of Makaopuhi seismometer.	----------
10	23	25	28.7	3.4	----	--------	--------	Kaoiki----------	Pahala and Volcano
11	22	46	25.6	2.2	----	--------	--------	Kaoiki----------	----------
12	01	24	26.1	2.8	8	19°38.7'	155°59.2'	1 km E. of Kailua----	----------
12	03	00	32.7	3.1	8	19°23.5'	154°56.4'	12 km S. of Pahoa----	Felt
12	22	08	10.7	2.5	3	19°26.0'	154°54.6'	8 km SSE. of Pahoa---	Kapoho----------
14	15	53	18.5	3.3	----	--------	---------	Kaoiki----------	Felt----------
15	09	56	25.4	2.4	35	19°26.5'	155°14.6'	5 km ENE. of Uwekahuna seismometer.	----------
17	17	04	16.0	2.5	3	20°04.9'	155°27.8'	1 km SE. of Honokaa	----------
18	03	15	29.0	3.0	10	19°18.1'	155°10.0'	7 km SSE. of Makaopuhi seismometer.	----------
20	16	17	24.0	3.2	13	19°10'	156°20'	59 km SW. of Kealakekua	----------
21	14	55	09.0	2.3	----	--------	---------	KM 30----------	----------
24	01	54	12.3	2.7	----	--------	---------	KM 30----------	Pahala----------
24	03	41	15.3	2.1	10	19°18.1'	155°10.9'	6 km S. of Makaopuhi seismometer.	----------
24	06	50	41.0	3.2	8	19°27.6'	155°56.7'	9 km SE. of Kealakekua	Kealakekua---------
24	16	12	41.1	2.4	10	19°18.6'	155°00.6'	6 km SW. of Kalapana	----------
25	22	10	32.4	2.1	10	19°17.5'	155°09.8'	8 km SSE. of Makaopuhi seismometer.	----------
25	23	41	25.8	2.2	8	19°49.1'	155°15.9'	23 km WNW. of Hilo	----------
26	18	00	21.5	2.7	Shallow depth	19°25.6'	155°41.5'	15 km SW. of North Bay seismometer.	----------
27	13	46	14.0	2.5	3	19°22'	156°17'	43 km WSW. of Kealakekua	----------
29	07	11	51.0	2.3	3	19°11.8'	155°40.4'	18 km NW. of Naalehu	----------
29	16	42	39.3	2.0	3	19°17.9'	155°28.2'	10 km WSW. of Desert seismometer.	Pahala, Pahoa
Dec. 2	04	12	32.0	2.6	10	19°15.6'	155°06.5'	14 km SE. of Makaopuhi seismometer.	----------
2	22	28	40.0	4.7	----	--------	---------	KM 30----------	Hawaii, Maui, Oahu
2	22	31	43.3	3.5	----	--------	---------	KM 30----------	Volcano, Pahala
2	22	34	45.8	2.4	----	--------	---------	KM 30----------	----------
2	22	36	46.2	2.3	----	--------	---------	KM 30----------	----------
2	22	44	03.4	2.0	----	--------	---------	KM 30----------	----------
2	22	48	26.9	2.3	----	--------	---------	KM 30----------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, October, November, and December, 1964--Continued

Date (1964)	Time h	m	s	Magnitude	Depth (km)	Epicenter Lat. N.	Long. W.	Description	Felt Report
Dec. 2	23	05	11.8	2.1	----	--------	-------	KM 30----------	----------
2	23	11	11.3	2.7	----	--------	-------	KM 30----------	----------
2	23	13	16.3	2.0	----	--------	-------	KM 30----------	----------
2	23	13	37.7	2.2	----	--------	-------	KM 30----------	----------
2	23	20	32.5	2.0	----	--------	-------	KM 30----------	----------
3	00	15	35.9	2.8	----	--------	-------	KM 30----------	Pahala----------
3	01	19	09.3	2.0	----	------	-------	KM 30----------	----------
3	01	22	42.5	2.1	----	------	-------	KM 30----------	----------
3	01	24	48.3	2.0	30	19°16.3'	155°18.2'	12 km SE. of Desert seismometer.	----------
3	01	35	47.8	2.1	----	--------	-------	KM 30----------	----------
3	05	54	40.8	2.7	----	--------	-------	KM 30----------	----------
3	07	56	00.5	4.0	----	--------	-------	KM 30----------	Volcano, Naalehu, Hilo.
3	12	17	04.0	2.0	3	19°32.1'	155°57.1'	5 km WNW. of Kealakekua	----------
3	12	19	25.0	2.0	8	19°17.9'	155°10.5'	8 km S. of Makaopuhi seismometer.	----------
3	15	40	16.2	2.3	----	--------	---------	KM 30----------	----------
3	18	21	24.0	2.5	----	--------	---------	KM 30----------	----------
4	02	01	45.9	2.0	----	--------	---------	KM 30----------	----------
4	03	16	35.8	2.1	----	--------	---------	KM 30----------	----------
4	04	24	19.0	2.2	5	19°30.5'	155°48.1'	13 km E. of Kealakekua	----------
4	12	17	42.7	2.5	10	19°11.4'	155°37.6'	15 km NNW. of Naalehu	----------
4	12	45	36.1	2.6	8	19°11.8'	155°37.1'	15 km NNW. of Naalehu	----------
6	16	52	04.8	2.3	40	19°27.6'	155°05.9'	10 km SSW. of Mt. View	----------
6	20	06	57.4	2.2	5	19°20.5'	155°03.5'	14 km ESE. of Makaopuhi seismometer.	----------
7	03	24	12.6	2.8	8	19°29.1'	155°50.9'	9 km ESE. of Kealakekua	----------
7	06	13	38.0	2.0	13	19°26.6'	155°36.2'	6 km SSW. of North Bay seismometer.	----------
8	23	37	09.9	2.0	30	19°19.3'	155°16.8'	7 km SSW. of Ahua seismometer.	----------
9	00	06	30.1	2.0	----	--------	---------	Kaoiki----------	----------
10	01	53	45.0	5.0	10	19°18.5'	155°12.2'	7 km SW. of Makaopuhi	Naalehu, Volcano,
Dec. 10	02	03	03.2	2.3	5	19°16.7'	155°12.1'	10 km SW. of Makaopuhi seismometer.	----------
10	04	12	04.2	2.4	10	19°18.1'	155°11.6'	7 km SSW. of Makaopuhi seismometer.	----------
10	05	52	04.6	3.2	----	--------	---------	KM 30----------	Hilo, Volcano, Pahala, and Naalehu.
11	03	51	43.6	2.7	10	19°52.1'	155°22.8'	7 km SW. of Keanakolu	----------
11	20	07	18.0	3.4	10	20°06.0'	155°53.1'	9 km NW. of Kawaihae	Kamuela----------
12	17	20	56.4	2.1	3	19°28.5'	155°36.0'	Mokuaweoweo Caldera	----------
12	20	33	09.2	2.1	13	19°41.0'	155°38.1'	15 km SW. of Pohakuloa	----------
12	23	21	14.7	2.4	8	19°27.2'	155°26.4'	7 km SW. of Mauna Loa seismometer.	----------
13	02	14	00.5	2.1	3	19°59.1'	155°34.1'	14 km ESE. of Kamuela	----------
13	16	26	56.3	2.3	10	19°12.0'	155°36.1'	15 km N. of Naalehu	----------
13	19	30	19.7	3.8	3	19°23.3'	155°49.7'	8 km E. of Hookena	Volcano and Kealakekua
14	04	37	27.9	3.4	10	19°39.3'	155°12.2'	15 km WSW. of Hilo	Hilo, Volcano, Pahala
14	07	03	14.8	2.3	10	19°22.8'	155°12.7'	6 km E. of Ahua seismometer.	----------
14	10	19	03.4	2.1	----	--------	---------	KM 30----------	----------
14	13	21	32.8	2.3	5	19°47.5'	155°57.7'	4 km WNW. Puuwaawaa	----------
15	07	30	38.2	2.5	10	19°21.1'	155°12.8'	4 km WSW. of Makaopuhi seismometer.	----------
16	09	16	18.0	2.5	Shallow depth	19°31.1'	155°50.8'	8 km E. of Kealakekua	----------
17	08	11	46.0	2.4	13	19°55.9'	155°33.9'	17 km SE. of Kamuela	----------
17	11	47	46.9	3.2	----	--------	---------	Kaoiki----------	Pahala and Volcano
18	20	14	34.7	2.0	8	19°11.2'	155°26.9'	4 km ESE. of Pahala	----------
18	21	46	51.5	2.8	30	20°09.1'	155°49.0'	17 km NW. of Kamuela	----------
24	03	18	27.1	2.2	----	--------	---------	KM 30----------	----------
24	06	43	31.1	2.4	----	--------	---------	KM 30----------	----------
24	14	39	59.6	3.2	----	--------	---------	Kaoiki----------	Felt----------
24	17	39	25.9	2.1	5	19°21.8'	155°12.5'	5 km W. of Makaopuhi seismometer.	----------
25	13	23	49.5	2.4	10	19°25.3'	155°34.7'	8 km S. of North Bay seismometer.	----------
25	13	54	28.0	2.5	----	--------	---------	Kaoiki----------	----------
25	14	23	07.5	2.6	----	--------	---------	Kaoiki----------	----------
26	13	38	02.3	2.1	----	--------	---------	KM 30----------	----------

Table 4.--Local earthquakes recorded by seismographs of the U.S. Geological Survey, October, November, and December, 1964--Continued

Date (1964)	Time h	Time m	Time s	Magnitude	Depth (km)	Epicenter Lat. N.	Epicenter Long. W.	Epicenter Description	Felt Report
Dec. 27	10	11	01.2	2.8	8	19°52.0'	156°07.8'	16 km NW. of Keahole Point	----------
27	20	16	37.7	2.5	---	--------	--------	Kaoiki----------	----------
30	04	30	31.0	2.3	8	19°18.7'	155°13.6'	8 km SW. of Makaopuhi seismometer.	----------
31	01	31	51.7	2.5	10	19°18.8'	155°08.3'	8 km SE. of Makaopuhi seismometer.	----------

Table 5.--Distant earthquakes

Times are reported in Greenwich Civil Time which is 10 hours faster than Hawaiian Standard Time. A "c" following the time of P indicates compressional first motion; a "d" indicates dilatational first motion. Station symbols, locations, and instrumentation are presented in table 6. Magnitudes calculated from the Hawaii seismograms are followed by (HVO). Location of epicenter, origin time, focal depth, and magnitudes reported by other institutions are taken from "Preliminary Determination of Epicenters" published by the U.S. Coast and Geodetic Survey.

October 1, 1964

Pa	Z	Tmax	11:41:25

C&GS card 76-64:
11:00:48.3
43.5° N., 126.9° W.
Off coast of Oregon
h about 33 km.

October 1

Pa	Z	Tmax	19:15:06

C&GS card 79-64:
18:30:01.9
49.3° N., 128.8° W.
Vancouver Island region
h about 9 km
Magnitude 4.5-4.75 (Brk)
5.3 (CGS).

October 2

A	Z	iP	13:09:37.2 c
D	Z	iP	36.2 c
WP	Z	iP	37.2 c
MP	Z	eP	37.7 c
U	Z	eP	37.2 c
Pa	Z	eP	38.9 c
Na	Z	eP	33.9 c
Hi	Z	iP	39.8 c
NB	Z	iP	36.0 c
Ha	Z	iP	13:09:36.0 c
U	PEZ	eS	13:16:54
U	PEZ	eR	13:24:30

C&GS card 77-64:
13:00:39.7
10.5° S., 162.4° E.
Solomon Islands
h about 68 km
Magnitude 6.0 (CGS)
6.0 (HVO).

October 2

A	Z	Tmax	23:14:48
D	Z	Tmax	23:15:06
WP	Z	Tmax	23:14:46
MP	Z	Tmax	23:14:46
U	Z	Tmax	23:14:53
Pa	Z	Tmax	23:14:34
NB	Z	Tmax	23:15:03
Ha	Z	Tmax	23:13:30

C&GS card 78-64:
22:23:32.4
59.7° N., 144.5° W.
Gulf of Alaska
h about 22 km
Magnitude 5.2 (CGS).

October 6

U	PEZ	eR	07:53:22

C&GS card 78-64:
07:17:57.1
36.2° S., 100.9° W.
Southern Pacific Ocean
h about 33 km
Magnitude 5.5 (CGS).

October 6

U	PEZ	ePP	14:51:42
U	PEZ	ePPS	15:02:50
U	PEN	eSS	15:08:26
U	PEE	eL	15:19:42

October 6, 1964--Continued

C&GS card 81-64:
14:31:19.2
40.3° N., 28.2° E.
Turkey
19 killed, several injured, extensive property damage in western Turkey.
Felt widely throughout Black Sea region.
h about 10 km
Magnitude 6.75-7 (Pas), 6.75-7 (Brk), 6.25 (Pal), 6.0 (CGS), and 7.2 (HVO).

October 10

M	Z	eP	19:46:31.8 c
A	Z	eP	32.3 c
D	Z	eP	32.8 c

C&GS card 79-64:
19:38:47.7
60.4° N., 146.1° W.
Southern Alaska
h about 44 km
Magnitude 4.5-4.75 (Brk), 5.3 (CGS).

October 10

M	Z	iP	20:14:24.1 c
A	Z	iP	24.6 c
D	Z	iP	25.1 c
Ke	Z	iP	24.4 c

C&GS card 78-64:
20:06:39.8
60.5° N., 145.4° W.
Southern Alaska
h about 31 km
Magnitude 5.4 (CGS).

October 11, 1964

M	Z	iP	21:27:32.9 c
D	Z	eP	32.4 c
MP	Z	eP	33.6 c
U	Z	eP	33.0 c
Na	Z	eP	31.2 c
Hi	Z	eP	34.2 c
Ke	Z	eP	29.2 c
U	PEN	eS	21:38:01
U	PEN	iG	21:49:17
U	PEZ	eR	21:53:41

C&GS card 81-64:
21:15:03.9
0.6° S., 121.7° E.
Northern Celebes
h about 33 km
Magnitude 6.25-6.5 (Pal), 6.3 (CGS), 6.3 (HVO).

October 12

M	Z	Tmax	10:49:41
A	Z	Tmax	48
D	Z	Tmax	51
WP	Z	Tmax	47
MP	Z	Tmax	42
U	Z	Tmax	43
Pa	Z	Tmax	36

C&GS card 81-64:
09:14:52.2
55.9° S., 144.1° W.
South Pacific Cordillera
h about 33 km
Magnitude 5.3 (CGS).

October 12

M	Z	eP	15:54:49.9 d
A	Z	eP	50.1 d
NB	Z	eP	49.1 d
U	PEZ	eS	16:04:41
U	PEZ	eR	16:19:01

C&GS card 81-64:
15:42:54.7
3.0° N., 126.7° E.
Talaud Islands
h about 59 km

October 12, 1964--Continued

C&GS card--Continued
Magnitude 5.75-6 (Pal), 5.9 (CGS), and 5.9 (HVO).

October 12

M	Z	eP	22:06:20.1 c
A	Z	eP	18.9 c
D	Z	eP	19.4 c
MP	Z	eP	18.7 c
U	PEN	eS	22:15:11
U	PEE	eL	22:22:41
U	PEZ	eR	22:25:41

C&GS card 79-64:
21:55:33.2
31.3° S., 110.8° W.
Easter Island region
h about 25 km
Magnitude 6.25 (Pas)
6.25 (Brk)
5.75 (Pal)
6.0 (CGS), 5.9 (HVO).

October 13

U	PEZ	eR	11:05:36

C&GS card 80-64:
10:38:59.3
3.3° S., 149.9° E.
Bismarck Sea
h about 59 km
Magnitude 5.1 (CGS).

October 14

U	PEZ	eR	03:31:17

C&GS card 79-64:
03:04:59.6
33.4° N., 141.8° E.
Off east coast of Honshu, Japan
h about 33 km
Magnitude 5.6 (CGS).

October 15

M	Z	eP	20:35:56.8 c
MP	Z	eP	58.3 c
U	PEE	eS	20:43:39
U	PEE	eG	20:48:11
U	PEZ	eR	20:50:35

C&GS card 80-64:
20:26:53.5
44.7° N., 149.8° E.
Kurile Islands
h about 49 km
Magnitude 5.2 (CGS), 6.7 (HVO).

October 15

M	Z	Tmax	23:46:09
A	Z	Tmax	16
NP	Z	Tmax	06
WP	Z	Tmax	03
MP	Z	Tmax	05
U	Z	Tmax	09
Pa	Z	Tmax	05
Hi	Z	Tmax	23:45:38
NB	Z	Tmax	23:46:24
Ha	Z	Tmax	23:44:39

C&GS card 80-64:
22:59:43.6
56.8° N., 151.9° W.
Kodiak Island region
h about 33 km
Magnitude 5.2 (CGS).

October 16

M	Z	eP	07:08:46.3 c
D	Z	eP	47.1 c
MP	Z	eP	47.5 c
U	PEE	iS	07:16:11
U	PEE	iG	07:20:59
U	PEZ	eR	07:23:21

C&GS card 81-64:
06:59:38.6
44.3° N., 149.5° E.
Kurile Island
h about 33 km
Magnitude 5.5 (CGS), 6.5 (HVO).

October 16

M	**Z**	eP	08:27:35.5 c
D	Z	eP	36.0 c
MP	Z	eP	36.8 c
Pa	Z	eP	37.2 c
NB	Z	eP	34.8 c
U	PEE	iS	08:34:59
U	PEE	eG	08:39:41
U	PEZ	eR	08:42:21

C&GS card 83-64:
08:18:28.3
44.6° N., 149.4° E.
Kurile Islands
h about 33 km
Magnitude 6-6.25 (Pal),
5.2 (CGS), 6.5 (HVO).

October 16

M	Z	eP	09:27:28.3 d
D	Z	eP	28.9 d
MP	Z	eP	29.8 d
U	PEE	iS	09:34:59
U	PEN	eG	09:39:41
U	PEZ	eR	09:41:57

C&GS card 81-64:
09:18:16.6
44.5° N., 149.1° E.
Kurile Islands
h about 33 km
Magnitude 5.4 (CGS), 6.5 (HVO).

October 18

M	Z	iP	12:43:57.1 c
A	Z	iP	57.6 c
D	Z	iP	57.0 c
NP	Z	iP	57.6 c
WP	Z	iP	57.7 c
MP	Z	iP	57.8 c
U	Z	iP	57.6 c
Na	Z	iP	55.9 c
Hi	Z	iP	59.2 c
Ke	Z	iP	55.0 c
NB	Z	iP	57.0 c

October 18--Continued

C&GS card 83-64:
12:32:24.1
7.0° S., 124.0° E.
Banda Sea
h about 574 km
Magnitude 5.8 (CGS).

October 23

U	PEN	iG	02:34:01
U	PEZ	eR	02:38:12

C&GS card 85-64:
01:56:03.2
19.8° N., 56.0° W.
North Atlantic Ocean
h about 31 km
Magnitude 6.75 (Pas)
6.5 (Brk)
6.4 (CGS).

October 23

U	PEZ	eR	21:30:34

C&GS card 85-64:
21:06:24.2
44.0° N., 147.5° E.
Kurile Islands
h about 45 km
Magnitude 5.9 (CGS).

October 24

M	Z	Tmax	07:25:33
A	Z	Tmax	36
NP	Z	Tmax	33
WP	Z	Tmax	31
U	Z	Tmax	32
Pa	Z	Tmax	19

C&GS card 87-64:
06:44:38
44.4° N., 130.0° W.
Off coast of Oregon
h about 33 km
Magnitude 4.7 (CGS).

October 25

M	Z	iP	12:16:33.1 c
D	Z	eP	32.2 c
NP	Z	iP	32.7 c
WP	Z	iP	32.8 c
MP	Z	iP	32.8 c
U	Z	eP	32.8 c
Pa	Z	eP	34.2 c
Na	Z	iP	29.4 c
Hi	Z	iP	35.7 c
Ke	Z	iP	31.1 c
NB	Z	eP	32.5 c
Ha	Z	iP	38.0 c

C&GS card 85-64:
12:08:46.9
21.7° S., 179.2° W.
Fiji Islands region
h about 534 km
Magnitude 5.5 (CGS).

October 26

M	Z	iP	14:34:55.4 d
A	Z	iP	55.5 d
WP	Z	iP	55.6 d

C&GS card 86-64:
14:22:57.8
2.2° N., 126.8° E.
Molucca Passage
h about 48 km
Magnitude 6.0 (CGS).

October 26

M	Z	Tmax	15:19:15
Ha	Z	Tmax	15:17;47

C&GS card 84-64:
14:32:49.3
56.8° N., 152.3° W.
Kodiak Islands region
h about 33 km
Magnitude 5.0 (CGS).

October 27

U	PEZ	eR	22:19:19

C&GS card 84-64:
21:24:31.2
45.6° S., 96.1° E.
Southeast Indian Rise
h about 33 km

November 1

M	Z	Tmax	05:42:31
A	Z	Tmax	30
D	Z	Tmax	49
NP	Z	Tmax	32
U	Z	Tmax	33
Pa	Z	Tmax	36
Hi	Z	Tmax	43
NB	Z	Tmax	58
Ha	Z	Tmax	05:41:56

C&GS card 85-64:
04:55:47.4
51.8° N., 130.8° W.
Queen Charlotte Islands region
h about 33 km
Magnitude 4.9 (CGS).

November 1

M	Z	iP	12:37:51.9 c
D	Z	iP	52.0 c
NP	Z	eP	52.4 c
MP	Z	eP	52.7 c
U	Z	eP	52.1 c
Ke	Z	eP	48.9 c
NB	Z	eP	51.2 c

C&GS card 88-64:
12:26:06.2
3.1° N., 128.1° E.
North of Halmahera
h about 65 km
Magnitude 5.75-6 (Pal), 6.3 (CGS)

November 3

M	Z	eP	12:55:09.9 c
A	Z	eP	10.2 c
MP	Z	eP	10.4 c
NB	Z	eP	08.7 c

C&GS card 88-64:
12:43:04.7
0.1° N., 123.7° E.
Northern Celebes
h about 149 km
Magnitude 5.4 (CGS).

November 6, 1964

U	PEZ	eR	10:17:10

C&GS card 93-64:
09:53:22.4
44.4° N., 149.0° E.
Kurile Islands
h about 60 km
Magnitude 5.5-5.75 (Pal),
5.7 (CGS).

November 8, 1964

MP	Z	eP	02:55:50.9
U	PEN	ePPS	03:06:53
U	PEN	eSS	03:10:45
U	PEZ	eR	03:19:29

C&GS card 93-64:
02:43:57
49.0° S., 163.7° E.
Auckland Islands region
h about 33 km
Magnitude 6.5 (Pas),
6.25-6.5 (Pal),
6.3 (HVO).

November 12

U	PEN	eG	05:51:50

C&GS card 103-64:
05:33:29
18.2° S., 176.4° W.
Fiji Islands region
h about 107 km
Magnitude 5.2 (CGS).

November 16

M	Z	Tmax	03:29:10
A	Z	Tmax	15
D	Z	Tmax	26
NP	Z	Tmax	24
WP	Z	Tmax	23
MP	Z	Tmax	03
U	Z	Tmax	10
Pa	Z	Tmax	03:29:00
Ka	Z	Tmax	09

November 16--Continued

NB	Z	Tmax	26
Ha	Z	Tmax	03

C&GS card 96-64:
02:46:43
36.9° N., 121.8° W.
Central California
Minor damage at Corralitos,
Morgan Hill, San Jose and Santa
Cruz.
h about 33 km
Magnitude 5.25 (Pas)
5 (Brk)
5.2 (CGS).

November 17, 1964

M	Z	iP	08:25:34.9 c
A	Z	iP	34.9 c
D	Z	iP	34.1 c
WP	Z	iP	35.0 c
U	Z	iP	35.1 c
Na	Z	iP	32.1 c
Hi	Z	eP	37.2 c
Ke	Z	eP	31.9 c
NB	Z	iP	33.8 c
Ha	Z	iP	34.2 d
U	PEZ	iPP	08:27:38
U	PEE	iS	08:33:42
U	PEZ	eSS	08:37:25
U	PEN	iG	08:39:43
U	PEZ	iR	08:42:19

C&GS card 92-64:
08:15:39.3
5.7° S., 150.7° E.
New Britain region
h about 45 km
Magnitude 7.25 (Pas), 7-7.25 (Brk),
6.7 (CGS), 7.25 (HVO).

November 17, 1964

M	Z	iP	11:11:04.0 d
A	Z	iP	03.7 d
D	Z	iP	03.1 d
WP	Z	eP	03.4 d
MP	Z	iP	03.7 d
U	Z	iP	03.5 d
Pa	Z	iP?	05.1 d
Hi	Z	eP?	06.2 c
NB	Z	eP	03.9 d
Ke	Z	iP	01.9 c

C&GS card 96-64:
11:03:06.8
23.4° S., 179.9° W.
South of Fiji Islands
h about 549 km
Magnitude 5.5 (CGS).

November 17, 1964

M	Z	iP	17:53:04.3 d
A	Z	eP	03.7 d
WP	Z	iP	04.4 d

C&GS card 92-64:
17:40:57.4
0.1° S., 122.9° E.
Northern Celebes
h about 160 km
Magnitude 5.4 (CGS).

November 18

M	Z	iP	14:45:05.4 c
D	Z	iP	04.6 c
Hi	Z	eP	06.3 c
Ka	Z	eP	04.4 c
Ke	Z	eP	01.3 c
Ha	Z	eP	03.5 c
U	PEN	eG	15:00:13
U	PEZ	iR	15:03:05

C&GS card 92-64:
14:34:54.5
6.0° S., 148.2° E.
New Britain region
h about 49 km
Magnitude 6.1 (CGS)
6.25 (HVO).

November 19

M	Z	iP	23:45:09.0 c
A	Z	eP	09.3 c
D	Z	eP	08.1 c
MP	Z	eP	09.5 c
Hi	Z	eP	11.1 c
Ke	Z	iP	05.8 c
U	PEN	iS	23:53:16
U	PEN	iG	23:59:24
U	PEZ	iR	00:02:16

C&GS card 95-64:
23:35:06.0
6.0° S., 150.8° E.
New Britain region
Slight damage at Walindi
h about 3 km
Magnitude 6.75 (Pas)
6.75 (Brk)
6.0 (CGS), 6.7 (HVO).

November 20

M	Z	eP	23:42:13.9
MP	Z	eP	15.4
U	PEN	eG	23:54:52
U	PEZ	eR	00:00:24

C&GS card 93-64:
23:33:08.9
44.6° N., 149.7° E.
Kurile Islands
h about 33 km
Magnitude 5.6 (CGS), 6.2 (HVO).

November 21

A	Z	eP	02:28:35.4 d
MP	Z	eP	36.0 d

C&GS card 95-64:
02:16:44.5
1.0° N., 124.0° E.
Northern Celebes
h about 248 km
Magnitude 5.8 (CGS).

November 22, 1964

M	Z	iP	02:45:45.0 d
A	Z	iP	44.6 d
MP	Z	iP	45.0 d
Pa	Z	eP	46.7 c
Na	Z	iP	41.2 c
Hi	Z	iP	02:45:47.4 c
Ke	Z	iP	42.7 c
NB	Z	iP	44.5 d
Ha	Z	iP	49.7 c

C&GS card 94-64:
02:38:29.0
17.9° S., 178.5° W.
Fiji Islands region
h about 563 km
Magnitude 5.0 (CGS).

November 23

M	Z	eP	22:27:58.4 d

C&GS card 92-64:
22:15:47.0
0.1° S., 124.5° E.
Molucca Sea
h about 66 km
Magnitude 5.7 (CGS).

November 24

M	Z	iP	12:52:48.3 c
D	Z	iP	48.3 c
MP	Z	iP	48.9 c
U	Z	eP	48.7 c
Pa	Z	eP	51.9 c
NB	Z	eP	48.0 c
U	PEE	eS	13:02:34
U	PEZ	eSS	13:07:21
U	PEZ	iR	13:15:41

C&GS card 93-64:
12:40:51.4
13.1° N., 124.7° E.
Luzon, Philippine Islands
h about 5 km
Magnitude 6.1 (CGS)
6.9 (HVO).

November 25, 1964

M	Z	iP	09:35:42.9 d
A	Z	iP	42.8 d
D	Z	eP	42.1 d
MP	Z	iP	43.3 d
U	Z	eP	43.1 d
NB	Z	eP	41.6 d

C&GS card 94-64:
09:24:08.9
4.3° S., 122.2° E.
Celebes
h about 610 km
Magnitude 6.2 (CGS).

November 27

M	Z	eP	13:57:47.2 d
D	Z	eP	47.5 d
Na	Z	iP	48.5 d

C&GS card 93-64:
13:47:42.7
37.9° N., 138.3° E.
Near west coast of Honshu, Japan
h about 36 km
Magnitude 5.5 (CGS).

November 30

U	PEN	eG	13:11:44
U	PEZ	eR	13:16:44

C&GS card 95-64:
12:27:38.6
6.8° N., 94.8° E.
Nicobar Islands region
h about 33 km
Magnitude 6.5-6.75 (Pal), 5.7 (CGS).

November 30

M	Z	eP	19:01:11.7 d
WP	Z	eP	11.6 d
MP	Z	eP	11.3 d
Hi	Z	eP	14.5 d

C&GS card 98-64:
18:53:11.4
24.0° S., 179.9° E.
South of Fiji Islands
h about 550 km
Magnitude 5.5 (CGS).

November 30

M	Z	iP	22:47:37.2 d
A	Z	iP	38.2 d
D	Z	iP	38.2 d
NP	Z	iP	37.7 d
WP	Z	iP	37.9 d
MP	Z	iP	38.2 d
U	Z	iP	37.6 d
Hi	Z	eP	35.1 d

C&GS card 94-64:
22:40:46.0
53.7° N., 167.7° W.
Fox Islands, Aleutian Islands
h about 69 km
Magnitude 5.0 (CGS).

December 2

M	Z	eP	13:26:34.5 c
A	Z	eP	36.3 c
D	Z	eP	36.8 c
MP	Z	eP	37.0 c
U	Z	eP	35.9 c

C&GS card 93-64:
13:18:29.0
53.8° N., 165.4° W.
Fox Islands, Aleutian Islands
h about 35 km
Magnitude 5.0 (CGS).

December 5-6

U	PEZ	eR	00:18:42

C&GS card 94-64:
23:55:59.2
54.0° N., 161.5° E.
Near east coast of Kamchatka
h about 39 km
Magnitude 5.0 (CGS).

December 6

M	Z	eP	04:38:08.0

C&GS card 98-64:
04:27:16
2.3° S., 138.3° E.
West New Guinea
h about 33 km
Magnitude 5.0 (CGS).

December 7, 1964

M	Z	iP	09:08:32.9 c
A	Z	eP	33.0 c
D	Z	eP	32.1 c
WP	Z	eP	33.1 c
U	Z	eP	32.9 c
Pa	Z	eP	35.1 c
Na	Z	iP	30.4 c
Hi	Z	iP	35.4 c
Ka	Z	eP	32.1 c
Ke	Z	iP	29.5 c
NB	Z	eP	31.8 c

C&GS card 98-64:
08:58:43.8
5.4° S., 151.3° E.
New Britain region
h about 54 km
Magnitude 5.5-5.75 (Brk)
6 (Pal)
5.8 (CGS).

December 8

Pa	Z	Tmax	16:52:09

C&GS card 100-64:
16:11:25
45.0° N., 130.1° W.
Off coast of Oregon
h about 28 km
Magnitude 4.3 (CGS).

December 10

M	Z	iP	15:21:06.5 d
A	Z	eP	07.2 d
D	Z	iP	06.8 d
WP	Z	eP	07.2 d
MP	Z	eP	07.9 d
U	Z	eP	07.1 d
Pa	Z	eP	09.0 c
Na	Z	iP	07.3 d
Hi	Z	eP	07.4 d
Ke	Z	iP	04.0 d
NB	Z	eP	06.2 d
Ha	Z	iP	15:20:58.0 c

C&GS card 103-64:
15:11:05.5
40.4° N., 138.9° E.
Eastern Sea of Japan
h about 33 km
Magnitude 6.75-7 (Brk), 6 (Pal),
6.0 (CGS).

December 11, 1964

M	Z	eP	16:14:53.2 c
A	Z	eP	53.9 c
D	Z	eP	53.4 c
Pa	Z	eP	55.1 c
Na	Z	iP	54.0 c
Hi	Z	iP	16:14:53.7 c
Ha	Z	eP	44.8 c

C&GS card 101-64:
16:04:58.2
38.9° N., 130.0° E.
Sea of Japan
h about 550 km
Magnitude 5.6 (CGS)

December 12

Pa	Z	Tmax	21:58:24
NB	Z	Tmax	21:59:05
Ha	Z	Tmax	21:58:15

C&GS card 99-64:
21:17:21.0
40.3° N., 125.1° W.
Off coast of northern California
h about 33 km
Magnitude 3.5 (Brk).

December 13

M	Z	eP	00:41:43.4 c

C&GS card 102-64:
00:33:24.7
64.9° N., 165.7° W.
Alaska
Felt: Nome
h about 15 km
Magnitude 6 (Pal)
5.4 (CGS).

December 15

M	Z	iP	05:18:19.9 d
A	Z	eP	20.2 d
D	Z	eP	19.2 d
MP	Z	eP	20.2 d
U	Z	eP	20.2 d
NB	Z	eP	18.7 d

December 15--Continued

C&GS card 99-64:
05:06:22.8
2.3° N., 126.6° E.
Molucca Passage
h about 45 km.

December 15

A	Z	eP	12:23:25.8 d
D	Z	eP	26.8 d
MP	Z	eP	25.5 d
Hi	Z	eP	24.3 d

C&GS card 101-64:
12:13:25.8
14.7° N., 91.7° W.
Guatemala
h about 118 km
Magnitude 5.4 (CGS).

December 16

M	Z	iP	04:07:07.8 c
A	Z	iP	07.9 c
NP	Z	iP	07.9 c
WP	Z	iP	07.8 c
MP	Z	iP	08.4 c
U	Z	eP	07.9 c

C&GS card 101-64:
03:57:17.2
21.6° S., 169.6° E.
Loyalty Islands region
h about 44 km
Magnitude 4.3 (CGS).

December 17

D	Z	iP	05:27:57.4 d
WP	Z	iP	57.6 d
Pa	Z	eP	59.1 d

C&GS card 101-64:
05:18:34.8
45.4° N., 150.1° E.
Kurile Islands
h about 17 km
Magnitude 5.3 (CGS).

December 17-18, 1964

U	PEZ	eR	00:01:11

C&GS card 102-64:
23:44:46.2
51.4° N., 177.9° W.
Andreanof Islands, Aleutian Islands
h about 57 km
Magnitude 5.5 (CGS).

December 22

M	Z	iP	08:13:17.4	d
A	Z	iP	16.7	d
D	Z	iP	17.3	d
WP	Z	iP	16.8	d
Pa	Z	iP	14.9	c
Hi	Z	iP	15.5	d
Ka	Z	eP	18.5	d
NB	Z	iP	18.7	d

C&GS card 102-64:
08:01:12.6
18.4° N., 68.8° W.
Mona Passage
Felt widely on Puerto Rico
h about 115 km
Magnitude 6 (Pas)
5.6 (CGS).

December 24

M	Z	eP	18:55:17.9	c
D	Z	iP	17.8	c

C&GS card 105-64:
18:45:45.5
4.4° S., 153.1° E.
New Ireland region
Felt: Rabaul and Londolouit
h about 93 km
Magnitude 6.1 (CGS).

December 26

M	Z	iP	14:39:05.5	c
D	Z	iP	06.7	c
NP	Z	iP	05.8	c
MP	Z	iP	07.1	c
U	Z	iP	06.1	c
Pa	Z	iP	07.2	c
Na	Z	iP	07.7	c
Hi	Z	iP	05.4	c
Ka	Z	eP	00.5?c	
Ke	Z	iP	02.4	c
Ha	Z	iP	14:38:54.3	c

C&GS card 104-64:
14:30:29.1
51.8° N., 156.8° E.

December 26--Continued

C&GS card--Continued
Kamchatka
h about 136 km
Magnitude 5.7 (CGS).

December 28

M	Z	iP	16:23:55.6	c
A	Z	iP	55.5	c
D	Z	iP	55.1	c
NP	Z	iP	55.7	c
WP	Z	iP	55.7	c
MP	Z	iP	56.0	c
U	Z	iP	55.9	c
Na	Z	iP	52.5	c
Hi	Z	iP	57.2	c
Ka	Z	iP	56.8	c
Ke	Z	iP	52.8	c
NB	Z	eP	55.4	c
Ha	Z	iP	54.3	c
U	PEZ	epP	16:25:41	
U	PEZ	esP	16:26:55	
U	PEE	eS	16:30:11	
U	PEE	eScS	16:32:53	
U	PEE	isS	16:33:29	
U	PEE	iG	16:36:41	

C&GS card 104-64:
16:16:11.0
22.1° S., 179.6° W.
South of Fiji Islands
h about 611 km
Magnitude 6.25-6.5 (Pas)
6.2 (CGS).

December 30

Pa	Z	Tmax	10:33:04	

C&GS card 105-64:
09:26:40
9.6° S., 109.1° W.
Northern Easter Island Cordillera
h about 33 km
Magnitude 4.5 (CGS).

December 30

Pa	Z	Tmax	11:04:16	

C&GS card 105-64:
09:58:01
8.7° S., 109.3° W.
Northern Easter Island Cordillera
h about 33 km
Magnitude 4.6 (CGS).

December 30, 1964

M	Z	iP	15:37:06.9	d
D	Z	iP	07.1	d
NP	Z	iP	07.5	d
WP	Z	iP	07.5	d
MP	Z	iP	08.2	d
U	Z	iP	07.1	d
Pa	Z	iP	09.5	d
Na	Z	iP	06.6	c
Hi	Z	iP	07.5	c
Ka	Z	eP	02.5	d
Ke	Z	iP	03.4	d
NB	Z	iP	06.0	d

C&GS card 104-64:
15:27:25.8
31.3° N., 138.8° E.
South of Honshu, Japan
h about 261 km
Magnitude 5.4 (CGS).

December 30

M	Z	iP	21:38:56.0	d
D	Z	eP	54.8	d
WP	Z	iP	55.4	d
NP	Z	iP	55.3	d
MP	Z	iP	55.2	d
Pa	Z	iP	56.9	c
Ka	Z	iP	58.3?c	
NB	Z	iP	54.9	d

C&GS card 105-64:
21:30:58.8
23.3° S., 179.9° W.
South of Fiji Islands
h about 547 km
Magnitude 5.2 (CGS).

The following persons or agencies reported "felt" earthquakes during the 4th quarter, 1964. Their assistance is gratefully acknowledged.

Mauna Loa summit area

Mr. W. Francis
Mr. R. Decker
Mr. A. Yamamoto

Kilauea summit area

Mrs. C. Wentworth
Mr. A. Yamamoto
Mr. R. Decker
Mr. D. Peck
Mrs. B. Sumner
Mr. and Mrs. G. Yong
Mr. and Mrs. J. Hanson
Miss M. English
Mrs. M. Gorder
Mr. H. Mist

North Hawaii

Mr. R. Eklund
Mrs. P. Richards
Mr. A. Walker
Mr. Y. Kojima

Kona

Miss A. Greenwell
Mr. R. Apple
Mr. M. Sutherlund
Miss N. Wallace
Mrs. C. Higashihara

Kau

Mrs. Hunter
Mrs. A. Paiva
Mrs. P. Billings
Rev. D. Thompson
Mrs. Carvalho
Mr. W. Meinecke
Mr. E. Ross
Mrs. C. Ashton

Hilo region

Miss E. Patton
Mr. J. Bryan
Mrs. B. Shaffer
Hilo Police Station
Civil Defense Office
Mr. H. Pierce
Mr. J. Chang
Mr. Walker
Mr. H. Lewis
Mr. E. Crumb
Mr. S. Ho
Mr. R. Baldwin

Puna

Mr. R. Edwards
Mr. H. Warner
Mr. K. Kimura
Mr. C. Guerino
Mr. E. Ross
Mr. R. Williamson

Publications of special interest and
HVO numbered contributions, 1964

Decker, R. W., 1963, Magnetic studies on Kilauea Iki lava lake, Hawaii: Bull. Volcanol., Tome XXVI, p. 23-35. (HVO Contr. 187.)

Koyanagi, R. Y., 1964, Hawaiian seismic events during 1962, in Short papers in geology and hydrology: U.S. Geol. Survey Prof. Paper 475-D, p. D112-D117. (HVO Contr. 183.)

_____1964, Seismicity of the lower east rift zone of Kilauea Volcano, Hawaii, January 1962-March 1963, in Geological Survey Research 1964: U.S. Geol. Survey Prof. Paper 501-C, p. C103-C105. (HVO Contr. 188.)

Krivoy, H. L., and Eppley, R. A., 1964, T-phase of May 11, 1962, recorded in Hawaii, in Geological Survey Research 1964: U.S. Geol. Survey Prof. Paper 501-B, p. B105-B107. (HVO Contr. 185.)

Macdonald, G. A., and Eaton, J. P., 1964, Hawaiian volcanoes during 1955, U.S. Geol. Survey Bull. 1171, p. 1-170.

Moore, J. G., 1964, Giant submarine landslides on the Hawaiian ridge, in Geological Survey Research 1964: U.S. Geol. Survey Prof. Paper 501-D, p. D95-D98. (HVO Contr. 189.)

Moore, J. G., and Krivoy, H. L., 1964, The 1962 flank eruption of Kilauea Volcano and structure of the east rift zone: Jour. Geophys. Research, v. 69, no. 10, p. 2033-2045. (HVO Contr. 184.)

Peck, D. L., Moore, J. G., and Kojima, George, 1964, Temperatures in the crust and melt of Alae lava lake, Hawaii, after the August 1963 eruption of Kilauea Volcano--A preliminary report, in Geological Survey Research 1964: U.S. Geol. Survey Prof. Paper 501-D, p. D1-D7.

Richter, D. H., Ault, W. U., Eaton, J. P., and Moore, J. G., 1964, The 1961 eruption of Kilauea Volcano, Hawaii: U.S. Geol. Survey Prof. Paper 474-D, p. D1-D34. (HVO Contr. 186.)