PREFACE

The Volcano Letter was an informal publication issued at irregular intervals by the Hawaiian Volcano Observatory (HVO) during the years 1925 to 1955. Individual issues contain information on volcanic activity, volcano research, and volcano monitoring in Hawaii. Information on volcanic activity at other locations is also occasionally included.

To increase accessibility of this resource, previously only available in print format, this compilation was scanned from the highest quality Volcano Letter originals in the HVO archives. Optical Character Recognition (OCR) was run on the entire file. In addition, the file size was reduced by making it compatible with only Adobe Reader v. 8 and later. The scanning was done by Jim Kauahikaua and the quality control and posting was done by Katie Mulliken, both current staff at the Hawaiian Volcano Observatory.

Originals of the first three Volcano Letters could not be found so copies plus the Title Page and Index for 1925 have been extracted from an excellent scan of Volcano Letters for 1925 to 1929 available in Books.Google.com

The Volcano Letter was published by HVO through multiple changes in administration, including the Hawaiian Volcano Research Association (1925-1932), the U.S. Geological Survey (1932-1935), the Department of the Interior (1935-1938), and the University of Hawai‘i (1938-1955). Issues 1–262 were published weekly from January 1, 1925, to January 2, 1930, and consisted of a single page of text. Issues 263–384, also published weekly, from January 9, 1930–May 5, 1932, were generally longer—four-pages—and provided more detail on volcanic activity, including photographs, maps, and plots. Weekly issues 385–387, published May 12–26, 1932, were a single page of text due to budget reductions brought on by the Great Depression. Budget restrictions reduced the publishing frequency to monthly for issues 388–428, covering the period of June 1932 to October 1935; these issues were generally shorter, 1–2 pages, and sometimes featured figures. From November 1935 to July 1938, issues 429–461 remained monthly but increased in length (generally eight pages) and featured figures frequently. Issues 462–530, published over the period of August 1938–December 1955, varied in length from 2–15 pages, but were published quarterly, rather than monthly.

Six of the letters are misnumbered:
Jan. 21, 1926 number is 55 though it should 56
July 29, 1926 number is 82 though it should be 83
Feb. 16, 1928 number is 161 though it should be 164
May 31, 1928 number is 197 though it should be 179
Nov. 29, 1928 number is 204 though it should be 205

For background information on the Hawaiian Volcano Observatory: https://pubs.usgs.gov/gip/135/

The Volcano Letter publications are also available in print:

Fiske, R.S., Simkin, T., and Nielsen, E.A., eds.,1987, The Volcano Letter, No. 1-530. See https://www.si.edu/object/siris_sil_328087

April 2023

The Volcano Letter

No. 419—Monthly U. S. Geological Survey, Hawaii National Park JANUARY, 1935

KILAUEA REPORT FOR JANUARY, 1935

Including weekly press reports 1198 to 1202
December 30, 1934, to February 3, 1935, midnight
Section of Volcanology, U. S. Geological Survey
T. A. Jaggar. Volcanologist in Charge

VOLCANOLOGY

The general situation in the Halemaumau pit bottom for the month of January shows much volcanic motion centering about Kilauea. The lava floor of September, 1934, is hot and uneasy, snapping noises are heard, the tilts about the pit are rather strong and in new places, the hot fume is increasing at the west edge of bottom of pit, and new cracks have appeared near the rim.

Slides at Halemaumau

January 1, forenoon, a few rocks heard falling at the north. January 2, after the strongish earthquake of 6:47 a. m. originating under Kilauea, slides were started, and the pit was watched, but no excessive sliding was reported. January 8, a collapsed rim crack south of Halemaumau indicated recent motion. January 13, at 10 a. m., a slide occurred southwest. January 14, at 9:37 a. m. rocks fell at the east. January 18, at 2:15 p. m., and at 2:30 p. m. lasting a half-minute, slides were reported. January 21, at 9:05 a. m., a fall of rocks occurred near the SW tunnels. January 22, at 9:30 a. m., after a faint booming noise, a few rocks fell, and at 10:09 a. m., a moderate slide occurred south, after other noises. Seven slides occurred in one half hour period. January 26, the excessive sliding on the SSW wall made a streak of dust to the bottom, where fresh debris lay on the south talus and floor; the falls had started 100 feet below the edge. January 27, small slides at the SSW wall occurred twice in the hour 8:40 - 9:40 a. m. January 29, a few rocks fell prior to 10 a. m. January 31, between 9 and 9:20 a. m., a few rocks fell NW and E. A track of a recent slide lay on NW wall through the middle of the 1934 lava cascades. February 3, in the forenoon dust rose from east wall; the slides there were renewed 12:40 p. m., 12:50 p. m., dwindling to 1:05 p. m.; slight sliding occurred continuously 1:30 to 2:30 p. m. The location was above the east talus. There was some sliding at south wall also.

Sounds in Halemaumau

January 1, a clanking noise was heard twice, seeming to come from the 1934 lava lake cup. January 14, at 9:40 a. m. a snap was heard toward the north. January 18, two cracking sounds were heard after 2:30 p. m. January 22, at 9:02 a. m. a loud boom was heard, a faint sound at 9:30, and dull sounds from the east end of the lake cup came at 9:41; at 9:45 a dull sound seemed to come from the bottom of SE wall; again at 9:56 from the SW bay; and from the NW part of the floor at 9:58 a. m.; slides occurred during this half-hour. January 25. One snap was heard NW. January 27, eleven snapping noises were counted between 8:43 and 9:02 a. m., averaging one every 1.7 minutes. The sound is like the blow of an underground hammer. The south wall was sliding slightly. January 31, 9 to 9:20 a. m., some dull thudding noises were noted, and a hissing noise was heard from the SW bay.

Solfataras, at Halemaumau

January 1, five fuming places were noted, at the E, NE, N, and NW taluses, and at the Yellow Solfatara, a vent at the northern base of the west cascades of 1934. January 8, with very heavy rains, there were thousands of steam jets on the hot floor, but not at the lake cup. The heaviest steam jets were at the Yellow Solfatara, and at NW and E taluses. January 10, after more rains, the fume over Halemaumau appeared dense. January 14, after rain, 19 places were steaming or fuming inside the pit. There were hot dry places at the base of talus slopes, which are heaps of broken bowlders extending down under the 1934 lava fill to a depth of 600 feet, and these are porus filters for hot gas. January 17, at noon, with strong southwest wind, the fume from the pit did not show. The vapor jets on the outer floor of Kilauea crater at the north, during such wind, are nucleated by invisible fume from the pit, and show scores of white jets. January 21, the yellow solfatara was strongly fuming. January 25, the heap of sulphur-stained sulphates at the Yellow Solfatara had increased and been washed by rain, and fume was still more voluminous. The solfataric bank on the NW talus showed pink, red, yellow, white and gray salts, with vapors presumably rotting the 1934 pumice, suggesting the Red Solfatara of 1921. January 29, with southwest wind blowing, both fume and vapor were moderate in amount in Halemaumau.

The cracks in the floor of Halemaumau, and elsewhere, were observed as follows:—

January 2, after the earthquake, the cracks and swellings of the floor showed some new features. January 11, new cracks were reported at the tourist stand SE. January 12, cracks were reported newly breaking the curb masonry 450 feet back from the rim of Halemau SE. January 19, this crack in the masonry at the pit measured 3 mm. January 21, the radial cracks on the floor southeast appear widening. One cross-crack has formed in the south floor. The marginal ridge in the floor all around exhibits large gaping cracks. January 25, eleven cracks radial from the cup were counted on the eastern half of the floor, and five or six more are on the western half.

Weekly measurement of 32 marked rim cracks around Halemaumau, resulted as follows:

Week ending forenoon

Jan. 5,	15 opened,	3 closed,	aggregate opening	12 mm.
Jan. 12,	8 opened,	5 closed,	aggregate opening	1.5 mm.
Jan. 19	12 opened,	1 closed,	aggregate opening	7 mm.
Jan. 26,	5 opened,	7 closed,	aggregate closing	0.5 mm.
Feb. 2,	14 opened,	2 closed,	aggregate opening	8 mm.

T. A. J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Moderate earthquakes	Distant earthquakes	Local * Seismicity
Jan. 6	72	10	1	2	26.00
Jan. 13	26	3	0	0	8.00
Jan. 20	14	3	0	0	5.00
Jan. 27	18	5	0	1	7.00
Feb. 3	29	4	0	0	9.25

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated. The location of epicenters is based on three main

seismograph stations, Kilauea, Hilo and Kona. The intensity is that recorded on the Kilauea instruments.

Dec. 31, 1934, at 10:40 p. m. very feeble, was SW of Kilauea crater lat. 19° 21′ N long. 155° 19′W 12 mi. deep. It was reported felt near Kilauea crater.

Jan. 2, 1935, at 6:47:17 a. m. moderate, was under the Uwekahuna rim of Kilauea crater. 19° 25.5′ N 155° 17′ W. 2 mi. deep. Reports indicated that it was felt generally over the island of Hawaii, objects fell in Hilo, and a landslip was started in Halemaumau.

Jan. 8 at 2:09 p. m. very feeble, was near Kulani cone 19° 31′ N 155° 17′ W.

Jan. 13 at 1:33 p. m. very feeble, was 3 miles ENE of the Observatory 19° 26′ N 155° 13′ W and 4 mi. deep.

Jan. 17 at 11:35 a. m. very feeble, was probably at sea SE of the island, near 19° 15′ N 155° 0′ W.

Jan. 17 at 10:58 p. m. very feeble, was near Wood Valley, 19° 20′ N 155° 30′ W. It was reported felt at Kapapala Ranch near the epicenter.

Jan. 19 at 5:49 a. m. a tremor, was in Kilauea crater, probably near Byron's Ledge.

Jan. 21 at 0:02 a. m. very feeble, occurred 35 miles deep under the east slope of Mauna Kea, 19° 44′ N 155° 22′ W. It was reported felt along the NE coast of Hawaii.

Jan. 27 at 7:23 p. m. very feeble, was 30 miles deep under Puu Ulaula rest house on the Mauna Loa NE rift zone, 19° 31′ N 155° 29′ W.

Jan. 29 at 4:01 p. m. very feeble, was probably under the summit crater of Mauna Loa.

Jan. 29 at 6:41 p. m. a tremor, was probably near the Kealakekua Bay fault. It was felt and well recorded in Kona.

Jan. 30 at 9:51 p. m. very feeble, was probably on the chain of craters 7 miles SE of Kilauea.

Feb. 3 at 4:21 p. m. very feeble, was 2 miles ENE of Kilauea crater, 19° 26′ N 155° 14′ W, near the epicenter of Jan. 13.

The preliminary waves of a teleseism began recording at 8:16:50 a. m. Dec. 31, 1934. The secondary waves were missing, the long waves were missing, the long waves began to record at 8:32:08 a. m. It was about 3,400 statute miles distant.

The preliminary waves of a teleseism began at 2:58:12 a. m. Jan. 1, 1935. The secondary waves began at 3:03:49 a. m. It was about 2,500 miles distant.

The long waves of a poorly recorded teleseism began at 9:08 p. m. Jan. 22. The distance was unknown.

Microseisms were abnormal Jan. 2, 3, 4, 5, and Jan. 17 to Feb. 3. They were normal Jan. 6, 7, 9, 10, 12. 13, 14, 15, and 16; and subnormal the remainder of the time.

A. E. J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea Crater; at Halemaumau, the readings from each clinoscope, and the algebraic sum of radial tilts for the three clinoscope cellars, towards or from the center of the pit.

At the Observatory the total accumulated tilt in the year ending February 3, 1935 is 2.3″ N and 0.2″ W.

TABLE OF TILT

Week Ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
Jan. 6	0.8″ N 28° E	23.6″ S 28° E	28.1″ S 16° W	160.0″ N 20° W	185.0″ toward*
Jan. 13	1.7″ S 66° W	7.3″ S 71° W	7.7″ N 12° W	3.4″ S 4° E	2.9″ toward
Jan. 20	2.2″ S 52° W	2.3″ S 26° W	2.8″ N 25° W	33.6″ S 17° W	20.4″ from
Jan. 27	1.4″ S 55° W	5.1″ N 86° E	1.9″ N 58° W	4.3″ S 3° E	4.4″ from
Feb. 3	1.0″ S 3° W	6.3″ N 25° E	2.2″ N 23° E	9.2″ N 4° E	5.3″ toward

* Southeast station dismantled by earthquake of January 2, 1935.

A. E. J.

The Volcano Letter

No. 420—Monthly U. S. Geological Survey, Hawaii National Park FEBRUARY, 1935

KILAUEA REPORT FOR FEBRUARY, 1935

Including weekly press reports 1203 to 1206
February 3 to March 3, 1935, midnight
Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

VOLCANOLOGY

The month has produced local shakings close to Kilauea, some easterly tilt which suggests tumescence and is abnormal for this season, and small slides from the walls of Halemaumau pit. Many small earthquakes at the Halemaumau seismograph, are mere tremors at the Observatory near Volcano House.

Slides at Halemaumau

February 4, occasional rock falls all day, including one in SW corner of the pit at 5:09 p m. February 5, the scar of this slide was obvious, and rocks were falling there at 9 a. m. Other falls of rock were heard NE, the East wall and talus had been changed. About 7 p. m. a slide was reported. Feb. 6, rocks were heard falling NE and SW. Feb. 9, all the sliding areas appeared freshly disturbed, fallen stones lay on the 1934 floor SE, and the scar of a fresh slide marked the wall halfway up, at the east Feb. 10, at 9:30 a. m. rocks fell at the S wall, and along the swollen monoclinal ridge at the margin of the 1934 lava floor, fallen bowlders lay on the crest of the arched crust in several places. Opposite all the talus slopes there is now fresh fallen debris on the 1934 floor, as result of caving wall matter since the eruption, and at the base of rock walls SE, NE and W NW. Feb. 12, at 9 a. m. a slight rock fall occurred S. After 3:25 p. m. rock slides SE occurred for 30 minutes. At 3:30 a cloud of dust arose from the wall, at 3:40 a larger mass of rock fell from a thin-layered zone near the top, sending a cloud of dust over the floor, and this was followed by rocks slipping for 10 minutes. There were four slides in a half-hour, leaving fresh cracks in the soil back of the edge of the pit, fresh dust on the floor, and a scar on the wall. Feb. 14, about 9 a. m. a tremor and slides were reported, accompanied by the opening of a crack in the floor. Feb. 16, a few rocks fell. Feb. 17, debris had been added to the bases of the east and south taluses, and the eastern floor appeared more swollen and cracked near the east solfatara. Feb. 18, at 9:05 a. m. there was a southern fall of rocks, and at 10:43 a. m. an avalanche fell from half way up the NE wall to the small talus heap. Feb. 25, at 8:52 a m. a fall of rocks occurred NE. Feb. 27, at 11:50 a. m. a small noisy slide fell from the NW buttress. March 1, at 2 a. m. a slide occurred E S E.

Other Phenomena

Feb. 12, there were vaporings at south talus and wall, at west talus and the cascade wall, at the wall west of southwest tunnels; voluminous fume rose from the Yellow Solfatara NW, and there were many small fume jets at the floor edge under the NNW talus. It was a misty forenoon of high humidity after moderate rain, but for no obvious reason the northwest region had suddenly developed excessive vapor and fume, and these had diminished in the east part of the Halemaumau floor. February 17 in cold dry weather hot vapor and fume were very slight, but they had developed at the small NE talus. The vapor and fume certainly fluctuate with the rainfall; during very heavy rains about February 23 deuse clouds of vapor rose from the pit, originating in the symmetrical semi-circle of five fuming talus slopes around the lava-lake oval, or cup, which was the last active pool of lava of October 1934. In the morning light of February 25 the floor cracks around the edges appeared to have increased their gaping, and the crescent of stain in front of the NNW talus—the site of the pumice bank of the largest fountains of September 6, 1934—had definitely become a depression. There is an arc of cracks in front of it, and the floor still farther in front is a plateau; everywhere the floor is a swollen plateau above the wall-valley. The cracks at the edge of the floor plateau are tensional chasms, parallel to the strike of a monoclinal bend which dips down to the floor margin.

Rim Cracks

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau resulted as follows:

Week ending forenoon:

Feb. 9, 7 opened, 3 closed, aggregate opening 2.5 mm.
Feb. 16, 10 opened, 2 closed, aggregate opening 5.0 mm.
Feb. 23,* 16 opened, 4 closed, aggregate opening 9.0 mm.
Mar. 2,* 9 opened, 4 closed, aggregate opening 3.5 mm.

* Measured partly Feb. 24, because of heavy rains.

Noises

Thudding noises from the bottom of Halemaumau were heard at 8:58 a. m. and 9:02 a. m. February 12, a clanking was heard at the base of east wall at 10:10 a. m. Feb. 17, and a snapping noise NE at 11:05 a. m. that day, and again Feb. 25 at 8:40 a. m. T. A. J.

EARTHQUAKES

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Slight earthquakes	Distant earthquakes	Local * Seismicity
Feb. 10	28	6	1	0	0	11.00
Feb. 17	15	0	1	0	0	4.50
Feb. 24	46	5	1	0	1	15.00
Mar. 3	67	4	0	1	0	20.75

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated The location of epicenters is based on three main seismograph stations, Kilauea, Hilo, and Kona. The intensity is that recorded on the Kilauea instruments.

Feb. 4 at 7:45 p. m feeble, occurred under the west wall of Kilauea crater, under Uwekahuna. Reported felt near Kilauea crater.

Feb. 5 at 0.20 a. m. very feeble, occurred under the NE wall of the crater near the Observatory.

Feb. 11 at 3:59 a. m. very feeble, occurred under Mauna Loa, lat. 19° 26′ N long. 155° 28′ W 16 miles deep.

Feb. 15 at 6:12 p. m. very feeble, occurred 2 miles SE of Kilauea crater.

Feb. 20 at 9:27 a. m. feeble, occurred near the junction of the SW rift and the SW crater wall.

Feb. 21 at 1:21 p. m. very feeble, occurred in the crater, east of the Pit.

Feb. 21 at 8:56 p. m. very feeble, occurred outside of Kilauea crater near Keanakakoi crater.

Feb. 26 at 2:10 a. m. slight, occurred 5 miles deep under N rim of Kilauea.

Feb. 27 at 1:11 p. m. very feeble, near Keanakakoi crater.

Feb. 28 at 5:39 p. m. very feeble, reported felt at Naalehu, located on the Mauna Loa SW rift, near 19° 10′ N 155° 45′ W.

Mar. 3 at 11:11 p. m. tremor, near SW wall of Kilauea crater.

Feb. 22 the preliminary waves of a small teleseism began recording at 6:43:58 a. m. the secondary waves began at 6:50:20 a. m.

Microseismic motion was abnormal Feb. 11, 12, 13, 14, 15, 16, 17. normal Feb. 4, 6, 18, 20, 21, 24, 27, 28, Mar. 1 and 2. and subnormal during the other days of the period.

A. E. J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea crater; and at Halemaumau the readings from each clinoscope and the resultant of radial tilts for the three clinoscopes, towards or from the center of Halemaumau Pit.

At the Observatory the total accumulated tilt for the year ending March 3, 1935 is 3.5″ N and 4.1″ E.

TABLE OF TILT

Week ending	Observatory station	Halemaumau Clinoscope Stations			
		North station	West station	SE station	Resultant
Feb. 10	1.3″ S 38° E	1.7″ S 70° W	2.8″ N 6° E	3.5″ N 43° E	1.7″ toward
Feb. 17	0.9″ S 80° E	3.2″ S 52° W	3.3″ N 81° W	5.9″ N 18° E	9.3″ toward
Feb. 24	0.2″ N 40° E	2.6″ N 68° E	5.1″ N 8° E	19.8″ S 9° E	20.5″ from
March 3	1.8″ S 39° W	2.0″ S 75° E	3.1″ S 86° W	14.7″ S 6° W	8.0″ from

A. E. J.

The Volcano Letter

NO. 421—MONTHLY U. S. Geological Survey, Hawaii National Park MARCH, 1935

KILAUEA REPORT FOR MARCH, 1935

Including weekly press reports 1207 to 1210
March 3 to March 31, 1935 midnight

Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

VOLCANOLOGY

The same processes of fuming, snapping, and avalanching from the walls, have continued in Halemaumau pit.

Slides at Halemaumau

March 4, at 9 a. m.; March 5, at 9:10 a. m.; March 6, a few rock falls after 9 a. m. and a slide at northeast corner 9:28 a. m.; March 7, a few rocks falling between 9:20 and 9:30 a. m.; March 8, rocks heard falling about 9:05 a. m.; March 10 debris on the bottom southeast, was in two new places. These are the incidents observed during a half-hour visit to the pit each forenoon.

March 16, debris at the west showed that a slide had occurred. Another slide scar appeared southeast, and other slides had occurred over the east bay, and at the NNE. March 23, at 9:02 a. m. a noisy avalanche reached the floor and sent up dust, at the south corner of the pit; the disturbance broke the rim, where fresh cracks in the soil were found, parallel to the edge of pit, fifteen feet back from the verge, and extending lengthwise more than a hundred feet. Another slide there at 2:25 p. m. made a similar dust cloud, and the noise was heard at a distance. Two other small slides fell from the west and north walls during the next half-hour.

March 28, slides were heard at 9:40 and 10:20 a. m. March 31, it was evident from the Pit seismograms, and from the dust over the south end of the pit floor, that a large slide had fallen at 8:15 p. m. March 30. The scar was from a point 100 feet below the top of the SSW wall, the same area that had been "working" lately. Cracks were widening in the soil above. The disturbance on the Halemaumau seismogram was much larger than on the Observatory record.

Miscellaneous Phenomena

Rainfall reached 7.5 inches in the four days preceding March 6, at the Halemaumau rain-gauge. Vapor plumes on the hot pit floor occasionally united into a dense cloud. At 9 a. m. March 8, an unexplained hissing noise seemed to be at the SW bay, and lasted about 3 seconds; earlier two dull thuds were heard NW and W. There had been five records of pit shocks on the Halemaumau seismogram, during the preceding 24 hours. The day before this there were one or two little shocks. On March 5, there were 8 small earthquakes on the Halemaumau record, only one of which was recorded at the Observatory two miles to the northeast, and that as a mere tremor.

The heavy rains tended to disturb the tilt instruments. However, there is always more intense volcanic tilting, and seismic activity, at the Halemaumau instruments, than at the northeast edge of Kilauea crater where the Observatory stands. This shows how important it is, in volcanology, to study seismically the innermost focus of a crater, in equipping with seismographs such a place as the summit crater of Mauna Loa. That particular crater must be so equipped very soon.

The radial floor crack at the bottom of Halemaumau, trending east, appeared to have widened March 16. The sulphur at the Yellow Solfatara northwest had so increased March 21 that the stain extended out on the floor, and its fume column was noticed at stations behind buttresses on the west rim of the pit, where it had been invisible before. March 25 about 8:40 a. m. two dull detonations were heard about five minutes apart. Three more were heard to the east of the pit between 9:20 and 9:30 a. m.

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau Pit resulted as follows:

Week ending forenoon of

March 9, 7 opened, 4 closed, aggregate opening 2.5 mm.
March 16, 19 opened, 0 closed, aggregate opening 13.5 mm.
March 23, 10 opened, 4 closed, aggregate opening 5.0 mm.
March 30, 11 opened, 5 closed, aggregate opening 3.0 mm.

T. A. J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Distant earthquakes	Local * Seismicity
March 10	22	2	0	6.50
March 17	20	4	0	7.00
March 24	16	2	0	8.00
March 31	20	6	0	8.00

* For local seismicity index see Volcano Letter 371.

The following local very feeble disturances began at the times indicated; the epicenters as shown were located from the seismograms; when possible the depth of the source is indicated. The location of epicenters is based on three main seismograph stations, Kilauea, Hilo, and Kona. For crateral earthquakes, stations at Uwekahuna and Halemaumau are used. The intensity is that recorded on the Kilauea instruments.

March 5 at 5:31 a. m. located one mile deep under the southwest end of Kilauea crater.

March 9 at 1:58 a. m. located half a mile deep under the east side of Halemaumau Pit.

March 20 at 4:48 p. m. felt at Puuwaawaa, but not recorded well enough to be located.

March 24 at 11:29 a. m. felt at Uwekahuna, located 5 miles deep under that wall of Kilauea crater.

March 25 at 0:20 a. m. 3 miles deep under the southwest rift zone, 1 to 2 miles from Kilauea crater.

March 26 at 5:52 p. m. 1 mile deep, 2 miles southwest of Uwekahuna.

March 27 at 0:38 p. m. 1 mile deep under Kaoiki fault, lat. 19° 26′ N, long. 155° 20′ W.

March 28 at 11:48 p. m. 3 miles east of the summit crater of Mauna Loa, lat. 19° 27′ N, long. 155° 34′ W.

March 29 at 2:59 a. m. reported felt in Hilo, not well located.

Microseismic motion of the ground was abnormal March 4, 13, and 16; normal March 7, 14, 15, 18, 19, 20, 22, 24, 25, and 29; and subnormal during the remaining days of the month.

A. E. J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea crater; at Halemaumau the readings from each clinoscope and the algebraic sum of radial tilts for the three clinoscope cellars, towards or from the center of the Pit.

At the Observatory the total accumulated tilt in the year ending March 31, 1935 is 1.1″ N and 0.6″ E.

TABLE OF TILT

Week Ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
March 10	1.4″ S 55° W	2.5″ N 67° W	5.1″ N 82° W	8.7″ S 48° W	6.2″ from
March 17	0.7″ N 67° E	3.3″ S 53° E	1.6″ North	12.8″ N 9° W	12.1″ toward
March 24	2.9″ S 50° W	1.3″ S 68° W	0.9″ S 86° W	4.2″ N 6° E	4.9″ toward
March 31	1.5″ S 12° W	1.8″ S 65° W	3.0″ N 11° E	6.4″ N 50° E	4.9″ toward.

A. E. J.

The Volcano Letter

No. 422—Monthly U. S. Geological Survey, Hawaii National Park APRIL, 1935

KILAUEA REPORT FOR APRIL, 1935

Including weekly press reports 1211 to 1214
March 31 to April 28, 1935 midnight
Section of Volcanology, U. S. Geological Survey
T. A. Jaggar. Volcanologist in Charge

VOLCANOLOGY

The month of April at Halemaumau pit was chiefly remarkable for the partial obliteration of the black, solidified lava cascades of September 6, 1934. This was achieved by avalanching, the upper wall NW falling away April 20, and the rim slab was completely removed in front of the West Steamhole. This west steam crack has been a landmark on the edge of Halemaumau since 1924, sending up white clouds of vapor always visible. The enlargement of the pit by engulfment of the rim rock in front of this crack, for a width of 20 feet lengthwise of the margin for 250 feet, leaves the western wall of the former steam crack merely part of the pit wall. The steam is gone. A few small steam cracks extend from here northward, back of the edge of the pit. The thudding noises in the floor have notably decreased since February.

Slides at Halemaumau

April 2 at 5:07 p. m. a noisy slide fell from the north wall, and coursed through the notch to the talus below, some of the bowlders reaching the floor. April 4 at 11:20 a. m. a small slide fell from the south notch which has been recently working. April 5 the pit was quiet between 5:10 and 5:45 p. m., but at 5:46 a moderate slide fell from the southeast wall north of the Tourist Lookout; this was followed by small slides NE and SSW. April 6 at 9 a. m. the rim of Halemaumau above the SSW scar revealed fresh cracking in the surface of the 1924 ash drifts and in the rock below, for 20 feet back from the edge. The length of the fresh breaks was 165 feet. The block of rim appeared ready to fall. April 7 at 9 a. m. there was slight dribbling of stones down the west wall, and there were southern slides later.

April 8 there was small sliding west and south at 9:30 a. m. April 10 at 9:15 a. m. a moderate slide fell from the southeast wall. April 16 a large slide about 1:30 p. m. fell from the NW buttress athwart the lava cascade locality and above the Yellow Solfatara. April 17 at 8:55 a. m. there was a small slide at the east corner of the pit.

Small quakes accompanying slides were recorded April 18. The next day April 19 slides five times made very feeble earthquake records on seismograms, and a still larger number of tremor records at Halemaumau. Seismograph records of slides thereafter became less frequent.

The working of the cascade rift northwest reached a climax of avalanching at 5:50, 5:53 and 5:55 a. m. April 20, largely sweeping away the black ribbons of lava cascade from the wall. What was left was almost covered by fresh dust. The cascade remnants are at the talus south of the scar (West Talus) and at the Yellow Solfatara on the north of it. There were several small earthquakes during the forenoon. A big slide at 9 a. m. fell over the northern end of the cascade, the larger rocks reaching the floor before the finer material. Marked crack No. 36 at the western rim had opened a little. The air in the pit was charged with vapor and fume, and some dust. A slide at 9:02 a. m. fell from three quarters of the way up the wall, over the north end of the lava cascades.

At 9:50 a. m. April 20 there was a small slide WNW. A small quake rang the annunciator at the Observatory at 1:36 p. m., and four minutes later dust arose from the north side of Halemaumau. There was continuous western sliding all day, with avalanches noted at 3:05, 3:15, and after 6:00 p. m. Rock trickling at the west continued all day April 21.

It was this April 20 crisis that destroyed the big west-rim steam crack, as described in the first paragraph above. The new talus below is large, widening the big west talus northward for 250 feet, and piled above the floor 200 feet. The west talus has been widened farther by recent tumbles of rock east of the SW rift caverns in the wall, so that the whole debris slope is now twice as wide as in August 1934 at the elevation now represented by the bottom contour. Two cascades of solidified lava remain on the main talus cone, as produced on September 6th.

Rocks continued to dribble down the western wall, with few intermissions, until April 28. April 22 slides on that scar were noted at 11:13, 11:17, and 11:25 a. m. and later, making dust clouds. April 23 small slides fell from the NW buttress at 8:50, 9:30 and 9:48 a. m. April 24 at 11:05 a. m., rocks fell at the northeast. April 25 rocks were falling on both east and west sides of Halemaumau. At 10:45 a. m. a large block fell, from 75 feet below the rim, at the east. At 12:47 p. m. a large slide was heard at the Observatory, and sent up a cloud of dust. April 26 at 8:50 a. m. there were steady small slides SSW and NW. April 28 rocks were falling more or less continuously at the western scar, making a noisy avalanche at 8:52 a. m. One slide was heard at the east. At 2:25 p. m. a slide at the northeast wall sent up a thick cloud of dust, followed at 2:32 p. m. by two smaller clouds.

Miscellaneous Phenomena

Fumes rose from the Yellow Solfatara in variable amounts. There are four other fuming places at the north and east edges of the floor. April 20 fume was more conspicuous at the NNW talus than at the East talus. During the small WNW slide of 9:50 a. m. that day there was hardly any fume at the East talus; ten minutes later it puffed fume. April 26 white vapor was variable at the three taluses W, S, and SE.

Levelling

Spirit levelling at the Halemaumau rim April 25 by A. E. Jones, using as base the bench-mark at the southern gravel ridge of Kilauea crater (Spit), determined that points on the rim of Halemaumau, since April 3, 1935, had been elevated about 1 cm. or less.

The eruption of September 1934, by this datum, (Volcano Letter 416) had shown elevation 39 cm. of the north rim, and depression each side of the raised area. This April lift is the first movement of elevation since the eruption.

Thus during the week prior to April 3, the levelling of that date had shown lowering of from 1 to 3 cm. since March 27. On March 27 there had been lowering in the 5½ months since October of from 4 to 7 cm. This makes the April 25 elevation a distinct change of habit, probably indicative of renewed lava pressure.

Rim Crack Measurements

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau pit, resulted as shown in the tabulation that follows.

This indicates a notable disturbance of the entire pit by the breakdown on April 20 of the western wall, followed by quiet. A similar crack-opening, aggregating 13.5 mm., affecting 19 cracks, occurred on March 16, during the avalanching of that month. There were other maxima January 5, February 2 and February 23. These were the months of snapping noises and of numerous slides. They were also months of lowering rim.

Week ending forenoon of

April 6, 12 opened, 6 closed, aggregate opening 6.5 mm.
April 13, 11 opened, 3 closed, aggregate opening 5.0 mm.
April 20, 16 opened, 1 closed, aggregate opening 12.0 mm.
April 27, 7 opened, 5 closed, aggregate opening 2.0 mm.

T. A. J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Distant earthquakes	Local * Seismicity
April 7	61	2	0	16.25
April 14	44	1	0	11.50
April 21	38	8	0	13.50
April 28	55	1	0	14.25

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated. The location of these three very feeble shocks is based on the main station at Kilauea Observatory and two subsidiary stations around the crater. The intensity is that recorded on the Kilauea instruments.

April 3 at 9:34 a. m. 4 miles deep under Kilauea southwest rift zone; lat. 19° 23′ N, long. 155° 19′ W.

April 20 at 1:10 a. m. 2 miles deep under Kaoiki Pali rift, 19° 21′ N, 155° 18′ W.

April 20 at 5:53 p. m. 1 mile deep under Waldron's ledge, part of the east rim of Kilauea crater.

April 22 at 0.18 p. m. an earthquake was felt at Hakalau, it recorded as a tremor at the Observatory.

Microseisms were normal April 10 to 14, and subnormal the remainder of the period. A. E. J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea Crater; at Halemaumau, the readings from each clinoscope, and the algebraic sum of radial tilts for the three clinoscope cellars, towards or away from the center of the Pit.

At the Observatory the total accumulated tilt in the year ending April 28, 1935 is 2.4″ N and 0.7″ E.

TABLE OF TILT

Week ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
April 7	0.6″ S 60° E	1.1″ N 7° E	0.3″ N 20° W	4.8″ S 71° E	8.9″ from.
April 14	0.8″ N 39° E	5.9″ N 84° E	4.2″ N 36° W	2.6″ N 32° E	0.2″ toward.
April 21	1.1″ S 66° W	7.9″ N 38° E	0.9″ N 66° W	12.2″ S 67° E	17.4″ from.
April 28	0.8″ N 86° W	1.7″ S 12° W	1.9″ S 31° W	1.1″ N 32° E	3.1″ toward.

A. E. J.

The Volcano Letter

No. 423—Monthly | U. S. Geological Survey, Hawaii National Park | MAY, 1935

KILAUEA REPORT FOR MAY, 1935

Including weekly press reports 1215 to 1219
April 29 to June 2, 1935 midnight
Section of Volcanology. U. S. Geological Survey
T. A. Jaggar. Volcanologist in Charge

The month of May was like April in making critical changes in the wall of Halemaumau by avalanching, but transferring the sliding activity to the south and east corners. The opening of rim cracks also reached a maximum about the middle of the month, followed by immediate diminution.

Slides at Halemaumau

The first week was notable for much sliding from E and S. walls of Halemaumau. April 29, following 8:15 a. m., the SSW scar was sliding, and a stain of dust extended across the floor from it NE. The rim block at the top fell at 9:16 a. m., making a noisy avalanche. This was followed by trickling of small stones NW, and one rock fall NE. At 12:35 p. m. April 29 a small slide fell W, and a large one ESE at 12:45 p. m. On April 30 the SSW scar had extended farther west. May 1, from 1:40 to 3:30 p. m. with snapping sounds at intervals of five to 10 minutes, small slides occurred N, and two larger ones there at 3:15 and 3:20 p. m. After dribbling slides in various places on May 2, a heavy dust cloud arose at 5:10 p. m. from a slide at the NE wall. At 9:30 a. m. May 3, a noisy fall of rocks stripped the east buttress, and this was followed by numerous slides there, north and south of the buttress during the next two days. From such slides a small balanced pinnacle was left on top of the buttress at 11 a. m., May 3, and by the next day this had fallen. On May 4, avalanches occurred here at 9:47, 10:02, and 10:10 a. m., and 6:40 p. m. A large avalanche here May 5, about noon, set up a thick dust cloud.

The following slides were noted during the second week: May 6, 9:15 a. m. NE, 9:36 SW and NW, 9:45 NE; a dust streak extended out on the floor from this place. At 9:58 there were slides W and NW, and again for five minutes after 10:05 a. m., making a continuous dribbling of gravel and much dust. Similar dribbling slides SW and NE occurred 8:45 a. m., May 7. May 10 there was small sliding at the SSW and W scars. May 11 the same thing was going on at 8:45 a. m., and with the strong wind continuous dust arose from these western slopes. At 12:25 p. m., a strong landslip sent up much dust ENE. At 6:00 p. m., a strong slide occurred W. Slides May 12 were at 8:50 a. m. W, 9:38 a. m. E, 9:58 W, and at 12:50 p. m., a large dust cloud rose above the west side of the pit and spread out so as to fill the whole pit.

The avalanching declined during the third week. May 13 rocks were falling SW, W and NE.; at 9:38 a. m. an avalanche fell near the SW trig station, west of the SSW scar, where there have been recent opening of cracks and engulfing of the ash soil. It was obvious that this rim block was about to fall. At 12:45 p. m., May 13 an avalanche sent up dust NE, loud noises were heard in the pit at 1:30 and 2:30 p. m., and that these were the roars of avalanches was verified by one occurring May 15, about 5:40 a. m., so loud that it was heard at Volcano House. At 7:20 a. m., May 15, there was another roar and at 7:54 a. m., a big avalanche fell at the eastern edge of the SSW scar. The stage was now set for the falling of the rim block at the western edge of this scar, and this happened at 12:41 p. m., after minor preliminary slides, the shock shaking the seismographs, sending up thick dust, and making a loud roar heard at a distance. This event brought to a close the active working of that part of the Halemaumau rim.

The fourth week ending May 26 was relatively quiet. The only slides noted occasioned dust clouds seen May 20, at 9:55 a. m., and at 3:25 p. m., and on May 21 at noon and at 4:25 p. m.

The week ending June 2 produced spells of more than 15 minutes at a time when no rocks could be heard falling. May 27 at 10:24 a. m., there was a slide at the SSW scar and at 10:25 a. m. a slide fell NW. May 28 to May 31, the pit was quiet, except for a few rocks heard falling but not seen at 9:50 a. m. on the last date.

Halemaumau Floor Solfataras

On May 7 the fume vents at the edge of the floor were active NW and NE, and at 9 a. m. May 9, though the atmosphere was dry there was much fume from the three solfataras NW, N and E. May 28, about 8:45 a. m., five northern vents were fuming, thudding noises were heard twice, and fume was in greatest volume at the Yellow Solfatara NW where it came up puffing. May 30, at 9:10 a. m., after a rainy night, all five fuming places were puffing. May 31, at 9:50 a. m., after only slight rainfall, the five fuming places were inconspicuous.

Changes In Halemaumau Floor

The May avalanching spells built two new talus cones under the SSW scar, and made a pink stain of dust extending out on the floor. At the lower part of the gulch that extends down the wall along a crevasse at the east, above the large eastern talus cone, vapor rises from the wall itself. Here a buttress of fresh grey rock hangs out toward the pit, in the middle part of a new eastern scar. Big bowlders had extended the eastern talus, but none had been able to surmount the marginal ridge of the floor. The marginal valley here is very deep. The chasms in the top of this ridge lengthwise, and the five eastern radial cracks extending across the floor from the lake basin of 1924, appeared more widely open than ever. It is worthy of note that the talus slopes north and northwest, which were the scene of sliding activity in October, 1934 after the eruption, have not been in motion in 1935.

Measurement of Halemaumau Rim Cracks

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau pit, resulted as shown in the tabulation that follows.

Week ending forenoon of

May 4, 11 opened, 3 closed, aggregate opening 6.5 mm.
May 11, 6 opened, 3 closed, aggregate opening 6.5 mm.
May 18, 12 opened, 6 closed, aggregate opening 5.0 mm.
May 25, 5 opened, 3 closed, aggregate opening 2.0 mm.

A large crack in the actual rim of the pit near the southwest trig station opened 23.5 cm in 14 days from April 20 to May 4. T.A.J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Distant earthquakes	Local * Seismicity
May 5	71	9	0	0	22.50
May 12	38	11	0	0	15.00
May 19	41	6	0	0	15.25
May 26	12	1	1	0	4.50
June 2	34	3	0	1	10.00

* For local seismicity index see Volcano Letter 371.

During the first week of May three slides in the Pit were large enough to record on the Observatory seismographs. During the second week five slides made very feeble records, with only one recorded during the third week.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated. The location of epicenters is based on the smaller network of seismograph stations, Kilauea, Uwekahuna, and Halemaumau. The intensity is that recorded on the Kilauea instruments.

May 13 at 1:46 p. m. beginning of a series of five very feeble shocks, not reported felt, lasting until 2:01 p. m. Only two could be located. The second of the series was

located about a mile south of Kilauea crater, not over two miles deep, Lat. 19° 23′ N, Long. 155° 17′ W. The third of the series could only be approximately located, two and a half miles west of Kilauea crater, Lat. 19° 25′ N, Long. 155° 20′ W. They were not recorded on the Hilo and Kona instruments.

May 23, at 1:37 a. m. a feeble shock was felt near Kilauea crater. It was located a mile west of Uwekahuna and five miles deep, Lat. 19° 25.5′ N, Long. 155° 18′ W.

The long waves of the destructive earthquake in Baluchistan began recording at 11:57 a. m. H.S.T. May 20.

Microseismic motion of the ground was normal April 29 and subnormal the remainder of the period. A.E.J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea Crater; and at Halemaumau, the readings from each clinoscope, and the resultant of radial tilts for the three clinoscopes, towards or from the center of Halemaumau Pit.

At the Observatory the total accumulated tilt in the year ending June 2 is 3.6″ N., and 0.5″ W.

TABLE OF TILT

Week Ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
May 5	1.6″ S 64° W	2.8″ N 54° E	5.0″ N 87° W	7.0″ N 45° W	1.7″ from
May 12	1.0″ N 16° E	2.0″ N 15° E	6.8″ N 36° W	5.8″ S 83° E	9.3″ from
May 19	0.6″ West	3.8″ N 19° E	1.8″ S 62° W	2.4″ N 29° W	2.6″ from
May 26	0.9″ N 30° E	3.8″ N 69° E	1.4″ S 25° E	5.4″ N 28° E	1.1″ toward
June 2	1.0″ S 77° W	1.0″ S 80° W	1.6″ S 83° W	2.8″ S 27° E	2.2″ from.

A. E. J.

ERRATA

Following Sept. 11, 1934, Volcano Letter 415, the resultant tilt at Halemaumau should be as follows;

1934		1935	
Sept. 16	0.8″ from	Jan. 6	165.″- toward
23	1.2″ toward	13	1.1″ toward
30	1.3″ from	20	22.5″ from
Oct. 7	7.9″ from	27	7.1″ from
14	11.0″ toward	Feb. 3	7.7″ toward
21	11.1″ from	10	1.7″ toward
28	8.2″ from	17	3.1″ toward
Nov. 4	2.0″ toward	24	18.2″ from
11	7.1″ from	Mar. 3	14.2″ from
18	12.6″ from	10	4.2″ toward
25	1.4″ toward	17	12.1″ toward
Dec. 2	28.0″ from	24	3.1″ toward
9	0	31	6.7″ toward
16	1.1″ toward	Apr. 7	8.9″ from
23	5.7″ from	14	4.3 from
30	7.8″ from	21	18.9″ from
		28	2.0″ toward.

A.E.J.

The Volcano Letter

No. 424—Monthly U. S. Geological Survey, Hawaii National Park JUNE, 1935

KILAUEA REPORT FOR JUNE, 1935

Including weekly press reports 1220 to 1223
June 2 to June 30, 1935, midnight

Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

VOLCANOLOGY

The month of June at Halemaumau pit of Kilauea Volcano was not remarkable for any important events until after the solstice when a very marked increase of earthquake frequency occurred along with notable sharp earthquakes at the end of the month. The press reports Vesuvian activity in Italy and earthquakes in Mexico.

Slides at Halemaumau

At 9:50 a. m. June 3, gravel was falling at the NW scar, and it was evident that some additional pieces of the rim slab had fallen there, and a remnant pinnacle appeared ready to fall. This is equally the case at the middle of the SSW scar, where a column on the rim is hanging out in unstable equilibrium. June 6, at 10:56 a. m. a noisy slide was heard. June 8, at 10:50 a. m. a moderate slide fell E, recording as a tremor on the Halemaumau seismograph. June 9, at 6:36 a. m. an eastern avalanche occurred, and at 9 a. m. the rock wall ENE was scarred and working. There was a fresh wet scar high up, and fresh red debris on the talus. At 12:52 p. m. a slide occurred above the E talus.

The second week produced repeated slides from the east buttress. At 9 a. m., June 14, and again at 9:05, avalanche dust arose. A visit at 9:15 showed that the slide was at the east wall; from the buttress there at 9:25 a large slide fell. At 3:30 p. m., June 15, and at 5:30 p. m., June 16, dust clouds arose.

This eastern sliding was replaced by avalanches on the opposite side of the pit during the third week. The west wall sent up dust June 17, at 4:15 p. m. and 5:00 p. m. This was at the WNW scar which had been quiet of late. Noisy slides were heard 9:50 a. m., 2 p. m., and 2:55 p. m. June 21, while a party was running levels around the pit.

The week ending June 30, stirred the walls considerably owing to large numbers of earthquakes. Slides were almost continuous the afternoon of June 28. and it was evident that the earthquake of 9 a. m. that day had dislodged a slide SSE. At 9:30 a. m. there was a slide NE, at 11:57 a. m., one N. June 29, at 4:35 p. m., a dust cloud arose NNE. June 30, at 11:55 a. m. a slide occurred NE, and dust arose above the pit at 3:10 p. m.

This northeast sliding was accompanied by fresh soil cracks observed 100 feet back of the northeast rim of Halemaumau for a length of 50 feet on June 29; and new breaks in the dirt occurred inside of old cracks NNE; this phenomenon was observed also along the WNW edge of the pit.

Halemaumau Floor Solfataras

June 3, at 9:50 a. m., there was a trace of thin rising fume at the north corner of the 1934 lake cup. Fume was abundant at the Yellow Solfatara NW. June 9, this place was fuming, and fumes were visible at the four other vents north and east. With increasing northeast wind and clear dry weather this fuming from the five vents at the NW, NE, and E edges of the floor continued on June 10. At the west rim of the pit sulphur dioxide could be smelled presumably from the bright yellow solfataras NW and NNW. On days when the relative humidity become lower both the vapor vents and the yellow solfataras produced clouds less dense. The odor of sulphur dioxide along the west rim of the pit was noted by the levelling party June 21. June 22, heavier fume than usual was observed issuing from the NW solfatara at 10:30 a. m.

The earthquake week at the end of the month disturbed the cracks around Halemaumau and increased the odor of sulphur gases from the floor fumeroles. Most of this came from the Yellow Solfatara northwest. The disagreeable odor of hydrogen sulphide was noticed in the early afternoon of June 28 and a little the next day.

Tilt Cellar Effects

The three tilt cellars around Halemaumau showed no unusual tilts after the earthquake of June 25, but their disturbance after the earthquake of June 28 was marked. The boom of the western clinoscope was moved 19 mm. SSW, that of the northern instrument 14 mm E. and at the southeast station the movement was 17 mm NW. Two days later this southeast station had accumulated an additional tilt of 57 mm. before it settled down, always with northwesterly or westerly trend. One millimeter equals approximately two thirds of a second. Northwesterly tilt at the southeast station means a tipping of the ground in the direction of the center of the pit, or in the direction of the northern rift of Mauna Loa. It should always be remembered that these tilting results after earthquakes are only approximate, as a shock disturbs the instrumental adjustments, and also the block of ground may be fractured locally whereon the instrument stands.

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau Pit resulted as follows:

Week ending forenoon of

June 8, 8 opened, 7 closed, aggregate opening 0.5 mm.
June 15, 12 opened, 3 closed, aggregate opening 5.5 mm.
June 22, 14 opened, 3 closed, aggregate opening 9.0 mm.
June 29, 11 opened, 4 closed, aggregate opening 9.5 mm.

Levelling

Spirit level determination of elevation changes around the rim of Halemaumau was made by A. E. Jones, June 4, 21, and 28. The base used was the bench mark at the southern gravel ridge of Kilauea Crater ("Spit"). Results showed that the NW trig station on Halemaumau rim had relatively lowered, or Spit B.M. had raised, between April 25 and June 4, 1 cm. or less; a reverse movement (NW up or Spit down) June 4 to June 21, 0.5 cm.; original movement (NW down or Spit up) June 21 to June 28, 2 cm. In this direction the total NW down or Spit up was 2.5 cm. or less since April 25 (see Volcano Letter 422).

Referring to the movement as NW station lowering, as was done in the Volcano Letter for April, and in other communications, this lowering of the crater floor is a continuation of movement in this direction since the eruption of Kilauea in September 1934, but is in contrast to the elevation of April 1935. The strong earthquake shock of June 28 may have been partly responsible for the sudden lowering of the crater floor between June 21 and 28. Levelling was in progress at the time of the quake, and was stopped by rain before a check could be made. It must be borne in mind that it is quite probable that the change of level of the eruption was a depression of the southern fault block under Spit relative to mean sea-level, and that the change of level since has been an elevation of that fault block relative to the crater floor. T.A.J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Moderate to Strong earthquakes	Distant earthquakes	Local * Seismicity
June 9	40	1	1	0	0	11.50
June 16	53	2	0	0	0	14.25
June 23	134	5	0	0	0	36.00
June 30	143	9	0	2	1	47.25

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated. The location of epicenters is based on five stations Kilauea, Hilo, Kona, Halemaumau, and Uwekahuna. The intensity is that recorded on the Kilauea instruments.

June 5, at 6:55 a. m., a feeble earthquake was felt at both Kilauea crater and Honokaa. It was located 15 miles

deep under the Kona side of the island, lat. 19° 28′ N, long. 155° 48′ W.

June 6, at 9:46 a. m., a tremor was recorded, it was larger on the Kona seismogram. It was tentatively located on the seaward extension of the Hualalai rift, in lat. 19° 50′ N, long. 156° 10′ W.

June 16, at 4:35 p. m., a very feeble shock was recorded from the Kaoiki rift about 19° 20′ N, 155° 25′ W.

June 25, at 0:45 a. m., a moderate earthquake dismantled the Observatory seismograph. It awakened people quite generally on south half of the island. The source was two or three miles deep under the north rim of Kilauea crater. 19° 26.5′ N, 155° 16.5′ W.

June 27, at 8:14 a. m., a very feeble shock was felt in north Kona and Puuwaawaa. It appeared to be located near Kailua Bay, 19° 40′ N, 155° 00′ W.

June 28, at 9:00:19 a. m., a moderate to strong earthquake began to record on the Observatory seismographs. The strong motion seismograph was the only instrument on the island not dismantled. The secondary wave did the dismantling. Some damage was caused in Hilo. The selected location was on the Mauna Loa northeast rift, 19° 36′ N, 155° 11′ W and five miles deep. It was felt generally on Hawaaii.

Microseisms were normal 5, 6, 18 and 28, and were subnormal the remainder of the period.

The preliminary waves only, of a teleseism began recording at 1:02:05 p. m., June 24. No location has been reported of it.

A.E.J.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea crater; and at Halemaumau the readings from each clinoscope and the resultant radial tilts for the three clinoscopes, towards or from the center of Halemaumau Pit.

At the Observatory the total accumulated tilt in the year June 30, 1935, is 3.0″ N and 2.7″ E.

TABLE OF TILT

Week ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
June 9	0.8″ S 20° W	1.4″ N 82° W	2.8″ N 89° W	7.0″ S 34° W	5.6″ From
June 16	1.3″ N 45° E	1.4″ S 70° W	2.4″ S 92° W	9.2″ N 18° E	3.2″ toward
June 23	0.6″ N 65° E	2.2″ N 63° E	6.8″ N 37° W	2.8″ S 70° E	7.6″ from
June 30	2.5″ N 80° E	24.3″ N 75° E	26.8″ S 32° W	118.″ N 60° W	96.″ toward.

A.E.J.

The Volcano Letter

No. 425—Monthly | Department of the Interior, National Park Service | JULY, 1935

KILAUEA REPORT FOR JULY, 1935

Including weekly press reports 1224 to 1227
June 30 to July 28, midnight
HAWAII NATIONAL PARK

E. G. Wingate, Superintendent
T. A. Jaggar, Volcanologist

The month of July at Halemaumau Pit of Kilauea Volcano showed high frequency of earthquake shocks, continued rock slides from the pit walls, and heavy fuming of the solfataras adjacent to the floor of the pit during the first two weeks, but thereafter the pit became very quiet.

Slides at Halemaumau

July 1, slides were reported at 11:55 a. m. and 5:40 p. m. July 2, there were two or three small slides during the day. July 6, the SW wall was making slides at 9:45 a. m. July 7, dust clouds from slides occurred at 11:00 a. m., 1:20 p. m., 3:00 p. m., and 3:25 p. m. There was very large slide at 5:50 p. m. The slide registered as tremors on the Observatory seismograph. Between 8:00 and 9:00 p. m., small slides were noted at intervals of about 9 minutes.

July 8, dust clouds indicated slides at 9:45 a. m., 10:37 a. m., and 10:45 a. m. July 9, at 8:55 a. m., 10:10 a. m. and 1:05 p. m. Small slides were practically continuous the morning of July 9. July 10 dust clouds arose at 1:07 p. m. July 11 there were rock slides at 9:10 a. m.

July 15 and July 20, dust caused by slides covered a large part of the lava floor of Halemaumau, especially NE, W, and N on July 20. Scars have been produced on the N Buttress by slides on July 15. Slides were reported at the following times:

July 16, at 12:53, 1:00, 1:38, 1:43, and 2:05 p. m., mostly E and NE. Very large slides on this day fell from the E wall at 11:00 a. m. and 4:30 p. m. July 17, another slide occurred here at 9:40 a. m. July 20, rocks fell from the N. Buttress at 11:25 a. m., the cloud resembling steam. July 21, there was a slide at 9:45 a. m.

The last week of the month, the pit was quieter, though the numbers of local seismic disturbances were more than 100 weekly throughout July. This was of interest as the numbers greatly decreased during the following month, and had been small before the solstice in June.

As shown by the earthquake report, increased frequency of earthquakes which originate away from Kilauea probably stimulates sliding; on the other hand, the disturbance of the pit occasioned by heavy sliding, itself makes tremors at the instruments. Most tremors are Kilauea phenomena and may be caused not only by slides in the pit, but also by lava movements under the pit. We have not yet devised any method of proving conclusively cause and effect, in the relations between tremors and slides.

Halemaumau Floor Solfataras

Fuming at the NW Solfataras increased slightly with puffs at 12:45 p. m. July 1, and at 2:00 p. m. July 2 fume filled the pit with heavy blue haze. At 12:30 p. m. July 6, sulphurous odor was noted and again the evening of July 7. These phenomena continued July 9, July 11, and July 13, and a small area of yellow sulphur had appeared at the E edge of the floor. By July 20, the fume had decreased. After heavy rainfall July 24, much vapor rose from cracks on the floor.

Tilt Cellar Effects

At the beginning of the month large tilt values continued to be recorded at the SE and W tilt cellars near Halemaumau. Following the earthquake shock of July 4, the W cellar registered about 6 seconds tilt NE, and the SE station about 12 seconds W.

On July 6, the SE cellar again registered a large tilt of 20 seconds W, without the stimulus of any unusual earthquake.

Measurement of Halemaumau Rim Cracks

Weekly measurement of 32 marked rim cracks around the upper edge of Halemaumau Pit resulted as follows:—

Week ending forenoon of

July 6	6	opened, 4	closed,	aggregate opening	2.0 mm.
July 13	9	opened, 7	closed,	aggregate opening	2.5 mm.
Ju'y 20	6	opened 5	closed,	aggregate opening	0.0 mm.
July 27	19	opened, 2	closed,	aggregate opening	11.0 mm.

T.A.J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Distant earthquakes	Local * Seismicity
July 7	105	6	0	0	31.25
July 14	136	8	1	0	42.00
July 21	136	1	1	0	35.50
July 28	119	3	0	1	31.25

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indictated. The location of the earthquakes are based on the main station at the Kilauea Observatory and two subsidiary stations located around the crater. More distant earthquakes were located with the aid of seismograms from stations at Hilo and Kealakekua.

July 4, at 10:02 p. m., slight earthquake under Kilauea southwest rift zone; lat. 19 degree 25′ 54″ N, long. 155 degree 17′ 57″ W, 1.7 miles deep.

July 5, at 9:44 p. m., very feeble earthquake between Keanakakoi and Lua Manu craters; lat. 19 degree 24′ 19″ N, long. 155 degree 15′ 39″ W, .0.9 miles deep.

July 8 at 4:21 p. m., moderate earthquake, some doubt as to the exact location but known to have been centered about 3.6 miles deep in the vicinity of Makaopuhi crater, probably along the southeast rift.

July 10 at 9:49 a. m., very feeble earthquake reported felt in Kona district and 31.4 miles from Kilauea. Thought to be located on S. W. rift of Mauna Loa.

July 10, at 6:47 p. m., very feeble earthquake reported felt in Kona district and 59.5 miles from Kilauea. Thought to be located on sea bottom west of Kealakekua.

July 12, at 4:32 a. m., very feeble earthquake 2.5 miles S. W. of Halemaumau in rift zone; lat. 19 degree 22′ 45″ N, long. 155 degree 18′ 36″ W 2.5 miles deep.

July 12, at 8:30 p. m. feeble earthquake reported felt at Kapapala Ranch where a window pane was broken and a noise like the report of a gun was heard. Located in S. W. rift zone 16.5 miles from Hawaiian Volcano Observatory; lat. 19 degree 15′ N. long. 155 degree 25′ W, 74.0 miles deep.

July 13, at 2:56 p. m., very feeble earthquake reported felt at Summer Camp on S. E. rim of crater. Probably located between Lua Manu crater and Keanakakoi about 1.2 miles deep.

July 16, at 5:10 p. m., a feeble earthquake, beneath ocean, 20 miles S. S. W. of Kilauea, 11.0 miles deep.

July 24, at 6:35 p. m., a very feeble earthquake 0.6 miles north of the north rim of Kilauea crater; lat. 19 degree 26′ 27″ N, long. 155 degree 16′ 9″ W, 5.4 miles deep.

July 26, at 1:51 p. m., very feeble earthquake probably centered in S. W. rift zone about 5 miles from Halemaumau.

The distant earthquake of July 28 which began to record at 9 h: 16 m: 40s p. m. originated 2,775 miles southwest of Hawaii near or in the Tonga Deep.

On July 31 at 9:01 a. m. and 9:35 p. m., 15 and 20 minutes respectively of harmonic tremor began to record.

Microseismic motion was subnormal during July except on the following dates: July 7, 8, 10, 17, 20 and 26 when it was normal and July 14 to 16 inclusive when it was abnormal.

H. H. Waesche.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at Kilauea Observatory, northeast rim of Kilauea Crater; and at Halemaumau, the algebraic sum of radial tilts for the three clinoscope cellars, towards or from the center of the pit.

At the Observatory the total accumulated tilt in the year ending July 28 was 1.1″ N and 4.2″ E.

TABLE OF TILT

Week ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
July 7	0.7″ N 24° E	2.4″ N 47° W	19.67″ N 18° E	74.5″ N 84° W	51.55″ toward
July 14	0.3″ S 27° E	4.9″ N 37° W	0.75″ S 31° W	51.8″ N 50° W	58.00″ toward
July 21	1.1″ N 45° E	1.2″ S 66° W	1.1″ N 56° W	4.4″ N 69° E	0.94″ from.
July 28	0.8″ N 20° E	0 0	3.96″ N 87° W	4.4″ N 37° W	8.23″ toward.

H.H.W.

The Volcano Letter

No. 426—Monthly | Department of the Interior, National Park Service | AUGUST, 1935

KILAUEA REPORT FOR AUGUST, 1935

Including weekly press reports 1228 to 1232

HAWAII NATIONAL PARK

E. G. Wingate, Superintendent
T. A. Jaggar, Volcanologist

During the month of August at Kilauea Volcano, there was steady decline in local seismicity, but a flurry of local movement occurred in the middle of the month.

Slides at Halemaumau

July 31, 10:50 a. m., a few stones were heard falling near N Buttress, and a similar movement of rocks and dust occurred there August 2, 10:45 a. m. August 7, 5:52 p. m., a slide occurred at the N, and a fresh scar streaked the N Buttress. More N Slides occurred August 8 and August 9 about 10:00 a. m. The N Buttress was again making slides at 2:55 p. m., August 12, and on August 15, a large slide fell at the W at 6:30 a. m. followed by others at the same place at 9:33 and 11:50 a. m.; and at 2:00 p. m., a large slide at the S occurred, another at the N Wall and a small slide occurred SW. August 19, 9:36 a. m. a noisy small slide fell at the N Wall and rocks were slipping at the W Wall. August 20, 9:10 a. m., there was a small slide N and others at the same place, sending up dust. August 21, 9:05 and 10:18 a. m. August 23, fresh talus appeared on the E floor. August 26, new rocks had fallen on the N floor and on August 30, at 12:40 p. m., a slide at the N sent up pinkish dust; gravel was slipping on that wall the next morning. September 1, 9:00 a. m. a snapping noise was heard, and a slight fall of stones occurred at the W five minutes later.

Halemaumau Floor Solfataras

August 3, the sulphur spot E had enlarged and become a brighter yellow. August 7, a new sulphur stain was observed at the foot of the NE talus. During rainy, foggy weather, August 10, there was much fume from the solfataras and vapor from the walls. A fume puff was observed 3:15 p. m. August 12, and on August 13, in the morning, the NW yellow solfatara was puffing vigorously but owing to dry weather fume did not show elsewhere. During afternoons, blue fume became conspicuous at the pit with sunlight in the background, and similarly fume showed over Mokuaweoweo at time of sunset. August 23, the E sulphur spot appeared larger and August 29 calm weather made the fume conspicuous; this continued September 1. as the fume appears heavy and settles. A crack at the NW border of the floor appeared to have widened during the last few months.

Measurement of Halemaumau Rim Cracks

Weekly measurements of 32 marked rim cracks around the upper edge of Halemaumau Pit resulted as follows:

Week ending forenoon of

August 3 10 opened, 3 closed, aggregate opening 2.0 mm.
August 10 6 opened, 9 closed, aggregate closing 2.0 mm.
August 17 8 opened, 6 closed, aggregate opening 1.5 mm.
August 24 10 opened. 4 closed, aggregate opening 2.5 mm.
August 31 14 opened, 3 closed, aggregate opening 7.0 mm.

Levelling

Spirit level determinations were run around the rim of Halemaumau August 15, 1935 by H. H. Waesche. Result shows that crater floor of Halemaumau had lowered 1.2 cm. since July 2. As shown by graphic method, the rate of lowering is about the same as between June 28 and July 2. With the exception of a slight upward movement of the crater floor in April, downward movement has been continuous since the eruption of September 1934. By downward movement is meant the relative lowering with reference to the S gravel ridge of Kilauea Crater (Bench Mark "Spit"). Total lowering has been 8.5 cm. or less since October 1934.

T.A.J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Distant earthquakes	Local * Seismicity
August 4	133	0	0	0	33.25
August 11	123	3	0	1	32.25
August 18	113	1	1	1	30.75
August 25	86	9	0	0	27.00
September 1	49	6	0	0	15.00

* For local seismicity index see Volcano Letter 371.

The fol'owing successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms; when possible the depth of the source is indicated. The locations of the earthquakes are based on the main station at the Kilauea Observatory and two subsidiary stations located at other points around the crater. More distant earthquakes were located with the aid of seismograms from stations at Hilo and Kealakekua.

August 9 at 8:40 a. m. very feeble earthquake under Kilauea S. W. rift zone, 1.5 miles S. W. of Halemaumau; lat. 19 degree 24′ N, long. 155 degree 18.5′ W.

August 11 at 7:12 p. m. very feeble earthquake about 1.2 miles deep and between 2 and 3 miles N. E. of the Volcano Observatory.

August 17, at 12:04 a. m. a slight earthquake felt in Volcano district by many and reported felt in Pahala, Hilo, Hakalau and Hookena. Location on Mauna Loa N. E. rift, 21.7 miles deep; lat. 19 degree 34′ N, long. 155 degree 25.2′ W.

August 20, at 1:23 p. m. a very feeble earthquake thought to have originated in area in S. W. portion of Kilauea Crater.

August 22, at 6:11 a. m. a very feeble earthquake probably located in Kilauea S. W. rift zone, 1.8 miles S. W. of Halemaumau.

August 22, at 8:12 a. m. a very feeble earthquake probably located in Kilauea S. W. rift zone, 0.8 miles S. W. of Halemaumau.

August 23, at 1:28 a. m. a very feeble earthquake probably located 1.7 miles S. W. of Halemaumau in S. W. rift zone.

August 23, at 5:13 a. m. a very feeble earthquake probably located 1.7 miles S. W. of Halemaumau in S. W. rift zone.

August 23, at 6:32 p. m. a very feeble earthquake probably located 2.1 miles S. W. of Halemaumau in S. W. rift zone.

August 24, at 8:20 a. m. a very feeble earthquake located 2.3 miles S. W. of Halemaumau in rift zone 2.5 miles deep; long. 155 degree 18.8′ W.; lat. 19 degree 23′ W.

August 27, at 3:15 a. m. a very feeble earthquake located ½ mile S. E. of Halemaumau near Keanakakoi 3.2 miles deep; lat. 19 degree 24.2′ N, long. 155 degree 16.7′ W.

August 27, at 2:23 p. m. a very feeble earthquake located 1 mile S. E. of Halemaumau about 1 mile deep; lat. 19 degree 24.1′ N, long. 155 degree 16.3′ W.

August 29, at 7:59 a. m. a very feeble earthquake 2.7 miles S. E. of Halemaumau and 3.5 miles deep; lat. 19 degree 22.7′ N, long. 155 degree 15.4′ W.

August 29, at 11:46 p. m. a very feeble earthquake probaly located 3.7 miles S. E. by S. from Halemaumau.

The surface waves of a distant earthquake began recording at the Volcano Observatory at 9 h: 30 m: 05s: p. m.. August 10.

The preliminary waves of a distant earthquake began recording at 3h: 23m: 51s: p. m., August 16. It was 3,660 miles from Kilauea and was located at or near New Caledonia.

Microseismic motion was subnormal during the month except on the following dates, August 5, 8, 13, 14, 15, 19, 20 and 24 when it was normal.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at the Volcano Observatory, northeast rim of Kilauea; and at Halemaumau, the algebraic sum of radial tilts for three clinoscope stations towards or from the center of the Pit.

At the Observatory the total accumulated tilt in the year ending September 1, was 0.74″ N and 1.5″ E.

TABLE OF TILT

Week Ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
August 4	0.93″ N 24° W	1.19″ S 29° W	1.79″ N 80° W	4.31″ N 82° W	2.37″ toward
August 11	0.55″ S 46° W	4.83″ N 71° W	6.17″ N 50° W	3.40″ N 56° E	4.54″ from.
August 18	0.77″ N 15° W	4.78″ S 78° W	4.41″ N 55° W	19.86″ N 53° W	15.93″ toward
August 25	0.76″ N 3° E	1.48″ S 62° W	3.64″ N 75° W	3.24″ N 48° E	1.92″ from
September 1	0.24″ W	1.00″ N 28° W	7.45″ N 36° W	4.54″ S 5° W	7.93″ from

H.H.W.

The Volcano Letter

No. 427—Monthly | Department of the Interior, National Park Service | SEPTEMBER, 1935

HAWAIIAN VOLCANO OBSERVATORY REPORT FOR SEPTEMBER, 1935

Including weekly press reports 1233 to 1236

September 1 to September 29, 1935, midnight

HAWAII NATIONAL PARK
Edward G. Wingate,
Superintendent

KILAUEA VOLCANO
T. A. Jaggar,
Volcanologist

VOLCANOLOGY

During the month of September, the seismicity declined, this being influenced by the amount of local tremor. At the time of equinox, the week ending September 22, there was distinct increase in seismic frequency and intensity. All but two of the earthquakes of the month were located near Kilauea. The excessive tilt at the SE clinoscope station for the third week is not trustworthy, as earthquakes derange these instruments. Halemaumau pit has been quiet.

Slides At Halemaumau

Slides from the wall of the pit have been noted as follows:—

September 3 at NW wall, 2:40 and 2:55 pm.
September 4, at E bay, 9:37 am.
September 7, large slide NE wall 1:05 pm.
September 7, NE wall, followed by continuous dribbling, 2:09 pm.
September 8, E wall, 1:30 pm.
September 9, NE wall, small slide, 4:45 pm.
September 10, N wall, small slide, 9:45 am.
September 11, E wall, slight slippings, 9:00 am.
September 17, N corner, 11:45 am.
September 17, large dust cloud, 11:55 am.
September 19, small slide E wall, 9:00 am.
September 20, numerous slides N corner, 9:30 am.
September 21, dust cloud and noise, N edge 1:45 pm.
September 21, dribbling on N and W slopes, 2:30 pm.
September 25 light dust cloud E, 10:00 am.

The slides of the first week removed a piece of rim rock NE and made a straight narrow scar down the wall, midway between the E and NE taluses; some fresh debris lay underneath.

Halemaumau Solfataras

In rainy weather, September 2, the walls were wet, and 14 vaporing places were counted. There were dry places on 8 talus slopes. Heavy blue fume arose at the NW Solfataras, and much steam came out of the W wall. On September 9, at 10:00 am, the solfatara at base of E talus was fuming, and fume elsewhere was not seen; at 10:45 am, however, the E fume had disappeared, but the NW Solfatara was smoking variably. For some reason these two places puffed fume interchangeably. September 21, it was apparent that the sulphur patch at edge of floor ESE is growing brighter yellow. September 22 at 8:40 am, with light southerly wind, the blue fume from NW Solfatara rose conspicuously.

Measurement Of Halemaumau Rim Cracks

Weekly measurement of 32 marked places on rim cracks around the upper edge of Halemaumau pit resulted as follows:—

Week ending forenoon of—

Sept. 7, 12 opened, 4 closed, aggregate opening 6.0 mm.
Sept. 14, 7 opened, 2 closed, aggregate opening 4.0 mm.
Sept. 21, 3 opened, 7 closed, aggregate closing 1.5 mm.
Sept. 28, 11 opened, 2 closed, aggregate opening 6.0 mm.

T.A.J.

EARTHQUAKES

TABLE

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Distant earthquakes	Local * Seismicity
Sept. 8	65	4	0	1	22.00
Sept. 15	40	8	0	2	14.00
Sept. 22	50	7	2	3	18.00
Sept. 29	38	8	0	1	13.50

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated; the epicenters as shown were located from seismograms. The depth of focus is indicated whenever determinations were possible. The locations of the earthquakes are based on the main station at the Kilauea Observatory, and the two subsidiary stations at Uwekahuna and Halemaumau respectively. More distant earthquakes were located with the aid of seismograms from stations at Hilo and Kealakekua. The latter net is primarily for locating earthquakes originating on the Island of Hawaii outside of Kilauea area.

September 5 at 10:29 am, very feeble, located under or near Halemaumau.

September 6 at 4:26 pm, very feeble. probably located on SE slope of Hualalai; 19° 36.5′ N; 155° 48.2′ W. Reported felt at Puuwaawaa Ranch.

September 9 at 5:06 am, very feeble, located 0.6 mile deep under SE portion of Halemaumau, 19° 24.5′ N; 155° 17.5′ W.

September 15 at 5:34 pm, very feeble, probably located under NE rift of Mauna Loa near the summit Crater.

September 17 at 10:06 pm, very feeble, located 1.6 miles SSW of Pit seismograph station and 1.7 miles deep. 19° 23.1′ N; 155° 17.7′ W.

September 19 at 9:07 am, very feeble, located 3 miles deep in the Puna rift zone between Lua Manu and Puhimau Craters. 19° 23.9′ N; 155° 15.4′ W.

September 19 at 9:10 am, very feeble, located 4.7 miles deep, 0.2 miles N of Devils Throat in the Puna rift. 19° 23.0′ N; 155° 14.2′ W.

September 20 at 2:31 am, very feeble, located 5.0 miles deep, 1.2 miles east of Halemaumau 19° 24.7′ N; 155° 16.1′ W.

September 20 at 3:59 pm, feeble, located 1.1 miles deep under east rim of Halemaumau. 19° 24.6′ N; 155° 17′ W.

September 21 at 10:31 pm, very feeble, located 5 miles deep, 3.8 miles SSE of Pit seismograph under Kalanaokuaiki Pali. 19° 21.2′ N; 155° 15.9′ W.

September 23 at 8:08 pm, very feeble, located 0.8 mile N of the Pit seismograph. 19° 21.0′ N, 155° 16.9′ W.

September 26 at 2:27 pm, located 0.6 mile deep under SE rim of Halemaumau. 19° 24.5′ N; 155° 17.1′ W.

September 28 at 4:09 am, very feeble, probably located under SE rim of pit.

Distant earthquakes were recorded as follows: September 8 at 7:58 pm, surface waves only, location 58° N; 139° E in the vicinity of Northern New Guinea. September 11 at 3:44 am (preliminary waves); location near Japan; 44° 5′ N; 147° E. September 15, at 4:06 am, long waves only, location, 28° S; 113.3° W, about 2000 miles W of Peru in the Pacific Ocean. September 19 at 3:28 pm; preliminary waves, location 4,510 miles from Kilauea immediately south of Australia and west of Tasmania, 40° S; 140° 5′ E. September 19 at 7:22 pm, surface waves only location in vicinity of the Admiralty Islands, 0° N; 146° E. September 22 at 11:18 pm, surface waves only, location 0.5° N; 141.5° E, in vicinity of Northern New Guinea. September 24, at 11:58 am, location 50° N; 129° W, off Coast of British Columbia.

Microseismic motion was slight during the month except on the following dates, September 12, 14, 16, 17, 23, 25, and 28 when it was normal. It was strong September 29.

H.H.W.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at the Volcano Observatory NE rim of Kilauea Crater and at Halemaumau, the algebraic sum of radial tilts for three clinoscope locations towards or away from the center of the Pit.

At the Observatory the total accumulated tilt for the year ending September 29, was 0.4″ N and 1.1″ E.

TABLE OF TILT

Week ending	Observatory	Halemaumau Clinoscope Stations			
		North	West	Southeast	Pit Resultant
Sept. 8	0.3″ S 65° E	3.59″ N 45″ W	2.38″ N 55° W	1.45″ S 33° E	4.57″ from.
Sept. 15	0.84″ N	0.90″ S 69° E	2.44″ N 78° W	2.59″ N 64° W	2.22″ toward
Sept. 22	0.15″ N	3.09″ S 35° W	3.58″ N 22° E	32.4″ N 59° W	33.20″ toward
Sept. 29	0.20″ S 45° W	3.51″ N 48″ W	4.62″ N 47° W	1.26″ N 82° W	3.23″ from

NOTE: SE Pit Clinoscope adjusted September 21. Had probably been partially dismantled since earthquake of June 28. rendering results between those dates doubtful.

H.H.W.

The Volcano Letter

No. 428—Monthly | Department of the Interior, National Park Service | OCTOBER, 1935

HAWAIIAN VOLCANO OBSERVATORY REPORT FOR OCTOBER, 1935

Including weekly press reports 1237 to 1240

September 29 to October 27, 1935 midnight

HAWAII NATIONAL PARK
E. G. Wingate
Superintendent

KILAUEA VOLCANO
T. A. Jaggar
Volcanologist

VOLCANOLOGY

A large group of exceptional earthquakes, moderate to strong, occurred on September 30 and October 1, originating under the rift system of Mauna Loa at estimated depths of 17 to 30 miles. In view of the lava flow of Mauna Loa that was to come in November, it is interesting to note that the strongest shock was felt all over Hawaii and its epicenter was located seismometrically under the NE slope of Mauna Loa, near where the Humuula Flow finally came forth. These earthquakes disturbed the Halemaumau walls, made avalanches and opened rim cracks excessively owing to the long swaying movement. Most of the centers were under Mauna Loa. The total number of disturbances for the week ending October 6 was 178. The spasm of 11 shocks the middle of October was quite different and centered at Kilauea. Except for the slides started by earthquakes, Halemaumau pit was quiet. Horizontal angles measured across pit and crater notably opened September 25 to October 30, the Halemaumau rim slightly lowered relative to the southern gravel spit, and tilt of the clinoscope stations around Halemaumau which lately had been away from the center, changed to a tilt towards the center in July and August.

Slides at Halemaumau

Slides from the wall of the pit have been noted as follows:—

September 30, large avalanche cloud, with two smaller ones following it, 9:45 am.
September 30, noisy slides made by the night earthquakes
October 1, smaller slide N wall. 1:20 am.
October 1, W side of pit after 6:00 am.
October 2, NW dribbling slides 10:35 am.
October 3, N wall dribbling slides, 9:30 am.
October 3, NE slide, 5:15 pm.
October 4, NE floor covered with dust, early morning.
October 5, NE slides, 10:32 and 11:00 am.
October 7, NE dust clouds, 4:45 pm.
October 8, dust clouds from slides leaving stones on E floor, 2:55 and 3:50 pm.
Octcober 17, small slides, SW 12:20 and 12:50 pm.
October 18, small slide NW. 12:15 pm.
October 22, rocks heard falling WNW, 9:50 am.

Halemaumau Solfataras

At 10:40 am, September 30, fume rose from yellow spot at E edge of floor. With 5 inches of rain in 2 days, October 12-13, the fuming vapor was dense at the Yellow Solfatara NW. White salts appeared at the vents of the 1934 Lava Cascades, and during heavy rain showers the forenoon of October 12, dense vapor clouds appeared there, and tails of vapor rose all over the floor.

Measurement of Halemaumau Rim Cracks

Weekly measurement of 32 marked places on rim cracks around the upper edge of Halemaumau pit resulted as follows:—

Week ending forenoon of

October 5, 17 opened, 5 closed, aggregate opening 21.0 mm.
October 12, 12 opened, 7 closed, aggregate opening 6.5 mm.
October 19, 8 opened, 5 closed, aggregate opening 2.0 mm.
October 26, 14 opened, 3 closed, aggregate opening 8.0 mm.

After the earthquake spasm of the first week, in some places soil had fallen down the measured cracks and hair cracks in the dirt appeared, showing the effects of disturbance of rim blocks by the earthquakes. T.A.J.

Crater Angles and Levelling

The horizonal angle measured from the Volcano Observatory between SE and NW rims of **Kilauea Crater** showed sharp closing of 4″, July 30 to August 3 and opening 0.8″, August 9 to 29. The angle closed 1″, August 29 to September 21, and opened an equal amount October 9. Opening continued, adding 4″ more October 9 to October 30, the angle on that date reading 38° 30′ 16.2″.

The angle across **Halemaumau** from SE to NW rim stations, changed similarly to the one across Kilauea Crater. It closed 3.0″ to a record dow value of 16° 14′ 27″, August 29 from its reading of July 30. From that date, there was steady opening 2.4″ to October 30.

Spirit levelling between Spit B. M. in the southern rim region of Kilauea Crater, and the NW station B. M. of Halemaumau, shows relative lowering of NW station. The amounts of lowering are as follows:

July 2 to August 13, 12.0 mm; August 13 to September 18, 1.0 mm; September 18 to October 18, 4.0 mm.

H.H.W.

EARTHQUAKES

TABLE

Week ending	Tremors	Very feeble earthquakes	Feeble earthquakes	Slight earthquakes	Moderate earthquakes	Local * Seismicity
Oct. 6	142	27	3	2	4	69,00
Oct. 13	36	2	0	0	0	10.00
Oct. 20	33	10	1	3	0	20.25
Oct. 27	30	3	0	0	0	9.00

* For local seismicity index see Volcano Letter 371.

The following successive local disturbances began at the times indicated and the epicenters were located from seismograms. The depth of focus is indicated wherever such determinations were possible. The locations of these earthquakes are based on the main station at the Kilauea Observatory, and the two subsidiary stations at Uwekahuna and Halemaumau respectively. More distant earthquakes were located with the aid of seismograms from stations at Hilo and Kealakekua. The latter net is primarily for locating shocks originating on the Island of Hawaii outside of the Kilauea Area.

September 30 at 8:28 am, very feeble, located 0.8 miles deep under SE rim of Halemaumau, 155° 17.1′ W; 19° 24.5′ N.

September 30, at 10:35 pm, very feeble, located 25 miles deep on NE rift near Summit Crater of Mauna Loa, 155° 31.6′ W; 19° 31.4′ N.

September 30, at 10:36 pm, moderate, felt generally on the Island of Hawaii. It was located 30 miles deep under the SW rift of Mauna Loa 155° 39.5′ W; 19° 22′ N.

September 30, at 11:58 pm, moderate to strong, felt over entire Island of Hawaii, located under NE slope of Mauna Loa about midway between Puu Ulaula and Humuula Sheep Station and 17.4 miles deep, 155° 26.3′ W; 19° 38.7′ N.

October 1, at 12:02 am, moderate, generally felt as a continuation of the preceding one, location undertermined, but focus was probably under the Mauna Loa rift system.

October 1, at 12:10 am, feeble, felt slightly in NE sections of the Island of Hawaii, location undetermined but probably under Mauna Loa, like preceding quake.

October 1, at 12:34 am, slight, associated with this same series of Mauna Loa disturbances.

October 1, at 12:54 am, slight, felt in Kilauea Area and NE section of Island of Hawaii, located half way between Mokuaweoweo and Hilo about 25 miles deep under the Mauna Loa NE rift zone; 22 miles NE of the summit Crater 155° 24.5′ W; 19° 34.4′ N.

October 1, at 10:22 am, moderate, reported felt in Hilo and in the Kilauea district, located under the NE rift

zone of Mauna Loa 15 miles SW of Hilo 155° 19.2′ W; 19° 38.3′ N.

Between 10:30 pm, September 30 and midnight October 1, there were 23 very feeble earthquakes associated with the disturbance centered under the SW and NE rift zones of Mauna Loa.

October 4, at 5:33 am, feeble, located 30 miles deep under SW rift of Mauna Loa about 6 miles SW of Summit Crater, 155° 38.2′ W; 19° 23.5′ N.

October 5, at 1:49 am, feeble, reported felt strongly at summit rest house of Mauna Loa. Also felt at Waiohinu, Naalehu and Honuapo, located approximately under NE edge of Mokuaweoweo.

October 11, at 7:37 am, very feeble, located 1.3 miles deep under Halemaumau 155° 17.1′ W; 19° 24.5′ N.

Octcober 15, at 4:53 pm, very feeble, located 2.8 miles deep near the Devils Throat in Kilauea SE rift zone 155° 14.4′ W; 19° 22.9′ N.

October 15, at 6:35 pm, feeble, located 3.7 miles deep 3.2 miles S of Halemaumau 155° 17.′ W; 19° 21.5′ N.

Octcober 15, at 7:20 pm, slight, located 1.8 miles deep near Cone Crater, Pit Craters and Puu Koae in Kau rift zone of Kilauea 155° 19.0′ W; 19° 21.5′ N.

October 15, at 8:09 pm, very feeble, located 4 miles deep and 3.3 miles SW of Halemaumau in Kau rift zone 155° 18.8′ W; 19° 22.1 N.

October 15, at 8:09 pm, slight, located 3.8 miles deep and 3.4 miles SW by W from Halemaumau 155° 19.7′ W; 19° 22.8′ N.

October 16, at 12:07 am, slight 1.3 miles deep and 0.5 mile NW of Puu Ohale 155° 17.3′ W; 19° 21.6′ N.

October 20, at 5:01 pm, very feeble, located 1.2 miles under east rim of Halemaumau 155° 17.0′ W; 19° 24.5′ N.

October 25, at 11:45 pm, very feeble, located 0.7 mile deep under Crater of Kilauea 0.2 mile NE of Pit seismograph station 155° 16.9′ W; 19° 24.4′ N.

No distant earthquakes were recorded during the month.

Microseismic motion was normal October, 1, 2, 5, 6, 7, 10, 11, 14 to 17 inclusive, 20 and 24; light 8, 9 and 21 to 23 inclusive; and strong September 30, October 3, 4, 12, 13, 18, 19 and 25 to 27 inclusive. H.H.W.

TILTING OF THE GROUND

The table shows tilt by weeks from seismograms at the Volcano Observatory, NE rim of Kilauea Crater; and at Halemaumau, the algebraic sum of radial tilts for two* clinoscope locations towards or away from the center of the Pit.

At the Observatory the total accumulated tilt for the year ending October 27, was 1.12″ S and 1.25″ E.

TABLE OF TILT

Week Ending	Observatory	Halemaumau Clinoscope Stations		
		West	Southeast	Pit Resultant
October 6	1.87″ N 32° E	14.75″ N 27° W	41.80″ N 8° W	27.69″ toward
October 13	0.9″ S 77° E	3.28″ S 79° W	8.42″ N 19° E	1.42″ toward
October 20	0.17″ S 44° E	6.57″ S 27° W	4.21″ S 39° W	4.56″ from
October 27	0.64″ S 82° E	2.98″ N 59° W	2.43″ S 51° E	4.80″ from

* N Clinoscope dismantled September 30. Discontinued until changes made in design. H.H.W.

THE VOLCANO LETTER

No. 429—Monthly, Department of the Interior, National Park Service, November, 1935

Hawaii National Park
Edward G. Wingate, Superintendent

Hawaii Volcano Observatory
T. A. Jaggar, Volcanologist

HAWAIIAN VOLCANO OBSERVATORY REPORT FOR NOVEMBER, 1935

Including weekly press reports 1241 to 1245
October 27 to December 1, 1935 Midnight

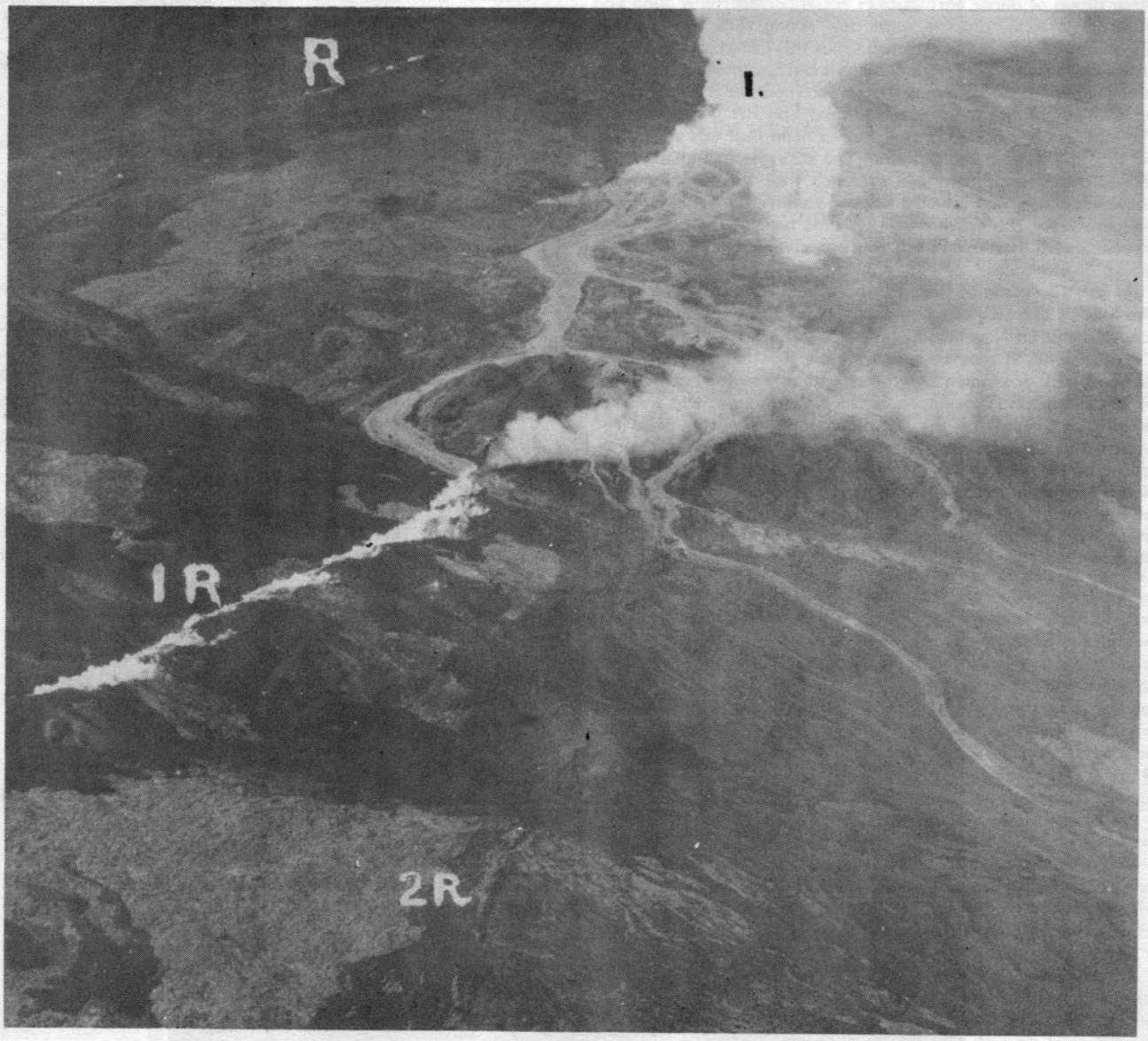


FIGURE 1. Airplane view November 22, 1935. Mauna Loa looking south. Showing northeast rift R; new rift fountaining and sending lava streams of aa north; (1) is a fountain; (1R) is the steaming lower end of new rift. (2R) is branch rift receiving a cascade of lava at a smoking pit below and to the right of (1). Probably (2R) developed into the flow outlet 2, Figure 6, about November 27.—By permission Fleet Air Base, Pearl Harbor, U.S. Navy.

VOLCANOLOGY

There were three reasons for expecting in 1935, an outbreak from Kilauea or Mauna Loa; and the preponderant evidence of recent years indicated it was likely to be Mauna Loa. The first is that the average interval between Hawaiian eruptions since 1924 has been 1.26 years, and the last oubreak was in 1933. The second is that the average cycle is 11 years, and the last cycle culminated in 1924. The third is that Mauna Loa had a summit crater eruption in 1933, which pointed to a coming lava flow on the north side in about two years.* Therefore it was not unexpected that Mauna Loa lava erupted from a north rift on November 21.

*The Coming Lava Flow, by T. A. Jaggar, March, 1934, Honolulu. (Published by Hawaiian Volc. Res. Ass'n.)

The Observatory headquarters at Kilauea had shown exceptional Mauna Loa earthquakes October 1, with an echo of Kilauea earthquakes, October 15. The month of November showed about 50 local seismic disturbances per week for the first three weeks. Then an earthquake strongly felt occurred at 1:11 am November 21 under the NE rift of Mauna Loa, slightly felt even in Honolulu. This was followed by minor shocks, and another group of minor earthquakes accompanied the Mauna Loa outbreak at 6:20 pm the same day. Along with this, tremors appeared which became continuous, but this lasted only two days; thereafter, the tremors were numerous but spasmodic. It is probable the period of continuous tremor accompanied the continuous rush of gas fountaining at the Mauna Loa rift. Halemaumau, the inner pit of Kilauea Crater showed little that was sympathetic with the Mauna Loa outburst. The stronger earthquakes dislodged slides, and there was evidence that the fumaroles became less active, and that the Kilauea steam cracks showed lower temperatures. The crack measurements around the pit showed more opening than usual, but this is a common effect of earthquake disturbance.

Fresh filaments of basaltic spun glass, or Pele's hair, from the Mauna Loa fountains nineteen miles away, fell all over Kilauea Crater on November 22.

In general, it may be said that the location of the Mauna Loa outbreak was indicated seismometrically by the earthquakes of October 1, and November 21; that the approach to the outbreak was forecast by the seismic conditions within these two intervals of 51 days and of 19 hours; and that the larger earthquake of the first group indicated a depth of seventeen and a half miles, while that of the day of the outbreak showed a depth of five miles or less, this difference implying a splitting movement from below upward, which the seismological travel-time data located at the point of outbreak.

Kilauea Observations

Slides at Halemaumau

Slides from the wall of the pit have been noted as follows:—

October 31, dust on NE floor, and gravel slipping from NE wall, 9:00 am.
November 1, rocks fall at NE and W scars, 8:38 am.
November 2, slides at NW wall, 10:45 am.
November 4, noisy slide at E wall, introduced by a small one, 10:00 am.
November 8, NE slide sent up dust, 2:20 pm.
November 16, small rock fall at NE talus, 9:30 am.
November 20, new scar of slide 150 feet below NW edge.
November 21, rocks dribbling down W wall, and N wall showing disturbance owing to earthquake of 1:11 am, observed 10:00 am.
November 22, rocks dribbling N wall 9:54 am.
November 22, noisy slide falling from point 200 feet below SE edge, 2:15 pm.
November 23, dust from slide at N wall, and trickles of debris moving down N talus, 10:00 am.
November 24, rocks dribbling continuously W wall, and small slide there 9:25 am.
November 24, slide W wall, 9:55 am.
November 25, slide making dense dust cloud, W wall 10:55 am.
November 27, slide made dust, 8:40 am.
November 28, two slides made dust clouds W, 1:35 pm.
November 30, slide W, 10:36 am.
November 30, noisy slide with thick dust NW, 11:09 am.

Halemaumau Solfataras

Observations of the sulphurous fumaroles around the edges of the Halemaumau floor, and of the vapor cracks, have been as follows:—

November 16, heavy fume at sulphurous spot E, in rainy weather, 9:30 am.
November 17, after heavy rain, vapor at all the solfataras, at other places on floor and walls, and at N side of 1934 lava lake basin. Cumulus over W side of Halemaumau, due to heat convection or nucleation from sulphur fume.
November 18, no fume detected, an unusual condition; some vapor places, 9:00 am.
November 23, no fume visible, 10:00 am.
November 23, faint puff of fume started at Yellow Solfatara NW, 10:57 am, and became normal 11:30 am.
November 25 to December 1, fume NW solfatara very slight.

FIGURE 2. Rift fountains in sheets. Maximum 500 feet high. November 22, looking southwest, 2 pm., elevation 12,000 feet, airplane view. After 19 hours of eruption, northeast rift of Mauna Loa. Liquidity high, continuous scarlet froth jets.—By permission 11th Photo. Section, U.S. Army.

FIGURE 3. Lowest series source fountains northeast rift, 250 feet away, 150 feet high. Mauna Kea in background. November 23, 1:30 pm. Liquidity dwindling after 43 hours of eruption. Cones building, fountain jets spasmodic. —Photo by Wingate.

Measurement of Halemaumau Rim Cracks

Weekly measurement of 32 marked places on rim cracks around the upper edge of Halemaumau pit resulted as follows:—

Week ending forenoon of

Nov. 2,	12 opened,	1 closed,	aggregate opening,	8.0 mm
Nov. 9,	9 opened,	5 closed,	aggregate opening,	3.5 mm
Nov. 16,	7 opened,	6 closed,	aggregate opening,	2.0 mm
Nov. 23,	20 opened,	1 closed,	aggregate opening,	20.0 mm
Nov. 30,	15 opened,	3 closed,	aggregate opening,	11.5 mm

The unusual opening of cracks noted November 23, followed the numerous unusual earthquakes of November 21, occasioned by the Mauna Loa eruption, which produced swaying disturbance of upright slices of the Halemaumau rim. This caused rocks to settle in the cracks, and so is different from gradual warping movement. —T. A. J.

Crater Angles and Levelling

Measurement with precision transit from the Observatory on NE rim of Kilauea across the crater between the SE and NW trig stations, on the edge of Kilauea Crater, showed a closing of 0.8" between October 30, and November 8. This angle measured again comparing November 8 with November 21 showed a closing of 3.3". Measured again, comparing November 21 with December 9, the angle opened by 2.4".

Measuring from the Observatory across Halemaumau pit from its SE rim station, to its NW rim station, showed similar changes. This angle closed 1.3" between October 30 and November 8. It closed 1.2" between November 8 and November 21. It opened 1.4" November 21 to December 9.

Spirit levelling, using Spit B.M. on the southern rim region of Kilauea Crater as a base, showed the NW station B.M. on the rim of Halemaumau to have been relatively stationary, comparing October 18 to November 26. This last date was the fifth day of the Mauna Loa eruption. —H. H. W.

MAUNA LOA OBSERVATIONS

Earthquakes

A moderate earthquake at 1:11 a.m. November 21 was felt generally from Hawaii to Honolulu, and strongly at Kapapala on the east side of Mauna Loa. Seismographic evidence located the origin less than five miles deep under the NE rift of Mauna Loa about 5 miles from Mokuaweoweo Crater. A felt earthquake of less intensity, followed by feeble ones, and tremors, occurred at 6:35 p.m. November 21, marking the visible beginning of a lava eruption on the NW side of this rift.

Rift Gushing

Light, gas-charged foaming incandescent lava opened cracks, extending from the north bay of Mokuaweoweo, where a pool of lava collected, to an old red cone 4 miles from Mokuaweoweo at elevation 11,453 feet above sea level. This line of cracking is on the NW side of the Mokuaweoweo Trail, which was invaded by the spill of the new lava only at one or two places along the upper stretches, relatively close to the summit crater. The upper two miles of the spurting cracks quickly became sealed the first night of the eruption leaving a line of small conelets, and small flows of pahoehoe lava. The next two miles NE by E became a place of large fountains, playing up in sheets along the crack, and sending floods of lava, pahoehoe above turning into aa below, down the Mauna Loa slope, in a direction nearly north towards Puu Koli.

These floods originated all along the two miles of opened crack, made braided streams, which distributed about islands of old lava on the slope to the north, changed from the smooth glassy pahoehoe to rough aa a mile or so from the vents, and united below into two main elongate torrents. Approximately the east flow travelled about 8 miles, and the west one about 7 miles in the course of the next two days, but their exact locations will not be known until this wild area of very rough ancient lavas is surveyed. The west flow went well below the treeline, as seen from airplanes the forenoon of February 22. Roughly the eastern flow was towards Mauna Kea and the western one was towards Kohala (Figure 9).

There were seven principal vents that made lava jets along the rift, each jet surmounted by gushing sulphurous fume that rose into the upper atmosphere, ginger brown in transmitted light, milky bluish in reflected light. The streamers made high cirrus, which lingered all day in the upper air. The drift of the upper wind the first day strewed Pele's hair over Kilauea. The first night there were high clouds, the glow was brilliant, and was seen from many NW localities, all the way to Honolulu.

Inspection 9:30 to 11:00 a.m. November 22 by airplane, was made by Mr. Jaggar and Mr. Waesche, flying at 11,500 feet elevation over the new flows and along the SE side of the belt of rift fountains. The field of activity was photographed from the air by Army and Navy photographers (Figures 1 & 2). Five main ribbons of liquid lava flowed in rather straight streams from the two miles of open rift, and these diverged from a wide river of lava that poured along the rift northeastward. This river divided around the old red cone, the northern branch pouring away down the slope, the southern one, after half encircling the cone, cascading into a newly opened crack on the NE side of the cone which was an extension of the rift. Beyond this point to the NE the crack was marked by many jets of white steam for perhaps a half-mile.

About a half mile west of this red cone (11,453 feet) there are some old cinder heaps on the map, and a profound pit. A branch of the rift river flowed northward about 2,000 feet to this pit and made a large cascade into it, disappearing into the depths of the mountain. Very hot fume puffed up from the pit where the bright orange melt disappeared into the void, and there was a similar gush of fume at the other cascade, by the cone.

The biggest fountains, guided by the upright planes of the gaping rift, squirted up as sheets, very narrow NE-SW, semicircular and scalloped in plan and profile, as seen from the SE. They shot up 200 to 300 feet, in about 10 main jets of scarlet molten slag, for a length of several thousand feet along the crack between elevation 11,600 feet and 11,900 feet. This region produced the effect of a flat, scalloped wall of fire with the jets continuous, like the squirting of water from a hose, (Figure 2). The detail of the rift that had opened at the base of the fountains

indicated a wall, higher on the SE side of the crack than on the NW side, where the torrents poured away down the mountain slope. Great quantities of fume rose from the fountains and the crack, and the splitting of the mountain was not confined to a single crack. With the wind blowing from the eastward, the sharp definition of the larger crack that gave vent to the fountains was very marked, the wall in plan taking the form of a series of cusps between the fountains, and of crescent bays where each larger fountain group stood. On the SE side of the line there was almost no outlying breakage or steaming. On the NW side, however, the new fractures forked in places, and the photographs show that an important secondary rift extended to the NE from the big cascade pit, with a tendency to curve northward, farther down the mountain. This crack distinctly diverges from the steam crack below the red cone. It seems likely that this fissure leads toward the lower flow vent, that later became important, (Figure 1).

The intensity of the fountaining along the open part of the crack was greatest at the NE when seen the forenoon of November 22, but angular measurement had indicated the brightest fountains farther SW the previous night. Toward the end of fountaining about November 28, the vent on the rift which persisted longest was at the SW end of the active belt, at about the 12,000 foot contour. This was destined to become a smoke hole over a concealed lava pit beneath, that acted as reservoir, within the mountain, for the Humuula lava flow of December. The increasing viscosity of the fountaining lava was very marked November 23-24, (Figures 3-4).

Upper Rift Lava Flows

The lava flows of the upper rift during the week from November 21 to November 25 were so rapidly and violently stirred into crystallization, at first, that the lava turned to aa clinker a short distance from the rift. The fountains as usual built up enclosing cones of spatter, and from breaches in the cones, pahoehoe flows poured in places along the rift belt on the SE side. The earlier photographs of November 22 show the torrents on the NW with dark clinker on each side, and with the peculiar surface pattern, of a dark line of lagging crusts up the middle of each stream; and more rapid flow along the bright glowing overhang of the stream margins. The result is a pattern of bright line crescents with the horns pointed downstream. This is exactly the opposite of the pahoehoe stream pattern, where in plan the horseshoe toe of the festoons points downstream, and the greatest drag, or restraint of the surface skin, is at the stream margin.

The fume column above the fountains was more than 5,000 feet high and above this stood a mushroom of rain cumulus. Along the crack uphill were fiery fuming vents of declining fountains, remnant from the first outbreak. Probably the first of these was the vent in the NW corner of the north bay of Mokuaweoweo. It is of interest to note that this eruption, breaking out in that bay, continued the splitting of the mountain northeastward, from where the crater outbreak left off, in December 1933.

The pattern of the flows which developed on this mountain slope to the north, appeared like that of the earlier ones which are numerous on this declivity. The braided torrents of glowing liquid were from 30 to 50 feet wide, near their sources, and these became narrower farther down the mountain and the rapidity of their forward motion became less. The front of each flow several miles down the mountain exhibited a widening into delta-shape, with dark cherry-red stream in the middle, covered with ragged sprouts and bowlders, and the actual front a glowing wall tumbling forward very slowly. Strong heat rose from the flows, and caused the airplanes to lurch violently. The odor was the usual foundry smell. The middle ribbon of liquid lava was bright orange near the source, the flow in the stream appeared liquid and rapid, within banks of its own clinker which formed fringes and tongues, of varying widths, on either side. These border fields appeared granular with many bowlders. All the torrents united into one about two miles from the source. Below this, the flow divided into two streams with one branch headed toward Mauna Kea, and the other toward Puu Koli. It is probable that these forked above the source heap of the 1843 Flow.

During the following week the pahoehoe lava of the fountains extended itself over the aa lava of the earlier flows, and also built up heaps along the rift line, the source fountaining becoming concentrated to a single cone. Probably there was flowing under the crust of the stream along the rift, and of some of the streams down the northern slope.

Detail of Upper Rift Fountains

H. H. Waesche and S. H. Lamb obtained night views of the upper fountains along with C. K. Wentworth, November 24. Fountaining activity extended for three-quarters of a mile along the fissure, with conspicuous fountain-built cones at each end. The large lower fountain had eight active centers, throwing spatter upward 100 to 300 feet. The cone was about 750 feet long, with a lava river at its base southeast, taking its origin in other cones southwest of it; this was pahoehoe flowing rapidly within a field of aa. At the upper limit of the active belt, there were three fountaining vents, the largest a truncated cone vomiting a very fluid lava from its northeast side which fed the flow pouring along the rift. The action was violent, sometimes flinging up material 400 feet, and the cone was 200 feet across and 75 feet high. A

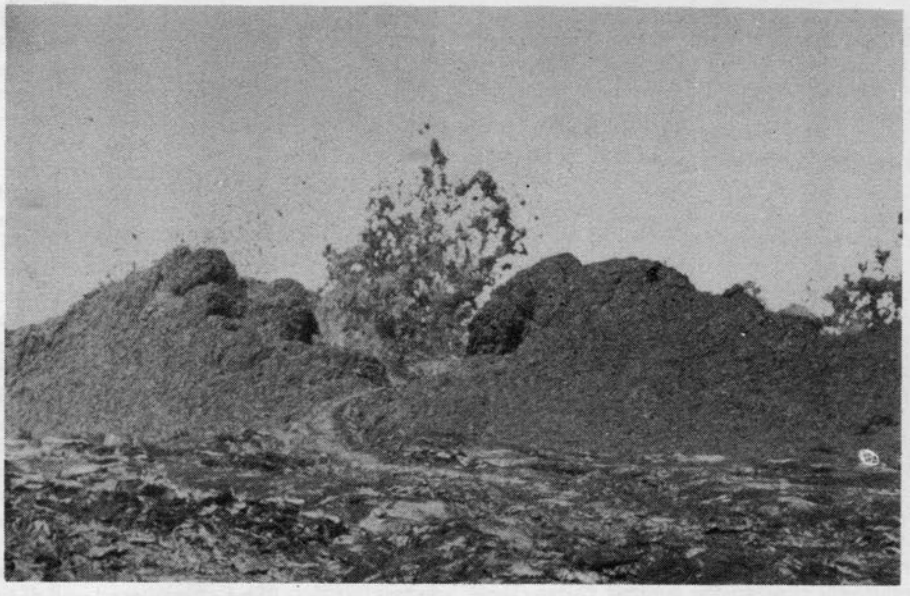


FIGURE 4. Detail of northeast rift fountains November 24, 7 am., showing overflow of pahoehoe lava from the cones. Liquidity low, viscous heavy slag after 60 hours of eruption. Looking northwest.—Photo by C. W. Carlsmith.

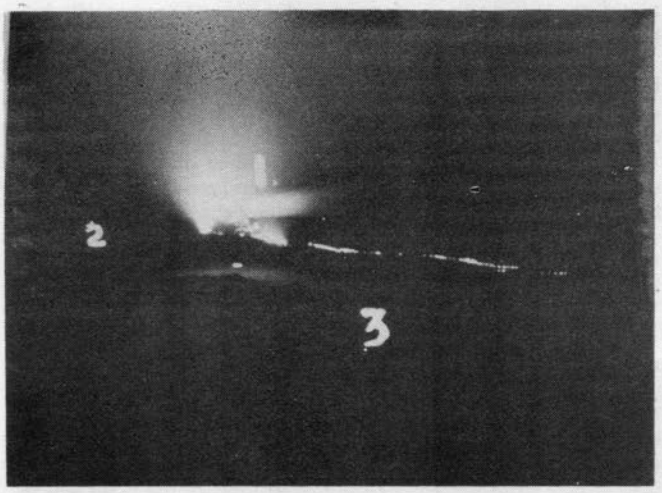


FIGURE 5. Mauna Loa from the north at Humuula evening November 24. To be compared with Figure 6. (1) is the rift fountain area, and long aa flows to the right. (2) later developed a flow source elevation about 9,000 feet. (3) was the flow front November 29. The glow spot between 2 and 3 lights a cloud behind Huluhulu hill. Its meaning is not clear.
—Photo by Hilo Photo Supply.

vent 75 feet NNE of this one emitted gas burning with a blue flame, occasionally jetting up in blasts with yellowish flames, at intervals of from three to five minutes. Seventy-five feet farther NE a spatter cone flung out filaments and gushes of viscous lava, building up the cone rapidly to the size of the larger ones within three hours. There were many vents farther NE flinging out incandescent cinders and showing blue flames or gas blasts. One large vent erupted with a roar at intervals of twenty minutes. Along the course of the flow there was a lava cascade. Crust on the flow would lift like a trap-door and emit rapidly cooling aa. The noise of the fountains was like surf on a rocky coast-line, and the gas vents made prolonged coughing exhausts. This entire history closely resembles that of the 1919 fountains. (See Bulletin Hawaiian Volcano Observatory, October, 1919, pages 131 and 155).

Development of Humuula Flow

As is usual with Mauna Loa outbreaks, the chief characteristic of the first week at the line of fountains, impelled up through the rift by gas-effervescence, was the rapid decline of heat and gas pressure, and the concentration of all activity to one vent (Figures 2, 3, 4). Apparently the rift opened quietly on the west side of the Dewey Crater of 1899, and a flow more than a mile long was reported there the morning of November 24. Then on November 27 there came the report of a light-colored flow originating at elevation 9,000 feet, at a fuming channel in the north side of the mountain midway between the 1899 Flow and the 1843 Flow. The area of this slope of the mountain is vast, and what really happened is obscure. Certain it is that a flow appeared, with a line of smoke at its source, about elevation 8,500 feet, Longitude 155°, 29.5′ west, Latitude 19°, 35.5′ north. Seen from the air, this place had two north-flowing pahoehoe lava channels emerging directly from under the skirt of an old flow. The larger channel had sulphur-stained fume vents along its bank, and inspection at night from Humuula sheep station, 8 miles away, showed bright spots here suggesting small standing fountains. The pahoehoe poured down these channels, spread out and changed into delta-shaped aa fronts, and as the flow progressed, these tended to force each new front farther westward than its predecessor.

The net effect of this, between November 27 and mid-December, was to make great fields of aa lava widening from above downward in the direction of Humuula station, and gradually overlapping the lava flow of 1843, the source being above elevation 8,500 feet, and the wide-spread frontal region in the vicinity of the 6,800 foot contour.

Decline of Upper Rift Fountains

H. S. Palmer and W. O. Clark spent the night November 27-28 at the rift cone, elevation 12,000 feet. There were three most active vents, behind a rampart 500 feet long and about 100 feet high, the NE one being the most energetic, and discharging great quantities of gas-carrying incandescent clots up into the air. The biggest of these were six inches across, sometimes falling outside the rampart and rolling down. Spindle and ribbon bombs were flung up, and others shaped like a dumbbell. The bombs generally followed parabolic trajectories but sometimes they took irregular, wavy paths. At the east end of the heap stood a beehive cone 50 feet high, surmounted by a glowing hole 25 feet in diameter, which discharged tremendous clouds of fume, believed to be steam and sulphur dioxide. The general level of activity was fairly constant with some increasing force about once an hour. There were pulsatory discharges at intervals of from one to five seconds with surf-like noise. The odor was of sulphur-dioxide when the gas came toward the observers, and there were some light drizzles.

This clotted activity reduced to a single vent, with the new pahoehoe lava flow stationary but hot, adjacent to the active cone, was succeeded on November 28 by a sinking away of the fountains so that the surf-like noise was replaced by explosive detonations at intervals, this process flinging out lava spatter and bombs. No glow or flinging out of material was seen at the upper rift source after December 1, but the fume continued to rise there charged with much white vapor. It was evident from the lowering of the lava in this craterlet, and from the explosions during the closing phases of its activities, that the rift underneath communicated directly with the 9,000 foot source of the Humuula flow farther down the mountain; and it did not seem likely that that source was a tunnel leading from the upper cone through new surface flows, as no glow whatever remained in the upper region. This makes it probable that the rift makes a long bend for six miles NE, and then north, under the shell of old lavas, and opens at the lower locality to give rise to the flow. The lower source is more than 3,000 feet below the base of the rift cone, and may be an old tunnel.

It is of interest to note that Ranger Kenneth Williams who was stationed at the upper rift and described the explosive recession of the lava in spells between November 28 and December 1, compared the action to the sinking spells of the lava in Halemaumau, described as "explosive drainages" in September and October 1934. (See Volcano Letter, of those months.)

FIGURE 6. Mauna Loa looking south from Humuula, November 30, 7 am. (1) rift cones: (2) flow source: (3) flow front of aa lava. Sheep pasture and Huluhulu hill in foreground. The glow spot of Figure 5 corresponds to the middle flow region of Figure 6. The upper flows of Figure 5 had now ceased action.
—Photo by Jaggar.

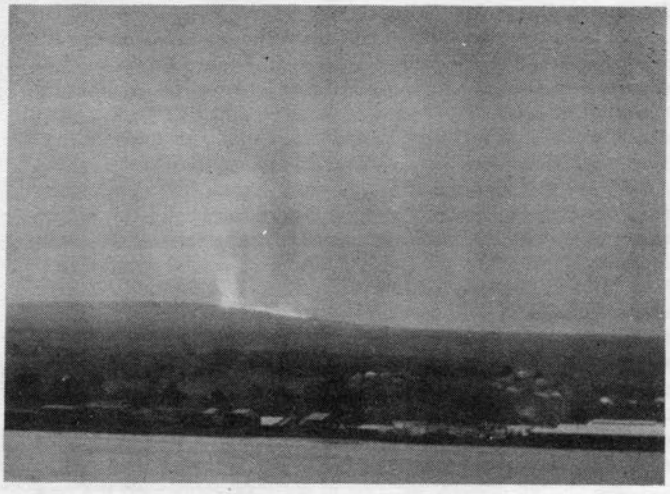


FIGURE 7. Hilo and Mauna Loa eruption, November 22, early morning light. Shows the high fume cloud, the fountains on northeast rift, and the upper flows of the first day sweeping northward. These flows stopped after five days. —Photo by Maehara.

Progress of Humuula Flow

The phases of this eruption had now been (1) Earthquakes of November 21. (2) Summit rift gushing November 21-26, producing short-lived lava flows. (3) Development of Humuula Flow, November 27-December 1, along with subsidence of upper rift lava.

From the hills east of Humuula, November 23, could be seen at night a meandering aa stream headed northwest, and joining a branch headed farther west between Puu Koli and the 1843 Flow, (Figure 5.) November 25, the west branch was visited by Naturalist Doerr, and Park Architect Sager and the live aa of 1935 was found on the west side of the 1843 Flow. The front, of the rough broken lava was 15 to 25 feet high, the end of a lobe moving only a few feet per hour, on top of ancient bushy country where falling incandescent bowlders occasionally set fire to shrubs. The main flow showed glowing areas 10 or 12 feet across. The cooler solidified rocks on top kept rolling down, to be over-ridden by the advancing paste, with a continual cracking noise. An eastern flow some miles away showed heat waves in the air rising above it. That night this east flow was dull and the extreme front of the west flow glowed. The latter came from the 12,000-foot rift.

November 28 the east or Humuula Flow developed a bright new phase of gushing at the 9,000-foot vents, and the west flow from the upper rift went out of action November 29. The new front was four miles north of Humuula on old pahoehoe lava; its middle lobe, fed by a medial stream, pushed ahead 120 feet per hour, November 29. The front as a whole was variable, making probably a half-mile per day. Sometimes the progress would increase, the glowing bank would increase in height, huge bowlders would topple over the front impelled forward on the upper surface of the delta-shaped plateau, and there was steady tinkle of falling debris down the 18-foot wall. Red hot blocks fell out with a musical ringing noise. The pasty swelling forward of the mass was distinctly visible. The behavior was like a caterpillar tractor. When a spell of increased thrust arrived, the front glowed more brightly, the tinkling noises were more continuous, the top of the bank piled up to heights of 20 to 25 feet, and larger fragments fell more frequently.

The flow as seen from Humuula was now like a snake in four meanders, and it had stopped to fan out at the bends. The front visited was 2,000 feet across, and a stream 50 feet wide and dark cherry-red in color occupied a canyon of its own making in the background, to spread in lobes as it fed the delta. The canyon appeared to have cascades of lava as one looked up the mountain, all the other bright places vanishing around bends in a shimmer of heat, and a dark line up the middle of the river marked the characteristic choked zone of rafts and crusts, which come tumbling along on the surface of aa liquid, and occasionally hit bottom.

The front of the flow produced flames, and smoke of the burning sparse vegetation; there were very large bowlders of lava on top of the delta plateau, sometimes 10 feet across and made of pahoehoe lava, where the stream had brought down rafts and thrust them into the lobes. The brightness of glow at the front was a direct measure of the activity of motion. Dust was made by the incessant flow of coarse and fine material down the frontal wall, and there were explosions in old caverns of lava under the flow, where the gases of burnt vegetation mixed up with air and ignited. Such explosions were not conspicuous outside of the front. The progress in 6 days was 0.4 mile per day.

On November 30, the aa front was widening eastward and was less bright and active than on the previous day. As one looked up Mauna Loa from Humuula, the source of the flow was seen to be at the tip of an inverted V of new lava, which meandered back and forth within the V, the swings of the meanders becoming wider towards the front (north). This V-pattern is of the same quality as that of the 1843 Flow, and of most of the flows which originate at a single vent and then widen out in a flat region below. The source of the 1935 flow showed two sulphurous smoking spots sending up a quantity of blue fume, and at night these places were very bright as though they were standing fountains of lava. In a straight line with them just below were several white steam jets, which suggested a crack, producing water vapor from its downhill extension, as in the case of the summit rift, (See figure 6). All this time the summit rift cone sent up dense fume clouds and at night the glow there was growing fainter. This was the time of the lowering lava in the shaft, and of the explosions.

—T. A. J.

EARTHQUAKES **TABLE**

Week ending	Minutes of tremor	Very feeble earthquakes	Feeble earthquakes	Slight earthquakes	Moderate earthquakes	*Local Seismicity
Nov. 3	41	7	1	0	0	14.75
Nov. 10	37	4	0	0	0	11.25
Nov. 17	44	4	0	0	0	13.00
Nov. 24	3281	8	2	2	1	835.75
Dec. 1	157	5	0	0	0	41.75

*For local seismicity index see Volcano Letter 371.

Epicenters of the following local disturbances were determined by means of seismograms from the stations operated by the Hawaiian Volcano Observatory on the Island of Hawaii. Kilauea earthquakes were located by means of the main seismograph station at the Observatory and the two subsidiary stations located at Uwekahuna Museum and the SE rim of Halemaumau respectively. The more distant of these quakes were located with the aid of seismograms from stations at Hilo and Kealakekua. All the disturbances began at the time indicated and whenever determinations were possible, the depth of focus is given.

November 1, at 6:23 pm, very feeble, located in vicinity of the S rim of the Crater of Kilauea.

November 1, at 6:34 pm, feeble, located 0.8 mile under N rim of Halemaumau. 19° 24.7′ N; 155° 17.2′ W.

November 1, at 7:40 pm, very feeble earthquakes in the same location as the one preceding.

November 7, at 5:36 am, very feeble, located 4.6 miles deep and 3.2 miles west of the Volcano Observatory. 19° 25.9′ N; 155° 18.6′ W.

November 17, at 1:52 am, very feeble, located 12 miles deep and 8 miles NW of Humuula Sheep Station. 19° 48′ N; 155° 32.5′ W.

November 18, at 3:04 pm, very feeble, located approximately under NE edge of Mokuaweoweo.

November 20, at 5:57 am, very feeble, located 4.5 miles deep and 1.8 miles W of Halemaumau. 19° 24.9′ N; 155° 18.8′ W.

November 20, at 11:52 am, very feeble. Probable location on NE rift of Mauna Loa halfway between Hilo and the summit crater, Mokuaweoweo.

November 21 at 1:11 am, a moderate earthquake was gen-

erally felt on the Island of Hawaii and was reported felt at Waikiki on the island of Oahu, and at Hana on the island of Maui. It was most strongly felt at Kapapala Ranch where the shock lasted one and a half minutes, made a noise like an explosion, knocked objects from shelves, broke one window, knocked over bottles and cause a tube of tooth paste to fall into a wash basin. In the Kilauea area, people were generally awakened, pheasants called, and in one case books were reported knocked from shelves. The seismographs at all stations were dismantled. Location in NE rift of Mauna Loa five miles SW by W from the rest house at Puu Ulaula and an equal distance NE by E from the center of Mokuaweoweo Crater. This quake was evidently caused by the opening of the NE rift in this vicinity resulting in the Mauna Loa eruption which started seventeen hours later. The depth of the quake is uncertain but is estimated to be not more than five miles and was probably less. 19° 31′ N; 155° 31.5′ W.

November 21, at 6:35 pm., there was a slight earthquake which probably marked the visible beginning of the Mauna Loa eruption. Preceding this shock, there were fourteen minutes of harmonic tremor, interrupted by a very feeble quake at 6:33 pm. Following this there were 3 more minutes of harmonic tremor. The tremor was interrupted by another slight earthquake at 6:42 pm. At 6:45 pm there was a feeble earthquake with its origin indicated as being at the NE edge of Mokuaweoweo Crater. Another feeble quake followed at 6:49 pm, located approximately 6 miles W of Puu Ulaula on Mauna Loa NE rift. A very feeble earthquake occurred at 6:58 pm. Harmonic tremor continued until midnight November 24. Tremors continued with a decreasing rate of frequency until the end of the month. The locations of these disturbances were approximately along the NE rift of Mauna Loa from the NE edge of Mokuaweoweo to a point approximately four miles SW by W from the rest house at Puu Ulaula. None of the shocks associated with the Mauna Loa outbreak was reported felt.

The harmonic tremor had a period of 0.6 second. The amplitude varied but indicated a ground movement at the Observatory of between 1 and 10 microns the first three days of the fountaining activity. Afterwards the tremors became intermittent with a decrease of both frequency and intensity.

November 24, at 2:46 pm, very feeble, 0.6 mile deep and 0.5 mile east of Tourist Stand on SE rim of Halemaumau. 19° 24.5′ N; 155° 16.6 W.

November 27, at 12:30 am, very feeble, 9.5 miles deep and 4.8 miles NW of Puu Ulaula on N slope of Mauna Loa. 19° 33.7′ N; 155° 32.0′ W.

November 27, at 6:15 pm, very feeble, located 1.1 miles deep 0.4 mile SW of Pit seismograph station. 19° 24.2′ N; 155° 17.2′ W.

November 29, at 1:48 pm, very feeble, located 0.5 mile SW of Pit seismograph. 19° 24.0′ N; 155° 20.6′ W.

No distant earthquakes were recorded.

Microseismic motion was normal, November 1, 2, 8, 11 to 13, 16 to 22, 25 to 27, 29 to December 1, inclusive. It was strong the remainder of the month except November 14, 15, 23 and 24, when it was light. —H. H. W.

Tilting of the Ground

The following table shows tilt by weeks from seismograms at the Volcano Observatory NE rim of Kilauea Crater and at Halemaumau the algebraic sum of radial tilts for two clinoscope locations towards or away from the crater of the Pit.

At the Observatory the total accumulated tilt for the year ending December 1, was 1.3″ S and 3.85″ E.

TABLE OF TILT

Week ending	Observatory	Halemaumau Clinoscope Stations		
		West	Southeast	Pit resultant
Nov. 3	0.15″ E	1.04″ E	7.78″ N 11° E	6.22″ toward
Nov. 10	0.32″ S 41° E	5.13″ N 5° W	2.30″ S 55° E	2.12″ from
Nov. 17	0.83″ S 45° E	5.36″ N 5° W	12.96″ S 78° W	5.51″ toward
Nov. 24	1.83″ N 45° E	3.28″ N 75° W	14.90″ N 47° E	1.20″ from
Dec. 1	0.91″ N 70° E	1.88″ N 59° W	8.26″ N 30° E	1.75″ toward

H. H. W.

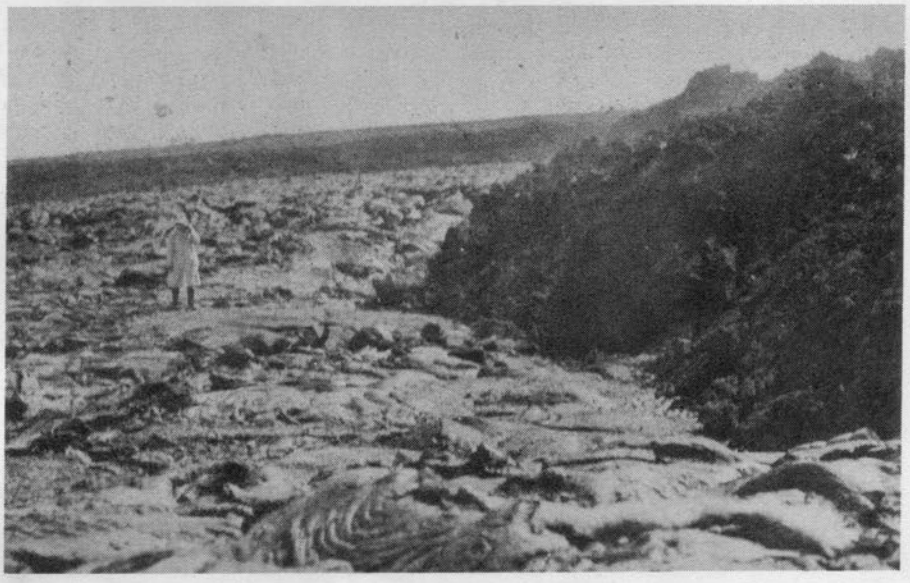
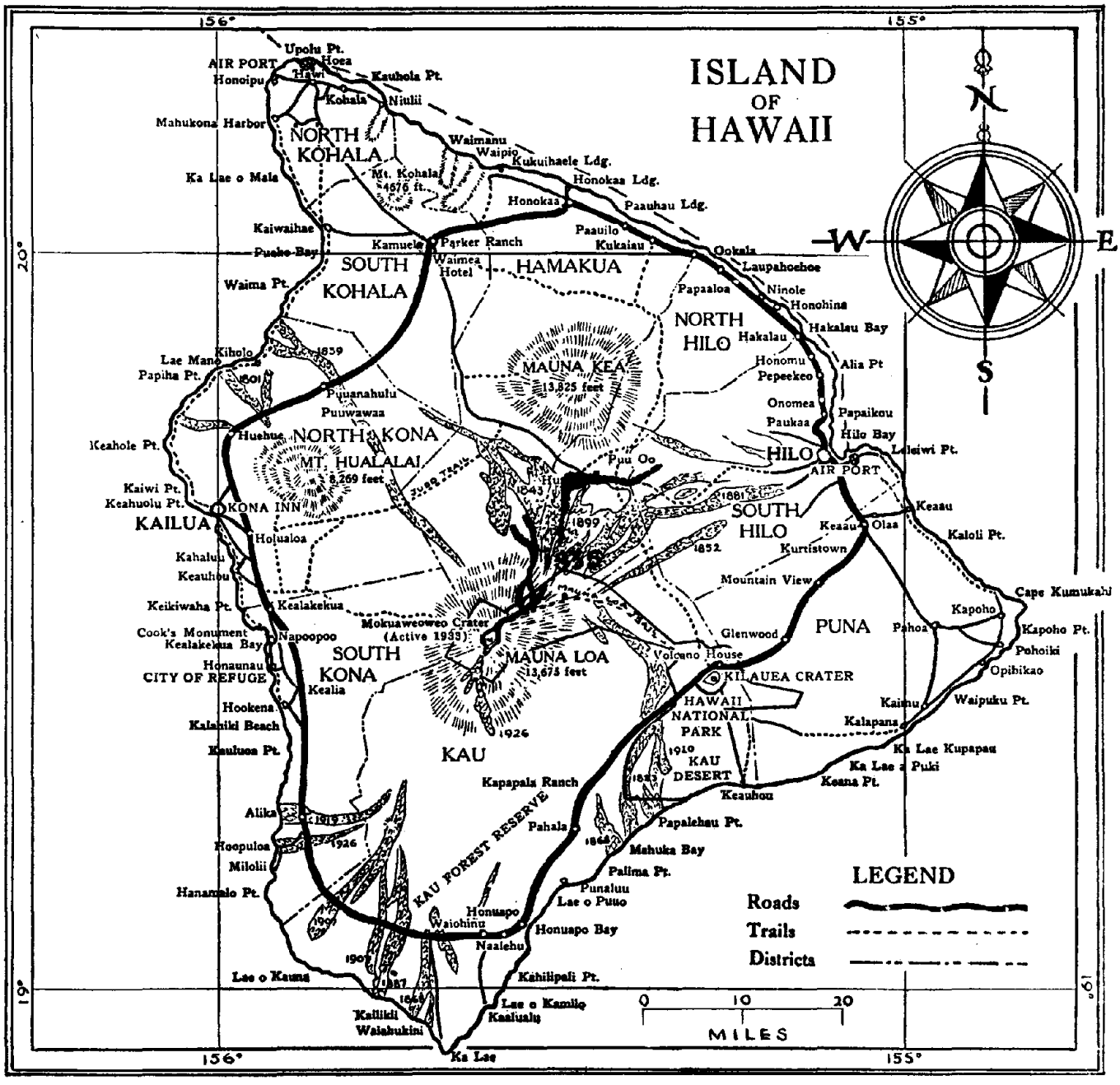


FIGURE 8. Front of glowing aa lava, 18 feet high, moving over old pahoehoe, right to left, at a rate 120 feet per hour. Looking east, 3.3 miles southwest by south from Humuula Station, 11 am., November 29. This was one of a succession of lobate fronts that moved north northwest from the 9,000-foot source, down the north slope of Mauna Loa—Photo by Jaggar.


ISLAND
OF
HAWAII
N
S
E
W
156°
155°
20°
19°
Upolu Pt.
AIR PORT
Honoipu
Hawi
Hoea
Kauhola Pt.
Kohala
Niulii
Mahukona Harbor
NORTH KOHALA
Waimanu
Waipio
Kukuihaele Ldg.
Ka Lae o Mala
Mt. Kohala 4676 ft.
Honokaa Ldg.
Honokaa
Paauhau Ldg.
Kaiwaihae
Kamuela
Parker Ranch
Paauilo
Kukaiau
Ookala
Puako Bay
SOUTH KOHALA
Waimea
Hotel
HAMAKUA
Laupahoehoe
Waima Pt.
Papaaloa
Ninole
Honohina
NORTH HILO
Hakalau
Hakalau Bay
Lae Mano
Kiholo
1859
Papiha Pt.
1801
MAUNA KEA
13,825 feet
Honomu
Pepeekeo
Alia Pt
Puuanahulu
Puuwawaa
Onomea
Papaikou
Paukaa
Hilo Bay
Keahole Pt.
Huehue
NORTH KONA
MT. HUALALAI
8,269 feet
HILO
Leleiwi Pt.
Puu Oo
AIR PORT
Kaiwi Pt.
Keahuolu Pt.
KONA INN
1843
1881
SOUTH HILO
Keaau
Olaa
Kaloli Pt.
KAILUA
1899
1852
Kurtistown
Holualoa
Kahaluu
Keauhou
Mountain View
Cape Kumukahi
Keikiwaha Pt.
Kealakekua
Kapoho
Mokuaweoweo Crater
(Active 1933)
Cook's Monument
Kealakekua Bay
Napoopoo
Glenwood
PUNA
Pahoa
Kapoho Pt.
SOUTH KONA
MAUNA LOA
13,675 feet
Volcano House
Pohoiki
Honaunau
CITY OF REFUGE
KILAUEA CRATER
Opihikao
Kealia
Hookena
HAWAII NATIONAL PARK
Kaimu
Waipuku Pt.
Kalahiki Beach
1926
Kalapana
Kaulusa Pt.
1910
KAU DESERT
Ka Lae Kupapau
KAU
Ka Lae a Puki
Kapapala Ranch
1823
Keana Pt.
Keauhou
Alika
1919
Pahala
Papalehau Pt.
Hoopuloa
1926
1868
Mahuka Bay
KAU FOREST RESERVE
Milolii
Palima Pt.
Punaluu
Hanamalo Pt.
Lae o Puuo
Honuapo
Waiohinu
Honuapo Bay
Naalehu
Lae o Kauna
1887
Kahilipali Pt.
Kailiki
Waiahukini
Lae o Kamilo
Kaaluulu
Ka Lae
0 10 20
MILES
LEGEND
Roads
Trails
Districts

THE VOLCANO LETTER

No. 430—Monthly, Department of the Interior, National Park Service, December, 1935

Hawaii National Park
Edward G. Wingate, Superintendent

Hawaiian Volcano Observatory
T. A. Jaggar, Volcanologist

HAWAIIAN VOLCANO OBSERVATORY REPORT FOR DECEMBER, 1935

Including weekly press reports 1246 to 1249
December 1 to December 29, 1935 Midnight

FIGURE 1. December 21. Pahoehoe flow at Humuula, advancing towards Hilo. Bronze in general color with glowing, cherry-red "toes."

VOLCANOLOGY

The release of gas, of molten lava, and of heat achieved in great quantities by the outflows of the Mauna Loa eruption in December, which continued throughout the month, reacted at Kilauea in a pronounced decrease in numbers and intensity of tremors and earthquakes. The weekly local seismicity declined from 30.50 to 4.25. This did not mean a decline in the volume of Mauna Loa outpouring, for seventy per-cent of the earthquakes located were Kilauea shocks. It appears rather to mean that a free release of thermal energy for the whole volcanic system, if continued through open vents, reduces the local seismicity. Thus we find the average weekly seismicity for October 27, for November 20, (disregarding the excessive figure for the week of outbreak, due to continuous tremor) and December 14. This tendency has been observed in other eruptions and suggests that abortive eruption or intrusion accounts for times of high seismicity.

A correspondence between the release of heat at Mauna Loa and an observed lowering of temperature at Kilauea was noted. The time when blue fume disappeared at the northwestern Yellow Solfatara in Halemaumau, November 18, three days before the Mauna Loa outbreak, was characterized by cooling of the bath steam in the Observatory ground. By December 18, sulphur fume reappeared at the pit and the vapor temperatures became hot again at the Observatory.

An observation worth recording reported by A. M. Brown of Keahou Ranch is the following:—

On July 22, 1935 at 4:30 am, along the Puu Oo trail, on the east slope of Mauna Loa about elevation 5,000 feet, between Keahou Ranch house and Keawewai Camp, in old pahoehoe lava, five persons noted hot places in the ground.

Kilauea Observations

Slides of Halemaumau

Slides from the wall of the pit have been noted as follows:—

December 5, continuous small sliding from W, NW, and N walls, 10:05 am
December 13, slides occasioned by slight earthquakes 9:31 am
December 13, dust rose from NW side at 12:49 and 12:55 pm
December 19, rocks were dribbling at E wall, 9:50 am
December 21, fresh scar observed on NE wall 10:00 am
December 22, avalanche dust arose NE, 12:55 pm
December 26, small slide E wall 9:58 am
December 26, noisy slide and dribbling of rocks at N wall, 10:03 am
December 27, small slide NE wall, 9:45 am
December 28, small slide N wall, 10:23 am

Such slides during the inspection hour indicate the average conditions.

For the last two weeks of the month, volcanic conditions at Kilauea were unusually and increasingly quiet.

Halemaumau Solfataras

Observations of the sulphurous fumaroles around the edges of the Halemaumau floor, and of the vapor cracks, have been as follows:—

December 3, almost no fume visible at NW Solfatara, fumes strong, from new sulphur spot SE, 10:20 am
December 5, fume normal at all vents, 10:05 am
December 13, new sulphur spots noticed SE 9:30 am
December 19, abundant fume in pit, apparently increasing at border crack SE 9:50 am

Measurement of Halemaumau Rim Cracks

Weekly measurement of 32 marked places on rim cracks around the upper edge of Halemaumau pit resulted as follows:—

Week ending forenoon of

Dec. 7,	6 opened,	3 closed,	aggregate opening	4.0 mm
Dec. 14,	17 opened,	1 closed,	aggregate opening	14.0 mm
Dec. 21,	8 opened,	3 closed,	aggregate opening	5.5 mm
Dec. 28,	6 opened,	7 closed,	aggregate opening	1.0 mm

—T. A. J.

Crater Angles

The horizontal angle measurement from Observatory showed a closing of the angle between SE and NW rims of Kilauea Crater, 1.0" comparing December 9, to December 19, and showed no change comparing December 19 to January 9, 1936.

The same kind of measurement across Halemaumau pit from the Observatory showed a closing of 2.2" between December 9, and December 19, and an opening of 1.2" between December 19 and January 9, 1936.

HAWAIIAN VOLCANO OBSERVATORY REPORT
Week Ending December 8, 1935

The northern flow of the current Mauna Loa eruption continued its advance during the week. The front of the flow moving to the north and west has reached a point within two miles of the Humuula Sheep station. All forward motion of the main flow had apparently stopped however, by December 7. The glow from the aa river feeding the flow was reported to be quite bright on the evening of December 7, showing that fresh lava was still being fed to the stream. At several localities the channel was probably being blocked by cooling lava as small flows issued from the stream and flowed for short distances from the side of the main flow. The upper source fountains have ceased all visible activity although a glow was still noticeable at that point from the north side of the Island, December 7. No glow at that point has been visible from the Observatory this week although heavy fume columns were visible during the day until December 6. Cloudy weather has prevented observation since that date but the fume was greatly diminished when last observed.

Little or no fume was visible at the N.W. solfatara of Halemaumau December 3, at 10:20 am; at the same time the fume from the comparatively new sulphur spot at the S.E. edge of the floor of Halemaumau was rather strong. The weather was rainy and the wind was moderate from the Northeast. Fume was apparently normal from all vents in Halemaumau at 10:05 December 5. Small slides occured from the west, northwest and north walls at this same time.

116 local seismic disturbances were registered on the Observatory seismograph of which 112 were tremors, one was a feeble earthquake and three were very feeble earthquakes. The feeble earthquake occurred at 9:13 pm, December 4 and was 2.4 miles from the Observatory probably under Halemaumau. It was reported felt at the C.C.C. Camp. The very feeble earthquakes were, December 2, at 7:55 am at a distance of 17.8 miles; December 3, at 6:30 am at a distance of 19.4 miles; and December 7, at 12:31 am at a distance of 2.4 miles. Those of December 2 and 3 were probably associated with the Mauna Loa eruption. Seismic index for the week was 30.50. Microseismic motion was normal but increased to strong on December 8. Tilting of the ground at the Observatory was slight S by E.

Measurement for the week of 32 crack localities around Halemaumau, December 7, showed that 6 had opened and 3 had closed for a resulting aggregate of 4.0 millimeters opening.

One hundred and sixteen local seismic disturbances were recorded at the Volcano Observatory during the week.

At 9:13 pm, December 4, a feeble earthquake was registered. The shock was apparently centered 2.4 from the Observatory under Halemaumau. The Pit seismograph was dismantled and the quake was reported felt at the C.C.C. Camp.

The following very feeble earthquakes registered.

December 2, at 7:55 am, at a distance of 17.8 miles
" 3, at 6:30 am, " " " " 19.4 "
" 7, at 12:31 am, " " " " 2.4 "

A total of 112 tremors were recorded for the week.

Seismic indices (0 to 12 miles: :1.50) (0 to 66 miles: : 1.00) Weekly 30.50.

Tilt—Dec. 2	61	184	M	
" 3	62	185	M	
" 4	62	182	M	
" 5	62	182	M	
" 6	65	180	M	
" 7	68	174	M	
" 8	64	168	St	
	63	179		63 179
	59	178		-17 000
	4 S	1 E	Slight S by E tilt	46 179 To compare with next week.

Of 32 crack points measured December 7, 6 opened, 3 closed for an aggregate opening of 4.0 millimeters.

HAWAIIAN VOLCANO OBSERVATORY REPORT
Week Ending December 15, 1935

The Mauna Loa eruption continued, with the front of the flow changing to pahoehoe, or glassy liquid lava, a half mile from the cones immediately west of Humuula. The pahoehoe has come down the lava channel overriding the aa fields. December 9 the aa front was three quarters of a mile from the foot of Mauna Kea and at 8 p.m. the pahoehoe began spilling out the west side of the front. The upper lava rivers were voluminous and

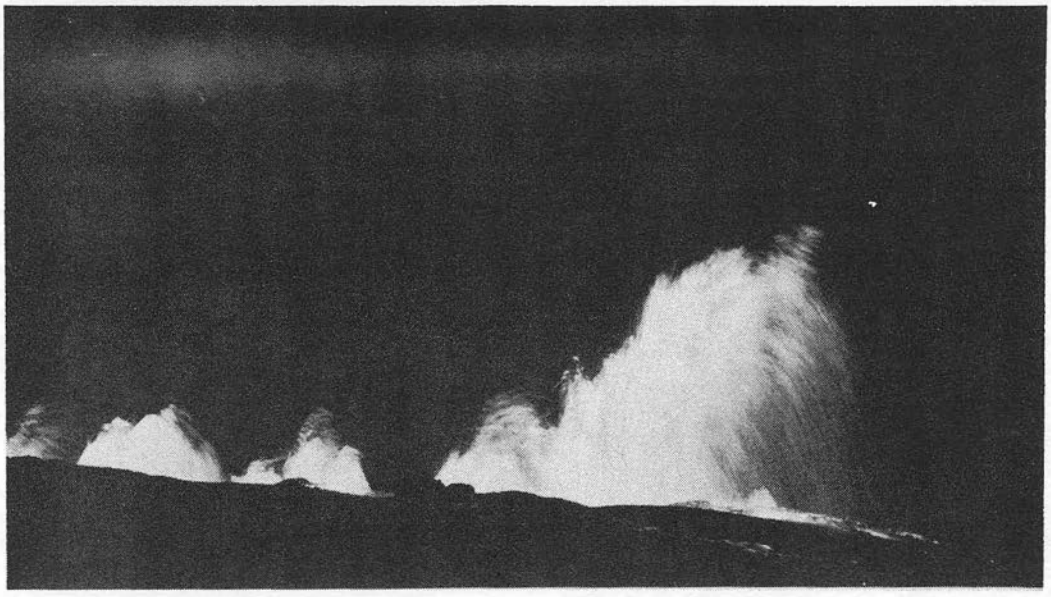


FIGURE 2. November 23, 7:00 p.m. Great fountains over rift-line. Right-hand fountain is approximately 400 feet high. —Photo by Wingate.

brilliant. The rift cones smoked, and the 9000-foot source made a line of smoke holes. December 10 the front slowed, but above there was dusty aa in motion. December 11 the front stopped. From Kilauea and Hilo there was smoke seen at the rift cones and glow above the lava flows. December 12 there was slight revival of the pahoehoe front which stopped the next day. December 14 the piling heaps of pahoehoe at the 9000-foot source appeared to make scattered flows westward. December 15 new aa fronts moving west from the heap and the big lava rivers of the middle slopes of the mountain increased in size.

Halemaumau has shown nothing of importance. A slight earthquake there December 13 at 9:30 am made some sliding. New sulphur spots were noticed southeast. Measurement December 14 of the 32 marked places on cracks around Halemaumau indicated that 17 had opened, 1 had closed, result in aggregate opening of 14 mm.

Assistant Naturalist H. H. Waesche reports 55 local seismic disturbances and one distant earthquake. The distant large earthquakes indicated origin 3780 miles away and began at 8:47 pm December 14.

A slight earthquake of 9:31 am December 13 was felt strongly at Halemaumau and a feeble shock 2:33 pm December 14 indicated origin 18 miles away from Kilauea, the distance of the Mauna Loa rift source of the present eruption. Very feeble earthquakes were registered December 10 at 6:09 am and 6:19 pm, distances 19 and 20 miles, December 11 at 1:36 pm distance 32 miles and December 13 at 9:31 am, distance 2 miles. Forty-nine tremors were recorded. Seismis index for the week was 17.25. Miscroseismic motion was strong. Tilting of the ground at the Observatory was slight NE.

Fifty-five local seismic disturbances were recorded at the Volcano Observatory during the week.

At 9:31 a.m., December 13, a slight earthquake was registered. The shock was centered under Halemaumau, 2.4 miles from the Observatory. It was felt by a few around the National Park Headquarters area and strongly by several on the rim of Halemaumau. The E.W. component of the Pit seismograph was dismantled.

A feeble earthquake registered at 2:33 pm, December 14. Its distance was 18.3 miles and was probably associated with the Mauna Loa eruption.

The following very feeble earthquakes were recorded.

December 10, at 6:09 am, at a distance of 18.9 miles
" 10, at 6:19 pm, " " " " 20.2 "
" 11, at 1:36 pm, " " " " 31.9 "
" 13, at 9:31 am, " " " " 2.4 "

There were a total of 49 tremors. The preliminary waves of a teleseism began recording at 8:47 pm, December 14. Distance 3,780 miles.

Seismic indices (0 to 12 miles: :1.50) (0 to 66 miles: : 3.50) Weekly 17.25.

Tilt—Dec.	9	47	164	St		
"	10	49	169	St		
"	11	49	175	St		
"	12	46	180	St		
"	13	41	182	St		
"	14	37	184	St		
"	15	36	186	St		
	44	177	Tilt this week		44	177
	46	179	Tilt last week		0	-13
	2N	2W	Slight NE tilt		44	164

To compare with next week.

Of 32 crack points measured December 14, 17 opened, 1 closed for an aggregate opening of 14 millimeters.

HAWAIIAN VOLCANO OBSERVATORY REPORT
Week Ending December 22, 1935

The Mauna Loa lava flow bent eastward toward Hilo December 22, creating a crisis. December 16 the brown fume arose densely at the rift sources, and glow of the pahoehoe streams was visible at Hilo and at Kilauea. These streams December 17 revived the front opposite Humuula. December 19 this pahoehoe lava moved northeast 1800 feet, and spread out in a sheet east of the 1843 flow, one-half mile south of the stone wall extending west from Puu Huluhulu at Humuula.

December 20, just on the solstice, with a spurt forward, the liquid overflowed the wall for one-half mile, fronting Puu Huluhulu within one-quarter mile. December 21 the forest and grass lands were burning on the flat south of Humuula sheep station. December 22 the pahoehoe lava passed Puu Huluhulu, between that hill and Mauna Kea, flowed eastward more than a mile, with a front 200 feet wide, and tended by reason of slope and stirring to change to aa lava. The progress had been one-quarter mile per day; it suddenly changed to one mile or more a day, draining the large lake which had accummulated in the saddle between Mauna Loa and Mauna Kea. The source heaps on the north flank of Mauna Loa were now brilliant with a meandering pahoehoe stream of liquid fiery lava, and soon the lava field closed around the Huluhulu hill, and sent a second stream on its south

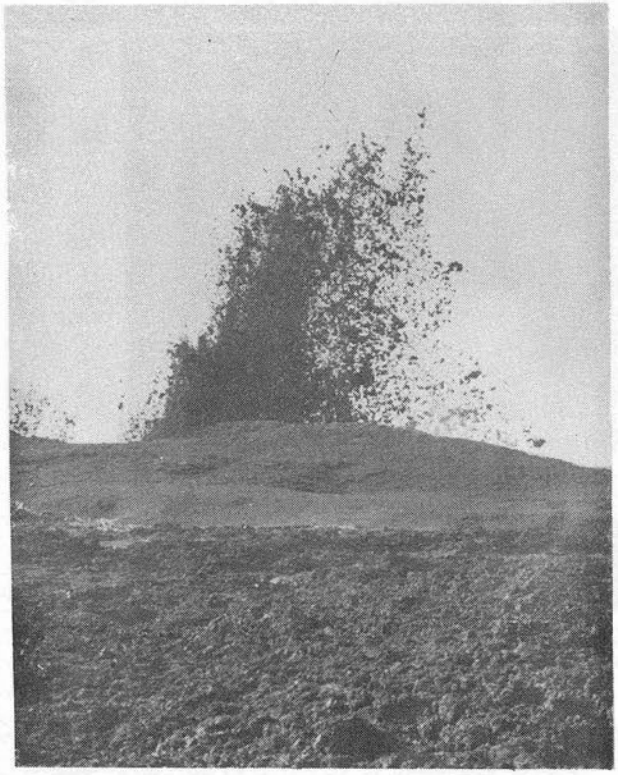


FIGURE 3. November 23, 2:00 p.m. 250-foot fountain over vent in lowest series. —Photo by Wingate.

side to join the main east-flowing river of slag. The flow-source about 9000 feet elevation, exhibits, from the air, a channel 40 feet wide emerging from under dead flows above, with smoking grottoes or vents, and silvery splashes of distributary pahoehoe make a widening feather-pattern down the mountain north, into which the glowing river disappears under gleaming crust. This flow source led into the rift belt southward, toward Mokuaweoweo at 13,000 feet where the eruption began on November 21. At elevation 11,000 to 12,000 feet, the 1935 cones and chasms of the rift belt sent up brown fumes in seven columns, densest at the big new cone. The cone lies at the southern end of the active cracks, which form a zone 3 miles long.

The eruption thus has three centers: The main summit crater shaft, the secondary smoke shaft within which the lava has lowered and the flow vent which siphons the liquid out at a single point. The liquid crusts and pours in tunnels down the mountain under its crust, distributing to numerous fronts. It is necessary to keep the upper smoke shaft and the lava vent separately in mind—they are six miles apart—in order to understand future developments.

At Halemaumau pit of Kilauea volcano trivial slides were observed December 21 and December 22. The reduction of blue fume at the Yellow Solfatara noted November 18 just before the Mauna Loa outbreak, was accompanied by cooling of the bath steam in the Observatory grounds. Both visible sulphur fume at the pit and steam temperatures at the Observatory, had returned to normal December 18.

Measurement of 32 marked crack localities, around Halemaumau pit, for the week ending December 21, showed that 8 opened and 3 closed, making aggregate opening of 5.5 mm.

The seismographs show approximately 31 disturbances, of which 29 were very feeble shocks and tremors. Feeble earthquakes occurred about 12:54 pm December 17, and 5:23 am December 20. Formal seismometric report will be made in January.

HAWAIIAN VOLCANO OBSERVATORY REPORT
Week Ending December 29, 1935

The Mauna Loa eruption continued to eject dense vapor and fume from the sulphur-stained rift cone at elevation 1,200 feet. December 23, the lava flow was 2 miles east of Humuula, about 200 feet wide, changing from pahoehoe lava to aa lava The stone wall drowned under a lake of lava, south of Humuula, tended to reappear as the lake level sank. Explosions were common in old cavities along the lava fronts. This had occurred from the time vegetation made carbon monoxide gas, and the liquid lava penetrated cracks and pockets under the soil, where mixtures of gas and air were ignited. In some places hundreds of feet from the lava front, bluish flaming gases of charred grass roots, shot up through sandy hollows. The explosions disrupted old rock surfaces, and made cannon-like detonations. December 24, smoke and glow at the saddle between Mauna Loa and Mauna Kea were plainly visible from Hilo. The aa flowed more slowly. December 25, a tongue of the front reached Puu Oo ranch, reaching the wall at 11 am; it had been wholly within the Parker Ranch. December 26, the front increased its speed locally to 800 feet per hour. The average progress was one mile per day on a grade 157 feet to the mile, steeper to the east. At this rate, the flow would have been in the Kaumana road of Hilo on January 9. The widest parts of the flow reached a breadth of 2000 feet, where there was a spreading out on flat places.

The volcanologist recommended bombing the source at elevation 8500 feet on Mauna Loa, to break up the stability of the flow tunnels, and to divert the flowing at the source region. This was done by U. S. Army bombing planes December 27, after the officers were shown the target, from the air. Six tons of T.N.T. explosive were detonated about the vent and channel. Fresh incandescent streaming there was seen December 28, and dusty aa flows in motion immediately below on the mountain slope were detected December 29 and later. At the front fifteen miles away down the lava stream, 33 hours after the bombing, the front stopped moving for a half-day in Puu Oo ranch. Apparently the violent release of lava, of gas and of hydrostatic pressure, at the source, robbed the lower flow of its substance, and of its heat.

At the lower front there was only side and frontal spilling of viscous channel lava thereafter. The total forward motion December 28 was approximately 1000 feet, and December 29, 500 feet. In the pooled pahoehoe lava of the divide at Humuula, fresh puddles of glistening slag welled up through cracks. The night following the bombing, the glow of the middle lava channels had been very brilliant, probably occasioned by drainage of the tunnels and over flowing of clogged canals.

At Halemaumau pit of Kilauea volcano conditions have been unusually and increasingly quiet. There were small slides at the east and north walls of the pit 9:58 am and 10:03 am December 26, at the northeast wall 9:45 am December 27, and at the north wall 10:23 am December 28, during inspections.

Measurement of the 32 rim crack localities around Halemaumau, for the week ended December 28, showed that 6 had opened and 7 had closed, resulting in aggregate opening of 1.0 mm.

H. H. Waesche, Assistant Geologist, reports as follows for the seismographs at Kilauea crater:—

For the week ending December 22, there were 21 local seismic disturbances, of which 18 were tremors, and 3 were very feeble earthquakes. The latter were at 12:13 am December 18, distance of origin 11 miles, 2:52 pm December 22, distance undetermined, and 6:35 pm December 22, distance 1.6 miles, Seismic Index was 6:00, microseismic motion was strong, and tilting of the ground at the Observatory was moderate SW by W.

For the week ending December 29, there were 17 local seismic disturbances, all tremors. At 4:31 pm December 27, a distant earthquake began recording, distance not evident. Weekly local seismic index was 4.25. Microseismic motion was strong. Tilting was moderate W by N.

JOURNAL MAUNA LOA ERUPTION DECEMBER, 1935

December 1

At 4:30 pm Mauna Loa showed three very slight puffs at rift source as seen from Observatory; Humuula reports glow of flow and aa progress still strong, but only smoke was seen at rift cone where glow has ceased. The flow was pushing its front NNW about a half-mile per day toward the 1843 pahoehoe.

FIGURE 4. December 21. Pahoehoe advancing through forest land and forming tree-molds by solidifying around the tree-trunks which are then burned away—leaving perfect casts of themselves in the rock.
—Photo by Maehara.

December 2

Strong white cauliflowers of fume rose at the rift source, and rumbling was heard there. The front of the Humuula Flow and its medial river were very bright and reported moving 150 feet per hour with the front migrating westward from its position of November 29.

December 3

At the resthouse on Puu Ulaula, elevation 10,000 feet NE side of Mauna Loa, a rushing noise could be heard underground along with rumbling in the direction of the 1935 fissure. The flow was reported to be overlapping the eastern belt of 1843 pahoehoe. It was said to be two miles nearer Humuula than on November 29. From eastern parts of the island, the bright glow had shifted from the source region to the flow region, so that from Kilauea and Hilo it stood as a broad band of light on the clouds, back of the lower northeastern Mauna Loa slope.

December 5

Two or three new lobes were moving west from the flow and the front progressed rapidly along the 1843 Flow overlapping the middle aa of that year. Seen from the air, the smoking source region of the flow, at elevation 8500 feet, appeared to be streams emerging from under the crust of an older flow.

December 6

The conspicuous feature of this day was the bright glow at night over the flow region, while the fume at the upper rift cone rose in great volume with ginger-red color and dense volutes.

December 7

The brightness of the Humuula Flow was occasioned in part by the development of floods of pahoehoe lava moving down the medial river channels of the main aa stream. When this happened, the front of the aa moving north, had spread into a wide delta about 2 miles south of the Omaokoili Hills, and its lateral spreading had checked its forward motion. It is probable that at this time side streams were making out from the source heap. The glow from the aa river was bright this evening, showing that fresh lava was still coming down, but small flows were issuing from the sides of the main aa flow. Glow was still seen occasionally at the upper rift conelet.

December 8

The source heap of the Humuula Flow was now developing pahoehoe lava veneering over its upper slopes and spreading down the big aa channel that led to the front.

December 9

The upper rift cone had now settled down to steady ejection of sulphurous fume clouds. The aa front of the Humuula Flow was three-quarters of a mile from the foot of Mauna Kea. From Humuula, the big flow was seen to be fed by a bright meandering river zig-zagging down the mountain, with its wide front west of the position of November 29, and 1.9 miles farther north. The front lay in the 1843 aa. About 8:00 pm the main feeding river began spilling pahoehoe lava at a position on the west side of the front; this was very brilliant, in contrast to the somber red of the aa river.

December 10

A visit to the front this day discovered a field of shallow slabby pahoehoe of thick porridge-like consistency, moving along the aa front eastward to within 200 yards of where that front lay on the eastern marginal strip of 1843 pahoehoe. The 1935 aa made occasional cavings along its front and showed red glow in cracks. Its wall was 20 feet high. The pahoehoe was spreading out vigorously on the 1843 aa, but it did not quite reach the eastern band of 1843 pahoehoe. Many pasty toes of lava were progressing, perhaps one-quarter mile per day as a whole, and the entire front was about one-half mile wide in an EW direction. The surface of the aa fields sloped down to where the river of pahoehoe swept in a curve from the west side of the front. This river then spread out eastward at the base of the aa wall. There was thus a narrow pahoehoe delta about 5 feet high, in front of the much higher and wider aa delta. The feeding river af pahoehoe coursed down the west side of the upper aa fields.

Looking from the summit of Puu Huluhulu at 3:00 pm the summit rift conelets of 1935 were seen to have their greatest development at the upper end where heavy fume rose in four jets. Farther to the left (NE) were three other faint vapor jets among small cones. On the mountain slope below were the floods of lava of November, with islands of old light-colored lavas amid the new dark streams. At the source of the active flow, in the direction of Pukauahi two-thirds of the way up the mountain, could be seen a line of blue smokes from separate vents trending apparently NNW, and the belt of aa streams meandered from that point, towards Humuula in three stretches, respectively, NNW, NNE, and NNW with bends between. The whole field at this time was mostly aa except for some silvery gleam of pahoehoe in the source region, and below, where a narrow band of the frontal pahoehoe made a fourth meander stretched eastward. Portions of the dull red river that occupied the main channel were visible in places where the bends of the channel made the gorge visible to an observer at the north. There were several places where aa was

in motion at tumbling fronts, which may be described as moving lobes at the meander elbows, particularly on the east side of the flow as seen from this position. These places sent up dust and also made some smoke, probably due to burning vegetation. They represented the eastern corners of successive deltas of aa which overlap in plan from SE to NW from about elevation 7,200 feet on the mountain. The second of these aa fronts made a huge wall more than 50 feet high and this was caving and making dust.

The process of the interior progress of an aa delta is exhibited by some of the vertical airplane photographs. These show wide medial streams and frontal outlines in plan like a feather to which the stream is the quill. On flat ground, these streams thicken, pile up, show transverse wrinkling and distinct marginal lobes are formed in plan, and slump terraces are developed at the front of the lobes. A large lobate feather of this kind may have a plexus of streams down the middle with wrinkled surfaces and a large number of delta lobes, like separate leaves. These recall the miniature deltas formed on low tide flats by rills. The pahoehoe pattern is altogether different, a delicate tracery like frost on a windowpane, with a tendency to overlapping "lobster claws" from uphill downward.

As a whole, it appeared that the pahoehoe was pushing its way down the mountain on the west side of the series of aa deltas. It was clear that at this time a very critical change had occurred, just as in 1843 the pahoehoe lava had come later than the aa, and poured down the mountain over the middle of it on the upper steep slope, and at the sides of the aa field below.

December 11

The new pahoehoe front of the Humuula Flow became quiet and relatively stationary. There was much river action in the upper parts of the flow and dusty aa was seen in motion. A series of panchromatic photographs was taken with color filters, of the flow, from the lower Omaokoili Hills. These pictures show how inconspicuous the pahoehoe was at this time in comparison to what it became later.

From Kilauea and Hilo smoke was seen at the rift cones and glow above the lava flow area.

An investigation of the location of the first two 1935 lava flows of November 21-24, obtained by questioning observers living at Humuula station makes it seem probable that this pair of flows lay on the west side of the present Humuula Flow. The easternmost of the two is overlapped by the western meanders of the present flow. On November 23, this eastern aa of the first pair may have come down the general line of the 1843 source well to the west of the smoking source streams of November 27-28. Numerous photographs taken from Humuula at this time suggest this arrangement. The observer at Humuula noted a very definite development at this last place on November 27 and sketched it as making new smoke where smoke had not been seen before. This new smoke was noted by both Mr. Wingate and Mr. Jaggar, on their arrival at Humuula November 28, after previous visits.

December 12

From Kilauea four fume columns appeared above the upper rift and no glow was seen at night. At Humuula there was revival of the pahoehoe front.

December 13

The glow and fume continued at the Humuula source and lava channel, the progress of the pahoehoe front was comparatively quiet, and an earthquake was felt at Kilauea.

December 14

The upper slopes along the course of the Humuula Flow showed glowing areas more scattered than before, suggesting pahoehoe flow over the western side of the heap. The pahoehoe front was glowing but not progressing. Smoke continued at both the rift source and the flow source and glow was reported but doubtful at the rift source. Another earthquake was felt, originating at the Mauna Loa sources. Seen from Kilauea, dense fume arose at the upper rift source in the afternoon.

December 15

The glowing stream of the channel of the Humuula Flow appeared bigger to observers at the ranch and the pahoehoe front was motionless. A new aa flow or branch in the middle of the flow region was reported to be moving on top of earlier aa flows in the direction of the upper 1843 aa westward from the middle stream of the Humuula Flow.

This may have meant that some of the new pahoehoe developing in the upper reaches of the flow had spilled over sideways and speeded up so as to be stirred into making aa. This would account for the lack of progress at the extreme front.

December 16

At this time, glow as seen from Kilauea appeared back of the lower part of the northern Mauna Loa profile. Wingate at Humuula reported revival of the pahoehoe front from the eastern side of the front of December 10 and progressing over the old aa between the 1843 Flow and Humuula station.

December 17

The pahoehoe front was reported to be 200 feet wide, proceeding toward the high stone wall of the sheep pasture, which extends west from Puu Huluhulu. The source of the flow was reported to be smoking, fiery, and the stream channels active. Wingate estimated the smoke source of the Humuula Flow to be at elevation 8,500 feet. From Kilauea at 5:00 pm the rift source showed a dense ginger-colored cloud rising with seven stems, a mushroom shape above and standing 2,000 feet above the rift.

December 18

On this day rangers Murray and Waesche explored the region immediately NW of Puu Ulaula resthouse for about 3 miles. From the large cone there at elevation 10,126 feet which is in line of the curved rift believed to extend northward to the flank outlet, which forms the source of the Humuula Flow, Waesche reported that the lava flows of November 21-22 were a considerable distance to the west. From that cone the smoking flank source heap of the Humuula Flow appeared very far away to the north over interminable fields of old aa. This observation is of great interest, in that it indicates the upper lava flows chose a path mostly west of the 1843 source.

One mile west of this old red cone, Waesche reports reaching the east side of an aa flow, probably 1935. From the top of it a ridge cut off his view westward. The only pahoehoe seen was up the mountain. The aa on December 19 was cold and quite accessible.

Comparing these facts with the data in the Army and Navy airplane photographs of November 22, it appears certain that the smoking source on the mountain flank, elevation 8,500 feet, of the Humuula Flow, was not in the track of the floods of lava of November 21-22 which made the two long streams in the direction of Puu Koli.

On the night of December 17-18, the glow over the Mauna Loa profile seen from the east appeared farther up the mountain than before and dense brown fume rose high in calm air from the upper rift source.

December 19

The flow was brilliant, the upper rift source fume was dense, and there was strong pahoehoe advance NE 1,800 feet over the old aa in the saddle between Mauna Loa and Mauna Kea to within a half-mile of the stone wall. The pahoehoe front was about a quarter-mile wide, spreading out in a sheet east of the 1843 Flow. The progress of the front changed for a time from spreading eastward to spreading westward. The wall of aa behind the pahoehoe and around the front of which the pahoehoe had executed an encircling movement from west to east between December 13 and December 19, was in motion, dropping rocks over its front with clinking noises. New appearance of pahoehoe lava was reported higher up the aa flow near the front of November 29 on the east side of the flow belt. A heavy pall of smoke 2 to 3 miles wide was rising in the evening at the upper rift cones. Soldiers visiting that region reported that they could not approach the cones because of irrespirable sulphur fume. The fume in the upper atmosphere made milky cirrus clouds. This intense development of sulphurous fume from the pit where the summit fountains had been, was entirely different from December 1914, and from December 1933, when the fountaining persisted at the upper vents until the end of the eruption. In 1935, the fountaining was far down inside the shaft and this concealed pit was acting as a

reservoir to the flank flow, just as Halemaumau had acted as a reservoir to the Kau Desert flow of 1920.

An unconfirmed report from one observer in Hilo mentioned two glow points seen from there at the upper rift the evening of December 18, which were called "fountains."

December 20

It was now evident that an extremely critical advance of the flow was in progress. The topographic map showed that the ground of the saddle under Humuula station slopes eastward towards Hilo. The solstice was producing sudden and rapid increase of lava pressure.

At markers placed at the front 8:00 pm December 19, the flow had moved northward 400 feet at 6:30 am December 20. On this day with a spurt forward, the liquid lava overflowed a half-mile of the stone wall, and the eastern side of the front was within one-quarter mile of Puu Huluhulu.

At 4:00 pm a visit was made to the pahoehoe front of the flow at the stone wall. The lava was pouring over it and into the hollows of old aa. It appeared to be a normal heavy pahoehoe, progressing toward the trees and grassy land at the base of Mauna Kea, and at this time approximately a third of the stone wall was being overwhelmed at elevation 6,575 feet above sea level. This stone wall extends 1.8 miles between Puu Huluhulu and the southernmost of the Omaokoili Hills. The middle and eastern portions of the wall were gradually covered. The wall was a massive structure of carefully piled lava slabs, about 3 feet thick and 6 feet high. The flow piled against it on the southern side, usually without knocking it down, until cascades of lava overtopped the wall and filled the space on the northern side. These cascades then fed flows which united in a pool on the northern side. All these pools merged and advanced toward the vegetation in the saddle. This vegetation was at the edge of a former flow from Mauna Loa consisting of both aa and pahoehoe, with large craggy domes, gorges, and forest trees north of the wall in the western part of the area, while towards Puu Huluhulu at the edge of the old lava there were open fields. All of this tract was destined to be invaded by the new pahoehoe, which cascaded into the chasms and burnt the forest at the west, and spread over the grassy lands at the east.

December 21

The development of pahoehoe had been very rapid over the source heap and the upper parts of the flow during the preceding week. The flow as seen from the Mauna Kea slope was now silvery pahoehoe on top in four large meanders, which sent out two tongues to the west over the 1843 aa. This silvery surface, reflecting the light from the sky, was in marked contrast to the earlier condition when the Mauna Loa slope was photographed December 11 and all the aa fields were dead and lusterless, of dark reddish-brown color, the only glossy pahoehoe being at the source, and on the crust of the main stream.

There was now a liquid sea of this silvery lava which had spread over a large area of the ancient aa fields immediately below Humuula station. This big lake on this day expended its energies of forward progress by penetrating the fields and low rocky hills and burning the vegetation WNW of Puu Huluhulu for a width of front of three-quarters of a mile, with its eastern limit about one-quarter of a mile from Puu Huluhulu. Estimates of progress at different lobes of the front showed the glowing paste progressing in one place 10 feet in 10 minutes, in another place 20 feet in 15 minutes, these meaning forward movement of from 60 to 80 feet per hour. The flow as a whole moved more slowly, but in detail there were places that were swift cascades, where the new fill overtopped ancient obstructions and rushed forward.

Some of the energy of the flood at this time was being expended in spreading out a mile or so south of the saddle in the region SSW of Puu Huluhulu among ancient flows which were almost horizontal. Individual tongues actually flowed backward or to the south in this country, at the southern edges of the lake of lava, and there was backing up of the lake also to the west as far as the slope would permit. The 1843 Flow, however, obstructed the new lava in that direction, where the older flow had partially encircled the wooded hill there which is 6,823 feet above sea level. Th backing of the lake soon reached its limit, and the greater stream which was pressing forward around the earlier aa front from the west pushed eastward into the saddle between Puu Huluhulu Mauna Kea where it found a pronounced valley leading down in the Hilo direction. Another stream from the SE tongues of the lake area found a similar grade eventually on the south side of Puu Huluhulu, that led it cascading NE into the same valley.

On this day another photographic panorama was made to show the contrast in the gleaming smooth-topped flow up to the source from the conditions of December 11.

A development which always accompanies the invasion of vegetation by pahoehoe lava, where the old ground under the root system is cavernous, was the exploding and flaming of carbon gases, supplied with oxygen of the air in the region adjacent to the front. The explosions became numerous and noisy, and in many places blocks of rock were flung up in heaps where mixtures of carbon monoxide and air were ignited in ancient lava caverns by flames or by penetrating tongues of melt. Another phenomenon, more unusual, was the presence of burning gases making wandering blue flames, or banners of yellow flames, in sand pockets sometimes 50 to 100 feet away from the lava front, in a grassy pasture. Apparently the carbon gas was generated by charring of the deep sod. This penetrated cavernous spaces or cracks under the field, and remained sufficiently free from contamination by air to escape and burn without explosion. Such flames were later seen burning in the hollows of the new lava, where it overlay masses of carbonized vegetation.

The lake area of the flow had a depth of 7 to 10 feet, was moderately flat on top, and the stretch of stone wall left its mark as a straight line through these portions of the flow where the wall was covered. This was due to some molding effect where the cascades over the wall left a scar on the final lava field.

December 22

The flow passed between Puu Huluhulu and Mauna Kea, found a steeper slope and progressed eastward more than a mile with a front 200 feet wide and tended by reason of slope and stirring to develop internal crystallization and so to change to aa or clinker lava. The progress, which had been of the order of one-quarter mile per day on the flat land, now suddenly changed to more than one mile a day, and this started draining the large lake which had accummulated in the Humuula saddle. The speed of progress was augmented when the second stream on the south side of the Huluhulu Hill joined the main east-flowing river of slag.

The Mechanism of Aa and Pahoehoe Lavas

There were now three distinct centers of activity requiring attention, in order to understand the Mauna Loa Flow. There was the smoking rift crack about elevation 11,500 feet, beneath which the internal lava was boiling in a pit. There was the source vent on the north flank of Mauna Loa, whence the Humuula Lava Flow poured down to the saddle between Mauna Loa and Mauna Kea. This flow source was 6 miles north of the upper rift and its smoke shaft. The third active area was the new drainage from Huluhulu Hill to the front of the lava flow, a steadily progressing mass of clinkery paste covered with huge bowlders, and fed by glowing torrents of slaggy melt which tended to crust itself over from the source downward to the broken dam at the Humuula lava lake. This melt was essentially a foam impelled both by gravity and by hot gas expanding within it. The tunnel system created by its crust made a pipe leading from elevation 8,500 feet down the slope of Mauna Loa to elevation 6,500 feet. Here the pipe bent sharply eastward at a right angle, and vomited out its content in an open river. Down to this point, the froth stream secreted a glassy skin over itself as a roof; this is pahoehoe lava.

Such a torrent in a tunnel, makes an adjusted pressure system connected with the foam column in the shaft, inside the mountain. The open pit at the top of this shaft sends up sulphur smoke and other gases, from the summit rift craterlet, which had been fountaining with the hot froth at the beginning of the eruption. The froth had lowered in the vent, and was now fountaining internally.

This statement exhibits the relationship of the upper vent to the lower flow vent. When the pahoehoe stage is reached, the adjusted pressure system above referred to, means an equilibrium of gas-heated foam holding a certain level in the shaft, and flowing foam in the pipe system which pours down the crusted-over river under both hydrostatic pressure and gas-pressure. A man with hob-nailed boots might possibly have walked eight

miles on top of the pahoehoe stream from the flow vent to Humuula and avoided any liquid. The main lava river was flowing in a tunnel.

This arrangement is closely similar to the overflow of an uncorked champagne bottle if one imagines a small pipe leading from the neck of the bottle and the uncorking controlled by a stop-cock instead of a cork. The foam might then be allowed to rise in the neck and overflow through the pipe, while the liquid being converted into foam always remained below the neck. So the magma in the mountain is the liquid below the foam with gases escaping from solution. The foam we call lava is frothing molten glass. It differs from champagne in that the gases react chemically to release heat and make the foam more fluent than the mother-liquid below, and in that it solidifies in cold air.

When the flow gathered speed down the valley east of Humuula station, by reason of suddenly breaking the dam beside Huluhulu Hill, the liquid under the crust, of the lake area, rushed out into the open and down the slope with a rapidity which stirred it into the "sugaring" condition, known as aa lava. There was at this point a sudden quasi-new eruption; a quasi-new vent broke out so to speak, from under a sensitively adjusted cover to a steeper slope beyond. The flow down this slope towards Hilo was thus a third repetition, on a small scale of the breaking out of November 21 from under the heavy ancient cover we call Mauna Loa Volcano, and of the second on November 27 from the flow source crack in the mountain flank. As in that case, the new gushing made skins over itself (pahoehoe) just below its point of escape at Huluhulu Hill, but below that it crystallized into clinker, with a dark-red river in the middle, and would make no more glassy skin over itself, until a new adjustment was reached by pooling in some hollow below, when the Huluhulu pahoehoe would push down the river and overtake the aa with a skin.

The process by which such an adjusted skinning over of a lava with a glassy crust comes about is as follows:—

The gas-charged melt of a vent is stirred and rapidly crystallized both by boiling or effervescing and by rapid flowing. If it rapidly flows with gases rising from within it, it is heated on top by the gases, it is heated within by crystallization, and it is cooled and solidified, chiefly on the bottom, by contact. The hot gases incessantly escape without forming bubbles, and the solidification proceeds from the bottom upward. This solidification is free to take forms of sprouting determined by crystal groupings, and no time is allowed for the separating out on top of a glassy foam. Such glassy foam is formed in enormous quantities near the vent, and makes the basaltic pumices, Pele's hair, Pele's tears, and heavy ropy folds of coarse pahoehoe which is always characteristic of the source region of any flow. A short distance away, the highly stirred crystallizing material pours out from under this tangle of glassy membranes, and the solidifying from there to the lower end of the first streams proceeds by the aa process.

When the gas stirring becomes less, and the rate of flowing becomes slower, whatever may be the causes of the change, glassy bubbles are free to form and rise to the top. These make a layer of many membranes of glass which stretch themselves over the expanding and advancing liquid. When this happens, there is no longer a heating on top by reacting, escaping, and oxidizing gas, and a cooling only at the bottom, with an eternal sprouting upward in a clinker, such as is characteristic of aa; but the cooling proceeds from above downward, and a glassy crust confines the melted stuff within. In this condition we have exactly the same liquid melt inside tending to crystallize, but it fills a pipe. This pipe itself imposes a continuous restraint by pressure, on the escape of gas from solution; and the eternal formation of new glassy membrane over the liquid, pushing out as toes under the skirt of crust at the front, imposes a restraint by pressure on the speed of flow of the liquid. These two restraints enforce a relatively constant adjusted pressure and the vesicular crust now has the effect of a heat and gas insulator and keeps the melt inside from losing too much gas—and gas is its main heating agent—and from radiating heat and so losing its liquidity. By keeping the gas in, it keeps the source of its auto thermic action. All these adjustments bring about the formation of a tunnel system, with liquid lava running through the pipe, and the pipe continually strengthened by layers of glaze added as interior coatings. As the gas does not escape, except through flaming cupolas near the vent, which have fountains inside, the whole system preserves the heat of reaction between the gases, and so a lava tunnel may be at brilliant yellow heat, even when the liquid river inside has lowered somewhat, and through windows is sucking in oxygen to unite with the gases, and also with the glazes, to keep the temperature high.

To return to the Humuula Flow: the transition from the aa stage of the first week of December, to the silvery pahoehoe crust covering the whole course of the flow the third week of December marked a gradual change in these adjustments of internal heating to external cooling. A highly critical point is reached whereby clinker sprouting and solidifying from below, is replaced by vesicular glassy crusting and solidifying from above. In general, the conquest of a flow by pahoehoe crust proceeds from uphill downward along the course of the river channel. In like manner, if the aa lava flow toward Hilo from Humuula station were to reach another pahoehoe adjustment, it would be by the pahoehoe skins and crusts spreading down the channels and mastering the front of the flow as had happened when the Humuula lake was the front.

There are three important corollaries to this heat argument, namely (1) pahoehoe and aa lavas are exactly the same substance. (2) The internal liquid or paste under any pahoehoe crust is quite competent to become aa lava if allowed to flow in the open. (3) The only mechanism which could carry a lava flow 30 to 50 miles on a flat grade is pahoehoe tunnel-making, for that insures retention of heat and liquidity.

A fourth experimental corollary of the pahoehoe argument is this:—

If an artificial disturbance like blasting is applied to the outside of the tunnel system near the vent, after pahoehoe adjustment had been attained, the stream inside under pressure would flow out into the open, without restraint of gas, and without restraint of flow. There would be immediate cooling and solidifying of the remnant material within the tunnel, after what remained liquid in the downhill system of tubes had poured out, and there would be nothing to keep up the supply.

A second possible result of such blasting might be this:—

If the stream suddenly released near the source vent were a foam torrent close to the hydrostatic level of the foam inside the shaft reservoir of the mountain, the gushing might drain the reservoir below that level, the flow would stop, cool, stiffen, back up, and seal the cracks from which it came, and the "small tube in the side of the neck of the bottle" would thereby be shut off. Rising of the foam thereafter in the shaft might pass this level, but newly solidified hot lava is an unbreakable plug. The reservoir shaft would continue its internal fountaining and external puffing of gas, until the gas release and heat radiation which determines the duration of an eruption were ended. Eruption would end, as all eruptions probably end, by an act of viscous intrusion somewhere inside the mountain. The blasting would have accomplished an interruption of the frontal progress of the flow, and also plugging of the flow vent.

December 23

The revived flow east of Humuula station travelled more than a mile turning into an aa stream with aa fields in front and at the sides. There was some slumping of the lava lake around the stone wall. In the evening a brilliant torrent was cascading around the south side of Puu Huluhulu, this joined the main river farther east, the front of which was some 2 miles from this hill. Flames burst through the marginal lava, there were big explosions in old caverns, and the large lake in the saddle was nearly black as seen at night.

The actual time when the flow passed Puu Huluhulu was the morning of December 22. There are now many explosions in old pahoehoe caverns not only at the borders of the pahoehoe near Humuula, but also at the lower aa front as the flow approached the wall which separates the Puu Oo lands, from the Parker Ranch, to which Humuula sheep station belongs.