MONTHLY BULLETIN
OF THE
Hawaiian Volcano Observatory
(U. S. GEOLOGICAL SURVEY)
Published by the
Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, JANUARY, 1929 No. 1

CONTENTS

VOLCANIC CONDITIONS IN JANUARY

Activity of Halemaumau and General Notes

At the beginning of the year conditions were very quiet at Kilauea with hardly any change at Halemaumau pit. Only two very feeble seismic disturbances were registered on the seismographs at Kilauea Observatory for the week ending January 2. Beginning January 5 there was marked increase in avalanching in Halemaumau pit at the south and southeast walls. This avalanching was continuous for several days, reaching a climax at noon January 10 when a section of the southeast rim about 100 feet long fell into the pit, just opposite the road terminus where visitors stand.

The breaking away of the wall at times was continuous, much of the south rim changed its shape, and a large fraction of the lava floor of the pit was buried under debris from a big avalanche the morning of January 7 that carried away the south surveying station. The ground back of the tourist stand was badly shattered, and by January 8 one crack had widened over a foot. The avalanching appeared to progress from south to southeast, originating part way down the wall and undermining the upper rim. The week ending January 9 produced 16 very feeble instrumental earthquakes, mostly at the time of the beginning of the avalanches January 5-6, and at the same time continuous tremor occurred which died out on the 9th. The following week produced eight

instrumental jarrings, the strongest of which coincided with the big avalanche January 10. A distant earthquake was recorded January 12 beginning 1:42 p. m.

After January 10 there were a few small slides and a little steam was seen emerging from a point on the south wall about where the sliding had originated. The week ending January 23 produced one slightly perceptible earthquake and 20 other very feeble ones, with spells of continuous tremor. Halemaumau remained unchanged at the end of January, the last week yielded 10 very feeble local seisms and fainter spells of tremor.

DISCUSSION OF SPECIAL FEATURES

The recurrence in the first part of January, 1929, of intense avalanching at Halemaumau, brings to mind the occurrence of this phenomenon the first part of January, 1928, when the welling up of lava from cracks in the floor was attributed to the pressure of landslip material. As events have proved since, the January, 1929, landslip was destined to be followed by a welling up of lava under strong gas pressure February 20, 1929.

The landslip of the south-southeast wall of 1929 was almost directly opposite the landslip of the north-northwest wall of 1928. Both half covered the floor with their debris.

The explanation given in this Bulletin of the welling up of lava in January, 1928, was to the effect that the heavy weight of material weighted down the crusted pool of July, 1927, where there was live lava below, and forced that lava up cracks. The writer is now disposed to have some doubts of that explanation, and to believe that it is possible the very feeble lava eruption of January, 1928, the seismic events, and the avalanches were all equally the results of magmatic disturbance.

If the reader will refer to Figure 47 of this Bulletin for December, 1927, he will see that earthquakes increased in frequency by months beginning October, 1927, from 76 to 191, 243, 149, and 165, the last being the figure for February, 1928. The December total of 243 was derived in part from a series of spasmodic tremors December 3, 4, and 5 described by the seismologist as "so definitely of volcanic origin that eruption of one of the volcanoes seemed both imminent and certain." (Bull. XV, 12, 97.) This frequency is four times the normal for an ordinary month.

Incessant slides and occasional big avalanches began near the end of December, 1927, and continued to the time of the crisis of January 11. During four weeks there was accumulation of more than 8 seconds of southerly tilt, which changed to slight northerly after the big avalanche.

VOLCANIC CONDITIONS IN JANUARY

Activity of Halemaumau and General Notes

The fire pit of Kilauea remained without new lava throughout the month, but the excessive tilts to the north and east which had been recorded in December were probably connected with magmatic movement under the bottom of the pit. This culminated in a series of avalanches at the southeast wall of the pit during the first week of January.

These avalanches destroyed the rim station at the southeast where the pit was ordinarily inspected by travelers, and big cracks formed back from the rim and older ones widened. It became necessary to change the trail to end at a station farther north.

The two biggest slides were on January 7 and January 10, and the former one started a landslip in the south talus cone which covered much of the lava floor of 1927. The south surveying station on the rim fell in.

Small slides continued during the month, and the measured widening of a crack at the former station continued until January 18. Thereafter little happened that was unusual.

JOURNAL JANUARY, 1929

January 2. At 10 a. m. inspection showed no change in Halemaumau.

January 4. At 9:40 a. m. an avalanche from the southeast wall was heard and sent up dust, and at 10:05 a. m. thin dust rose from a slide on the north wall.

January 6. Thin dust was seen rising from the pit many times during the day.

January 7. At 7:40 a. m. the loud rumble of an avalanche was heard two miles away at the Observatory and at the hotel.

At 8:30 a. m. a hotel guest reported the opening of new cracks near the tourist station on the southeast rim of Halemaumau. Inspection at 9:30 a. m. showed that the whole of this outlook area, on the southeast rim, hitherto regarded as one of the strongest edges of the pit, was broken by a dangerous network of new cracks of all sizes. The floor of the pit was half covered by a landslip from the south talus, which had been started by avalanches from the wall above. The south rim was indented where it had caved away, and the surveying station there had fallen in. As yet there was no sign of pronounced avalanches under the southeast cracked area. At 11 a. m. numerous avalanches had occurred sending up thin dust at the south wall. A large block under the SSE. rim was standing out where the material had cracked away from the wall. The continual slides had originated about one-third of the way down from the top of the wall.

January 8. Very frequent slides continued to fall from the south wall. A large avalanche cloud of dust rose from the pit at 10:15 a. m. Measurements at the cracks along the ESE. rim showed widenings and the biggest movement was at a crack back of the tourist stand, 10 or 12 feet from the rim of the pit, which by measurement had opened 1.2 feet.

January 9. From 3:30 to 4:20 p. m. there was general sliding of the southeast wall under the cracked area, without avalanches of any great size.

January 10. At 7:40 a. m. a noisy avalanche occurred at the southeast rim, and at noon a large portion of the rim at the crack locality fell in, carrying away much of the former tourist station. This had been preceded by many small slides.

January 13. There were occasional small rock falls at the southeast, but the remainder of the southern wall appeared to be becoming stabilized except near the top.

January 16. There were very small slides at the south and at 11:08 a. m. a slide occurred at the north wall. At 11:15 a. m. a small rock fall occurred at the southeast.

January 18. During a southwesterly rainstorm at 11 a. m. no slides were in progress, but it was evident that more of the southeast rim had fallen and also a strip east of it.

Measurement of crack No. 1, mentioned above on January 8, showed a widening of 2 feet since January 8, making the total widening about 3.2 feet since the measurement of December 4, 1928. Another crack (No. 4) showed a widening of 0.1 foot.

January 26. The pit appeared unchanged and crack No. 1 had opened no more.

January 28. There were occasional small rock falls at the north and a green spot was observed near the top of the west talus.

January 31. Dust rose from the pit in the morning, and at 2:30 p. m. there were signs of a fresh slide from the north rim.

SEISMOMETRIC RECORD

There were 57 local earthquakes and 1 teleseism recorded by the seismographs at the Hawaiian Volcano Observatory during the month ended at midnight January 31, 1929. These and other phenomena are listed below. The

time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks counted in the list makes such minute records that the character of the disturbance is not always apparent. Some are true earthquakes; others are perhaps the parts of greater amplitude of a continuous or protracted tremor, which at other times may be too feeble to record; some seem to be records of vibrations set up by avalanches in Halemaumau.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

January
1 9:59 a.m. vf.
2 2:36 p.m. vf.
5 12:04 p.m. vf.
4:49 p.m. vf.
4:55 p.m. vf.
5:13 p.m. vf.
5:24 p.m. vf.
6:19 p.m. vf.
6:23 p.m. vf.
6:25 p.m. vf.
6:27 p.m. vf.
7:15 p.m. vf.
7:05 p.m. to 12 mnt. *
6 2:32 a.m. vf.
6:25 a.m. *
9 3:51 a.m. vf.
5:11 a.m. vf.
5:50 a.m. vf. *
10 10:41 a.m. vf.
11:58 a.m. vf.

January
14 9:46 a.m. vf.
11:15 a.m. vf.
1:13 p.m. vf.
1:30 p.m. vf.
4:04 p.m. vf.
15 7:30 a.m. vf.
17 1:51 p.m. vf.
7:51 p.m. vf.
10:58 p.m. vf.
18 7:38 a.m. vf.
8:02 a.m. vf.
8:04 a.m. vf.
8:07 a.m. vf.
8:15 a.m. vf.
10:56 a.m. vf.
12:10 p.m. vf.
11:15 p.m. vf.
11:54 p.m. vf.
19 8:19 p.m. vf.

January
20 7:16 a.m. vf.
9:58 a.m. vf.
6:02 p.m. vf. △19.4 fl.
6:43 p.m. vf. △98-115
21 7:15 a.m. * to 12:05 p.m.
11:57 a.m. vf.
8:37 p.m. vf.
22 9:15 a.m. vf.
10:44 a.m. vf.
2:08 p.m. vf. △24.5
23 12:29 p.m. vf. * to 6 p.m.
24 6:31 p.m. vf.
25 7:09 a.m. vf.
8:09 p.m. vf.
26 8:15 a.m. *
4:08 p.m. vf. △28.
4:19 p.m. vf. △33.
27 7:00 a.m. *
6:13 a.m. vf.
8:26 a.m. vf.
12:47 p.m. vf.
28 * ends about 12 noon.
30 1:48 p.m. vf.
1:58 p.m. vf.
2:01-2:03 p.m. *
3:48 p.m. vf.
31 7:56 a.m. vf.

Teleseism

A distant earthquake occurred beginning at 1:42 p. m. January 12.

Harmonic Tremor

Spells of continuous tremor occurred from 7:20 to 7:40 a. m. and about 6:30 p. m. January 18, and on January 19 from 6:15 a. m. to 8:04 a. m. These were probably not different from the spells of spasmodic tremor recorded with asterisks. There was much continuous tremor throughout the avalanching period.

Microseismic Motion

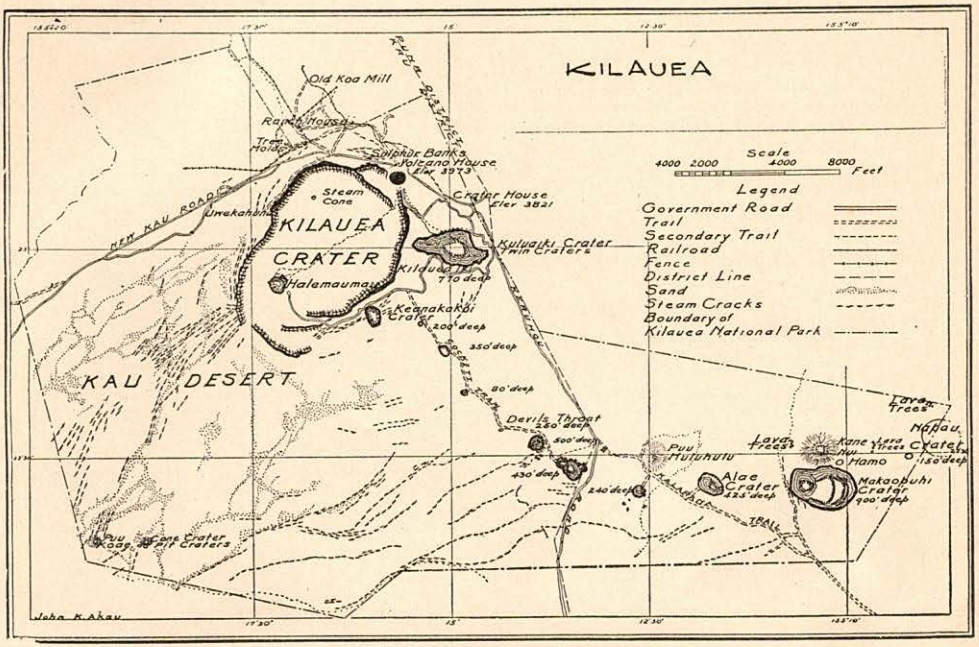
Microseismic motion increased and became excessive about January 23, diminishing to normal January 25.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change and direction of motion of the plumb line.

January	2-8	0.3 seconds	ENE.
"	9-15	1.0 "	N.
"	16-22	2.1 "	S.
"	23-29	0.3 "	NE.

EARL M. BUCKINGHAM,
Associate Engineer.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism, (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, FEBRUARY, 1929 No. 2

CONTENTS

VOLCANIC CONDITIONS IN FEBRUARY

Activity of Halemaumau and General Notes

After the notable avalanching of the southeast rim in January, nothing remarkable happened in Halemaumau during the early days of February. There was a strongly felt earthquake on February 5 so as to awaken sleepers generally and to be felt throughout the island. The seismographic evidence placed it under Kilauea, and it was accompanied by tilt ENE. suggesting rising lava. There were occasional small slides at the pit. February 19 the steam from the northwestern floor of the pit was slightly bluish.

Just after the midnight preceding February 20 molten lava gushed up at the edge of the floor northwest, inaugurating a new eruptive spell quite like those of 1924 and 1927, but ceasing action at 1:15 p. m. February 21. The fountainings at the edge of the new fill which reached a maximum depth near 60 feet were of the Mauna Loa type, the rift extending across the northwestern side of the bottom in a straight line, the active fracture being 1,370 feet long. The southern fountains quickly became submerged in the lake, but the northern one built up a pumiceous spatter bank and started with one great jet like an upturned hose shooting 225 feet into the air. The dwindling of this activity was very rapid. Out from the big fountain extended a streaming across the new

pool making radial bright lines, and around the southern fountains there was a concentric pattern of bright lines with much sucking inward of crusts.

Needles of lava glass and wisps of Pele's hair, along with pellets of pumice, fell to leeward and in the Kau Desert. Rampart shores of the lake formed, and around the big northern fountain a spray bank was built up like a throne, made at first of greenish-brown pumice, and later of black glass.

The Halemaumau seismograph, recording tilt to and away from the southeast rim of the pit, registered an astonishing tilting accompanied by small earthquakes two hours before the eruption was noticed, the movement being away from the center, and during the period of fountaining quite continuous, strong, volcanic tremor was written by the pen. This all ceased when the eruption ended in the early afternoon of the 21st, with strong tilt back toward the center of the pit during four hours preceding the cessation of action. The eruption left a net gain of five seconds tilt away from the pit, as though the inner dome of the Kilauea floor had been slightly elevated.

After February 21 the recession of the liquid lava and the shrinkage of the floor caused a lowering as usual of the central crusts of the lake, and there were numerous spots on the lake crust where the last lava trickles had welled up, and finally yellow stains appeared at the niche left by the big fountain. There were three slight local earthquakes felt in the Kilauea district.

JOURNAL FEBRUARY, 1929

February 2. Review of results of the avalanching of January 5 to 9: A large area of the rim from SE. to S. is gone, apparently from 5 to 10 feet back or more. The old S. station is gone and all the pinnacle slabs next east of it. These were upright slabs with steam about their bases, just inside the rim of the pit. The U. S. G. S. bronze plate bench mark at SE. station (tourist viewpoint formerly) is now on cracked unstable ground at extreme edge of pit. The olivine rock and old burned boards of the 1918 outhouse S. of former SE. station have fallen in. The entire SE. rim remaining, where tourists formerly approached the pit, is cracked and dangerously overhanging and is roped off.

A new tourist terminal has been constructed by the National Park just south of the east station and work is in progress to extend the road to the tourist shelter and sign.

The notch removed by the recent avalanching extends from the SE. station to a point somewhere E. of the tunnels of the SW. rift. The south talus was struck by the great avalanches and set in motion as a landslide to cover the whole S. half of the floor. This is much like what happened just a year ago January 11, 1928.

The only steam is high on the south talus, up the SW. talus, and in the hole of the central lava cone. Besides, there are minor wall cracks steaming. The SE. rim cracks are steaming and show fresh soil breaks back from the rim to the big crack that the tourist trail crosses.

It looks as though the wall rock between E. and SE. stations was particularly unstable and a different color from the stripped wall rock of the rest of the pit. Perhaps this will fall away back to the clefts and cracks that here steam 20 to 30 feet back from the rim.

There are blue-green algae in a wet place east of the SW. tunnels. If the top of the SW. talus is 350 feet down, the top of the S. talus is about 650 feet down. Inspection of the SW. rim seemed to indicate that much of that rim has fallen and changed the landmarks.

Rocks were trickling a little on the lower S. wall about 2:30 p. m.

February 3. At 2:30 p. m. nothing new was observed. Dust was seen rising at 2 p. m. at the north corner of the rim. Rocks were heard sliding a little south.

February 4. At 8:20 a. m. dust rose at N. corner of rim.

February 5. Nothing new was observed at 2:45 p. m. as result of the strongish earthquake of 2:25 a. m. that woke everybody and was felt strongly in Hilo and in Kohala. No avalanches were heard at the time of the earthquake. The pit appears just the same as when last seen.

February 7. No changes noted.

February 19. A survey party noted that the steam rising from the northwestern floor was a little bluish the forenoon. A few rocks fell from the northern walls. In midafternoon a very slight odor of sulphur dioxide was noted SE., and none of the steam jets in the pit was active.

February 20. A new outbreak of lava in Halemaumau began about 12:30± a. m. and was notified by a bugle from the Volcano House watchman. At 1:15 a. m. a bright glare was over Halemaumau.

At 2 a. m. a line of fountains over a crack trending NE.-SW., parallel to NW. well and tangent to the base of the NW. talus, was to be seen, with a big fountain of the Mauna Loa type jetting eastward 200-225 feet high at the north end of the live rift. Here the rift, which is straight for 1,000 feet from the NW. base of W. talus to NE. base of NW. talus, in a NE. direction, bends a little to the E., and the big fountain is in the bent portion.

A line of continuous fountains spraying upward 50 feet or more occupied the southwest end of the rift. The north end of this rift across the bottom of the pit was near that of July, 1927, but southward the line diverged to the west.

The beginning of the outbreak was described by the watchman as a black cloud rising from the pit, followed by white steam, both of these occurring before the glow began. The black cloud may have been partly dust from the disturbed talus slopes.

Between 2 and 3 a. m. the bottom of the pit was filled with a large lake estimated 1,500 feet long northeast by 800 feet wide northwest. The shape was like a map of Australia as seen from the south; the line of the rift crossed the northeast corner of the map. There was nothing really significant in the way of preliminaries on February 19.

The old central cone of 1927 made a crescent-shaped mound projecting through the lake with horns turned to the southeast. This served as a measure of the rapid rising of the lava lake as it became submerged. By 4:30 a. m. this peak was much smaller. Everywhere the edge of the lake made glowing toes that pushed out as the lake border rose up the talus slopes. The old lava floor was entirely covered and the new lava touched the northwest wall. The higher south cone at the edge of the lava floor of 1927 was now touched at its base by the new lava.

There was almost no avalanching. The pit seismograph showed continuous tremor from the moment of outbreak, with marked tilt away from Halemaumau just as the eruption began. The Observatory seismograms showed tremor accordant with the time of lava fountaining.

The big north fountain and its outliers and the next fountain to the southwest were making cones and grottoes at 4:30 a. m. The northernmost vents had built up a lava heap from which cascades poured down. The wind was northeast, blue fume rose from the fountains, salmon-colored clouds of vapor rose from the pit, while pumice and Pele's needles fell on the Kilauea floor to leeward.

At the edge of the pit the steady roar resembled surf, and at the Observatory two miles away the rumble of the fountains was audible, just as in the Observatory basement their vibration was recordable.

The lake surface was covered with an even pattern of bright lines showing outward streaming from the big north grotto and concentric cracking around the southern fountains. Away from the main line of fountains a few small bubble fountains broke the lake surface occasionally. About daylight one avalanche occurred at the northeast corner of the pit. The concentric breaking of the skin around the southwestern line of fountains showed that by this time the rift source was wholly submerged under the deepening lake.

From the Observatory at dawn the pit was bright and surmounted by a pink transparent veil of fume. When daylight appeared this fume was blue in reflected light and brown in transmitted light. It was surmounted by a high gray cumulus of water vapor sucked in convectionally and rising rapidly in an imposing pile of billows. The fountain fume rose mostly from the northwest side of the pit.

Plane table work for measurement of the new lake was started at 10 a. m. Exploration between 8 and 11 a. m. discovered Pele's needles and small pellets of pumice scattered to the southwest of the pit, and the fume smelled strongly of sulphur dioxide.

Farther away to leeward the needles gave place to coarse Pele's hair a quarter mile from the pit, and still farther away in the desert tangles of fine Pele's hair were falling.

During the forenoon the big north fountain changed to heavier melt jetting about 100 feet high making glassy spatter instead of pumice. The fountains of the southwest end of the rift were almost as big. The central cone of 1927 now appeared as only a heap of new crust and by 9:30 a. m. it had disappeared. A wide segment of the lake shore lay against the northwest wall of the pit next south of the northwest talus. Ramparts were now forming at the lake edge west and southeast, and the lake was making glowing toes that overflowed these ramparts. Pronounced spatter grottoes had been built up near the big fountain north.

The fountain next to the southwest of the big one now occupied a large spatter cone with a glow hole in its top. There was a space without fountains between the big jet and the line of southwestern boiling where at the beginning there had been continuous action.

A wide river-like stream poured from the big fountain out over the lake. The lake edge was climbing its shores rapidly. A grotto had formed west of the southwestern boiling next the wall. Big whirlwinds were formed by the heat at the upper south edge of the pit carrying lava lapilli which struck an observer with stinging effect. A small fountain appeared in a northeastern cove of the lake.

The big north fountain had built at first a large bank of pumice west of it. This was now continuously caving in with the surface becoming coated in glistening heavy glass.

A long rampart had formed at the lake edge at the base of the west talus, and a small rampart ESE. Occasionally heavy crusts on the lake surface cracked up and foundered. The pattern of the crust in daylight was blocky with a gray-black satiny sheen. The three centers of fuming, making blue smoke, were the large north fountain, the western line of boiling, and the northwest spatter cone.

With the rising of the lake the big fountain was becoming more and more drowned. At 10:30 a. m. the material flung up was heavy with jets not more than 75 feet high. The action from the first had been a steady vertical jet like the spouting from a hose at the north end of the vent, with a big doming jet alongside, and minor jets up the talus farther northeast. This refers to the detail of the big fountain locality. The little jets had made a line of spatter cones up the talus above the big fountain.

White steam rose from above the edge of the lake along the south talus. The lake was lead colored. At the boiling place of the southwest fountains the lake crust broke up in ellipses and the fragments were sucked in at the boiling cauldron.

Between 6:30 and 7:30 p. m. the north fountain had a high spatter wall under the northeast side of the large northern jet, and an oven on the northwest side. The lake had spread out against the northwest wall so as completely to bury the small talus which had been there. The rampart west showed a small line of grottoes under it.

The rumbling thud of the fountains both north and west had become deep and heavy with occasional detonations. The window had disappeared from the middle northwest cone. The pattern of bright lines radiated to the east, southeast, and south from the concentric ellipses around the western boiling. The action was still strong, the spray at times rising a hundred feet at the north fountain.

February 21. After an earthquake felt about 3:33 a. m. the lava was sinking, and avalanches were sliding at the north about 10 a. m. The west foun-

tains dwindled to a small spurting action at 10:30 a. m. and the big north jet became smaller. This last had built an "armchair" grotto. At 11:30 a. m the western boiling had gone out of action, seismometric tremor was decreasing, and the lake surface was sinking. At noon there was no trace of the line of western fountains, and it was evident that the active north fountain had built its niche by lowering and causing its cone to cave in. The second northwest conelet of the previous day was gone. The coarse blocky crust pattern showed no trace of the radial lines. In a few places the crust cracked, and glowing melt welled up. The border rampart was continuous, seven feet above the lake, with an overflow margin outside. At 1:10 p. m. the north fountain stopped and at 1:13 p. m. a slide occurred northeast. About the same time the three seismographs at the Observatory, the pit, and Uwekahuna showed marked decline and cessation of tremor. And the Halemaumau seismograph had exhibited tilt inward toward the pit. At 8:30 p. m. there was a long oval glow area trending north and south at the west side of the bottom, and a crescent of glow at the east. There was a little cracking and foundering around the edges of these places. The rest of the lake showed a dull glow-crack pattern resembling a cooled aa flow or a dull bed of hot coals. In daylight, however, the surface had pahoehoe appearance. A grinding noise came from the subsiding crusts. There was very little fume. An avalanche fell at the northwest at 8:50 p. m. Dull glow on the clouds over Halemaumau diminished during the night. An earthquake was felt about midnight, especially strong at Pahala.

February 22. The forenoon showed brown fume hanging under the rain-clouds far to the southwest, but the pit appeared clear. At 2 p. m. the lava lake had a fairly flat surface with an eight-foot rampart around its edges. Fresh avalanche debris lay on the eastern talus. Broken crusts had been made by subsidence around the lake edges. There were some places making thin fume. The northeast talus cone now had its top above the big white sill in the wall.

February 23. A little diffused fume rose from the pit and hot air rising from the lava surface generated a pronounced moisture cumulus hanging over Halemamau with a flat-bottom surface. During a rainy afternoon this was the condition, but in the coolness of the evening the cumulus extended itself downward in two long tails of cloud which connected with the steam at the edge of the pit.

February 24. Halemaumau was motionless with dark red walls, wet with rain. Steam appeared at the top and bottom of the south talus, and along the north edge of the new floor. There was more voluminous steam along the northwest edge of Halemaumau than elsewhere on the Kilauea floor.

On the flat lava crust of the frozen lake lumps of lava occurred at 15 places, apparently representing the last toes or crust heaps where spatter or melt had welled up.

February 25. Thin fume rose from the floor of the pit locally and small slides were heard at the north wall. Some of this may have been artificially started by park laborers blasting at the road terminal.

February 26. At 11 a. m. yellow stain was observed at the western base of the north cone, and some white stain on top of the cone. There were cracks between the rampart and the floor. Pahoehoe festoons marked the course of the stream which had extended out into the lake from the "armchair" cone where the big fountain had been. The material of the lake surface looked as though it might be sharkskin lava. Talus overlapped the new pumice west of the "armchair" cone.

LAVA AND TILT MEASUREMENTS

The survey measurements indicated that the average area of the new lava fill is 40.5 acres, and its average depth when solidified to the floor of 1927 45 feet. These figures give 51,900,000 cubic feet of new lava.

The Halemaumau seismograph installed in a hut back of the southeast rim of the pit, recording only NW.-SE. tilt (to and away from rim), registered 11 seconds angle of tilt to the SE. between 9:15 a. m. February 19 and 12:45 a. m. (time of outbreak) February 20. Five seconds of this accompanied small earthquakes between 10:06 p. m. the 19th and 12:35 a. m. the 20th. This was accordingly systematic centrifugal tilt that accompanied the welling up of the lava.

At the end of the lava activity the rim region tilted back to the northwest or toward the center of the pit by 6 seconds of angle between 12:35 a. m. the 20th and 2:23 p. m. the 22nd. The seismogram showed that tipping was strongest between 8 a. m. and 1 p. m. the 21st, or just at the time that the lava was observed to go down.

Taking together the centrifugal tilt at the time of the outbreak, and the centripetal tilt at the time that the lava activity ceased, the seismogram shows that there was thus a net gain of 5 seconds (11 minus 6) of tilt away from the pit. This was the most clear-cut angular measurement of tumescence accompanying a lava inflow, and registered by actual swelling of the floor of Kilauea, that has ever been made at the Observatory seismometrically.

SEISMOMETRIC RECORD

There were 37 local earthquakes and one teleseism recorded by the seismographs during the month ended at midnight February 28, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibration set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

February		February		February	
1	4:58 p.m. vf.	9	12:52 p.m. *	20	12:15 a.m. vf.
2	6:10 a.m. vf.	13	10:08 p.m. vf. △30		12:17 a.m. vf.
5	2:25 a.m. m. d. fl	14	1:41 p.m. vf.		12:27 a.m. vf.
	2:32 a.m. vf.	15	3:36 a.m. vf.		12:28 a.m. vf.
	3:31 a.m. vf.	19	10:42 p.m. vf.		12:46 a.m. vf. *
7	12:24 p.m. vf. double		10:47 p.m. vf.	21	3:33 a.m. s. △13
	12:56 p.m. vf.		10:56 p.m. vf.		11:30 a.m. * stopped
	1:55 p.m. vf.		11:04 p.m. vf.		12:00 mnt. s. △13 fl
8	11:17 a.m. vf. △18		11:07 p.m. vf.	22	12:22 a.m. vf.
	11:27 a.m. vf.		11:15 p.m. vf.		12:47 a.m. vf.
	6:48 p.m. vf. △18		11:30 p.m. vf.	24	4:51 p.m. s. △14 fl
			11:47 p.m. vf.		5:36 p.m. vf.
			11:49 p.m. vf.	25	2:43 p.m. vf.
			11:56 p.m. vf.		11:15 p.m. vf.
				28	8:33 p.m. vf.

Teleseism

A weak record of a distant earthquake began at 10:50 p. m. February 25.

Harmonic Tremor

Sinusoidal registration of characteristic volcanic tremor began at 12:46 a. m. February 20, continued during the lava fountaining, and stopped about 11:30 a. m. February 21. At the pit seismograph it continued until about 1:00 p. m. Temporary local tilt was strikingly away from the pit.

Microseismic Motion

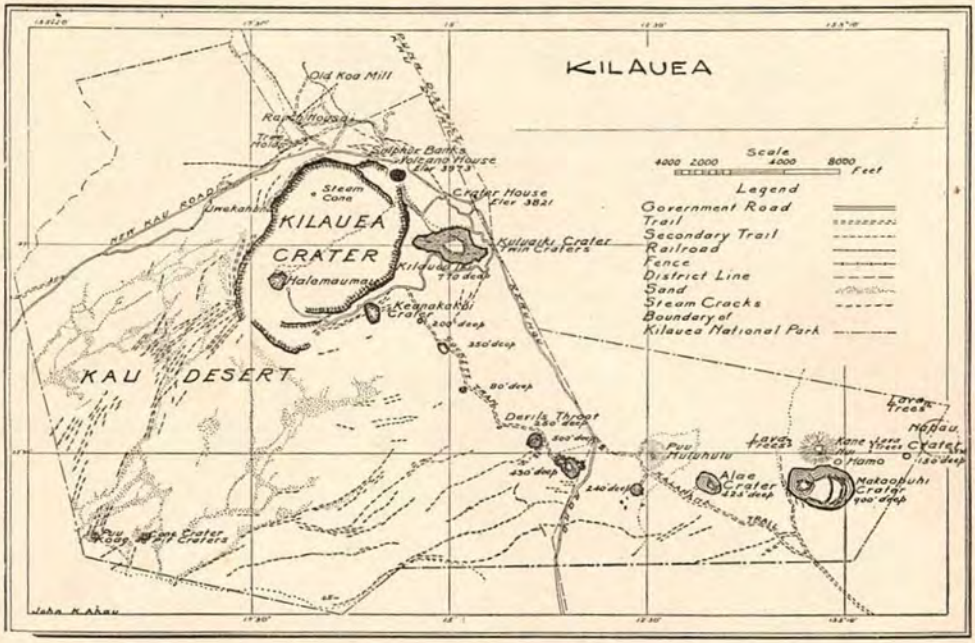
Microseisms were slight the second week of the month and increased at the end of the month.

Tilting of the Ground

By weeks this movement was as follows, expressed by overlapping seven-day means, in terms of angular change and direction of motion of the plumb line:

January 30-February 5	1.1	second	NE.
February 6-12	2.3	seconds	SSE.
" 13-19	2.7	"	S.
" 20-26	1.7	"	SSW.
" 27-March 5	1.6	"	E.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism. (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, MARCH, 1929 No. 3

CONTENTS

VOLCANIC CONDITIONS IN MARCH

Activity of Halemaumau and General Notes

At the beginning of the month the lava activity in Halemaumau pit which had created a new floor February 20, had entirely ceased. There remained the frozen lava lake which had added some 60 feet of thickness to the floor after shrinkage and collapse occurred, but there was no longer any glow or gas action.

Apparently some shrinkage or subsidence of the lava column continued during March, making much spasmodic tremor and numerous very feeble earthquakes during the fortnight about the equinox, and accompanying these there was minor sliding of debris from the walls of Halemaumau.

That subsidence was in progress is suggested by the strong and consistent tilt to the south and west (towards Halemaumau) recorded on the Observatory seismographs for March, in contrast to the easterly tilts which had characterized some weeks preceding the eruption.

An outstanding event of the month was the registration of an Aleutian earthquake March 6, of extraordinarily large amplitude seismographically. This made a small tidal wave at Hilo.

JOURNAL MARCH, 1929

March 1. Fresh debris from slides in Halemaumau lay under the eastern walls from the southeastern side northward to a point NNE. of the center, and a little fresh debris lay on the north and south taluses. At 11 a. m. a slide was heard in the region of the southwest tunnels. Sulphur stain was increasing on the north cone of February. A new patch of stain had appeared at the base of the south talus. A crack in the floor near where the line of fountains had been at the west indicated that the south side of the lava area was settling more than elsewhere. A white stain had appeared on a large red rock in the debris slope near the bottom at the east, and steam rose from the east end of the big sill. White stains were increasing on the floor.

March 2. At 10:19 a. m. an earthquake produced a small slide at the southeast wall.

March 3. At 11 a. m. a little sliding was heard. Yellow stain and steam were increasing at the southeast edge of the floor. Fresh avalanche debris had fallen at the east talus. The eastern spot near the bowlder in the flat gravel bottom outside the floor appeared like a yellow-stained solfataric hole. The usual line of steaming extended up and down the middle of the upper part of the south talus.

March 4. In the forenoon numerous small slides occurred at the north and northeast sides of the pit, some being started artificially by men throwing rocks, and these caused red scars on the wall and new white bowlders on the talus below. This shows how unstable are the walls.

March 5. In the forenoon occasional small falls of rock occurred at the north and southeast walls.

March 8. There was some rock sliding at the north.

March 12. A few rock slides occurred, less than on March 8.

March 13. At 11 a. m. fresh red debris was seen on the east talus under the end of the big sill. This was from a newly stripped portion of the wall one-third of the way up from the top of the talus. At the top of the talus there was a little steam.

The weather was sunny and no vapor whatever was detectable from any portion of the new lava floor. None arose from the north spatter cone nor from the stained spot at the south edge.

From the talus, near the southeast edge of the floor, and from a wet spot at the top of the south talus, a little steam arose. There was also steam and moist ground at a projecting ledge of the wall southeast. Most of the talus slopes appeared comparatively dry.

A few stones had rolled over the edge of the new lava at the southeast. A few stones were heard slipping only once during a 30-minute visit.

March 15. A small slide was heard at the north side of the pit about 9 a. m. and very little motion was observed thereafter.

March 16. In the forenoon there were occasional small slides.

March 18. At 9 a. m. in still sunny weather a very little sliding occurred at the northwest. At stained whitish spots at the edge of the new lava north and south yellow sulphur could be seen in cracks. The down-faulted bench all around the edge of the floor is in crescent-shaped steps. At the northern sulphur spot a little steam showed occasionally as though nucleated by invisible gas. There was steam high on the west talus, the south talus, the lower east talus, and at the top of the talus NNE.

March 19. At 6 p. m. dust rose over Halemaumau from slides.

March 20. At 3:10 p. m. avalanche dust rose from the northeast side of the pit.

March 23. In the forenoon what appeared to be a freshly broken scar from sliding was seen on the north wall, and a very few small slides occurred.

March 25. About 1 p. m. a slide fell from above the northwestern end of the large northeast sill.

March 27. At 8:40 a. m. the wind was light from the south, the weather partly cloudy, but the pit was very dry. Steam was conspicuous east, north, northwest, and west on the Kilauea floor outside the pit. The interior of the cauldron was quiet, showed no fresh avalanche debris, there was no steam on the bottom that could be seen, and there was the usual steam on the taluses. The supposed solfataric hole at the east had disappeared. About 11 a. m. dust rose from the pit.

March 29. A report that crack No. 8 had widened at the tourist terminal on the east rim of the pit was tested by measurement. No change was found in the crack, but crack No. 1 at the old tourist terminal was found to be 3.7 feet wide, an increase of 0.13 foot since January 18, 1929. In the other 13 cracks there was little change.

During a half hour no slides were heard. Fresh debris and scars were seen north and northeast. The northeast marks were said to be from an avalanche of 2:30 p. m., March 27.

March 30. At 8:30 a. m. a small slide fell from the east rim.

March 31. At 3:45 p. m. an avalanche made visible dust.

SEISMOMETRIC RECORD

There were 57 local earthquakes and one teleseism recorded by the seismographs during the month ended at midnight March 31, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibration set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

March		March		March	
2	1:20 a.m. vf.	18	12:49 a.m. vf.	26	5:41 a.m. vf.
	10:19 a.m. f. △16		7:52 p.m. vf.		9:23 a.m. vf.
	10:24 a.m. s. △17	19	11:14 a.m. vf. * △11		10:32 a.m. vf.
3	1:24 a.m. vf.		9:17 p.m. vf. *		11:48 a.m. vf.
4	7:59 a.m. vf.	20	5:38 a.m. *		3:19 p.m. vf.
6	12:17 p.m. vf.		5:52-6:06 a.m. *		3:44 p.m. vf.
	12:33 p.m. vf.		6:32-7:37 a.m. *		3:51 p.m. vf.
13	3:29 a.m. vf.		6:10 a.m. vf.		4:07 p.m. vf.
	5:51 a.m. vf.		8:00-10:02 a.m. *		4:20 p.m. vf.
	9:05 a.m. vf. △2		1:43 p.m. vf.		4:31 p.m. vf.
14	2:41 p.m. vf.		2:07 p.m. vf.		4:34 p.m. vf.
	3:00 p.m. vf.		8:50-10:45 p.m. *		4:50 p.m. vf.
15	8:13-8:15 a.m. *	21	6:30-8:00 a.m. *	27	5:36 a.m. vf.
	9:43-9:47 a.m. *	22	9:24 p.m. vf.		10:37 p.m. vf. △30
	12:52-12-53 p.m. *	23	10:00-12:00 a.m. *	28	12:42 a.m. vf.
	1:05-1:06 p.m. *		3:00-5:00 p.m. *		4:00 a.m. vf.
	5:31 p.m. vf.	24	6:00-7:00 a.m. *		7:58 a.m. vf.
16	5:51 a.m. vf.	25	9:34 a.m. vf.		7:13 p.m. vf.
17	10:28 a.m. vf. double		10:02 a.m. vf.	29	9:13 a.m. vf.
	12:04 p.m. vf.		10:03 a.m. vf.		12:46 p.m. vf.
	12:13 p.m. vf.		6:28 p.m. vf.	30	9:20 a.m. vf.
	2:22 p.m. *		9:34-9:37 p.m. *	31	12:02 a.m. vf.
	3:58 p.m. vf.				12:31 a.m. vf.
	3:59 p.m. vf.				11:57 a.m. vf.
	4:14 p.m. vf.				2:30 p.m. vf.
	9:57 p.m. * continues				

Teleseism

March 6
P 3:11:14.5 p.m. Distance 2,200 miles.
S 3:16:46.0 p.m.

Harmonic Tremor

This type of tremor was absent, although there were several spells of spasmodic tremor.

Microseismic Motion

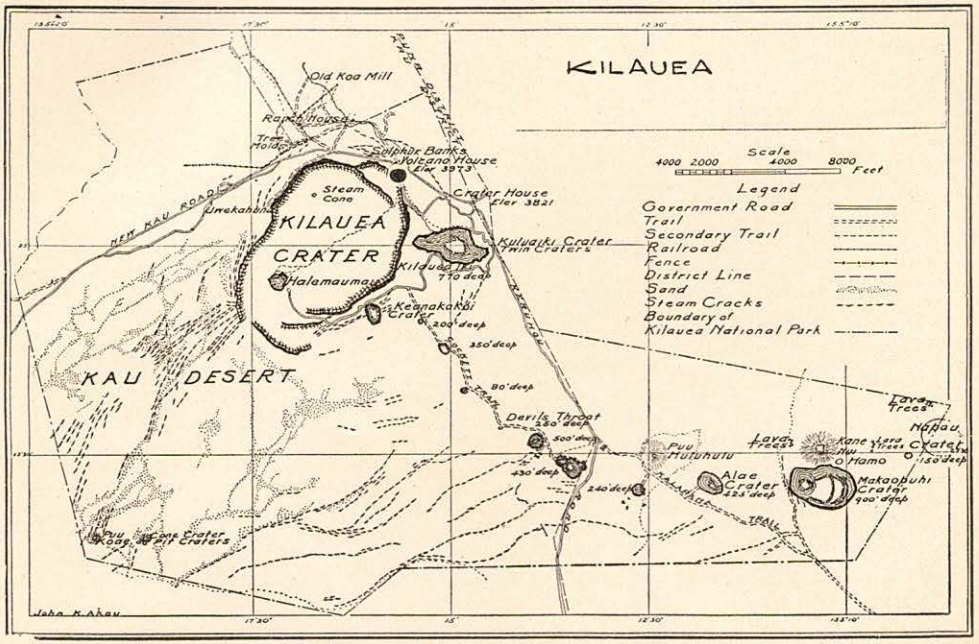
Microseisms were normal during the first week of the month, slight during the second week, normal during the third and fourth weeks, and diminishing at the end of the month.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change of direction of motion of the plumb line:

March	6-12	1.7 seconds	SSW.
"	13-19	2.3 "	WSW.
"	20-26	1.1 "	SSW.
"	27-April 2	0.2 "	S.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism. (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, APRIL, 1929 No. 4

CONTENTS

VOLCANIC CONDITIONS IN APRIL

Activity of Halemaumau and General Notes

Halemaumau was almost motionless the first 10 days of April and the new floor appeared almost as fresh as the day it solidified. In the middle of the month bluish vapor rose through talus at the east edge of the new floor and stained the rocks yellow, and a sulphurous patch with some yellow vapor was developing at the north edge of the new floor.

A number of slides occurred at the north wall of the pit April 17, but thereafter Halemaumau was remarkably quiet. The seismic activity of the month was very feeble.

JOURNAL APRIL, 1929

April 3. At 10:30 a. m., after several hours of light rain and southerly breeze, a cloud of steam rose from Halemaumau fully as large as the pit orifice. This indicated the presence of incandescence in the new lava pool, a few feet below the frozen surface.

April 6. At 10:30 a. m. a small slide occurred at the north wall.

April 9. At 8:05 a. m. a thin cloud of avalanche dust rose at the northeast wall. At 3:15 p.m. there was no motion in the pit. Much white salt had formed on the walls and talus after two dry days following rain. No new

talus overlapped the new floor, which still looked remarkably fresh as it was the day it cooled. A little vapor was visible at the top of the south and west talus slopes.

At 2:30 p. m. a 30-day pendulum clock was set up as a timepiece at the Halemaumau pit seismograph with a view to improving time service at that instrument.

April 10. At 9:30 a. m. the pit was quiet and the only change observed was the removal by rain of the evident whiteness from the salt-covered talus blocks.

April 11. Vapor appearing slightly bluish was staining the edge of the floor yellow at the ESE. A little yellow fume had been seen coming from the sulphur patch on the north edge of the floor. At 3:07 p. m. small avalanche occurred at the south. Above the February cone at the north some fresh red debris had fallen. The wind seemed to be loosening dust at the south wall where very small slides were almost continuous.

April 13. At 10:15 a. m. a new red scar was observed at the east wall above the end of the big sill and fresh debris lay below.

April 15-17. Each day pit was visited at 9 a. m. and nothing new was observed.

April 17. At 2:40 p. m. thin avalanche dust arose over the whole pit area. This was followed by more concentrated whitish dust at the north rim where men were standing and probably dropping rocks. This continued for an hour.

April 19. At 2:30 p. m. the cleft above the north talus appeared to have been enlarged by slides, and a fresh scar appeared to the west of the cleft. A thin layer of rock had fallen from a comparatively large surface of wall, probably on the 17th. Occasional rock falls were heard where single rocks dropped out of the north wall without making any slides or dust. At 2:35 p. m. dust arose from the cleft above the northwest talus.

April 22. At 10 a. m. the pit was quiet and unchanged.

April 24. At 9:30 a. m. a large slide was produced by visitors dropping rocks, and at 1:10 p. m. thick reddish dust at the north rose from what appeared to be a natural slide.

April 25. From 9:00 to 10:00 a. m. artificial slides were in progress north to northwest.

April 29. At 8:30 a. m. the pit was unchanged and very quiet and dry.

SEISMOMETRIC RECORD

There were 33 local earthquakes recorded by the seismographs during the month ended at midnight April 30, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibrations set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s. slight; m, moderate; d. instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

April		April		April	
1	2:03 p.m. vf.	13	9:15 a.m. vf.	21	11:03 p.m. vf.
	2:48 p.m. vf.		10:55 a.m. vf.	22	12:38 a.m. vf.
2	10:15 a.m. vf.		4:48 p.m. f. △11	23	9:24 a.m. vf.
3	5:51 a.m. vf.	14	12:17 p.m. vf. △8	27	11:08 a.m. vf.
	10:13 p.m. vf. △11	15	2:07 a.m. vf.		5:12 p.m. vf.
5	7:13 p.m. vf. △14	17	3:59 a.m. vf.		6:58 p.m. vf.
7	6:07 p.m. vf.		1:38 p.m. vf.	29	2:30 a.m. vf.
9	4:36 a.m. vf.	19	1:33 p.m. vf.		3:27 a.m. vf.
10	5:11 a.m. vf.	20	10:12 p.m. vf.	30	2:52 a.m. vf.
11	4:06 a.m. vf.		10:16 p.m. vf.		9:53 a.m. vf.
	4:59 p.m. vf.		10:21 p.m. vf. △16		
12	3:21 a.m. vf.				

Teleseism

None recorded.

Harmonic Tremor

This type of tremor was absent throughout the month, although spasmodic tremor occurred on April 3, 4, 5, 6, and 24.

Microseismic Motion

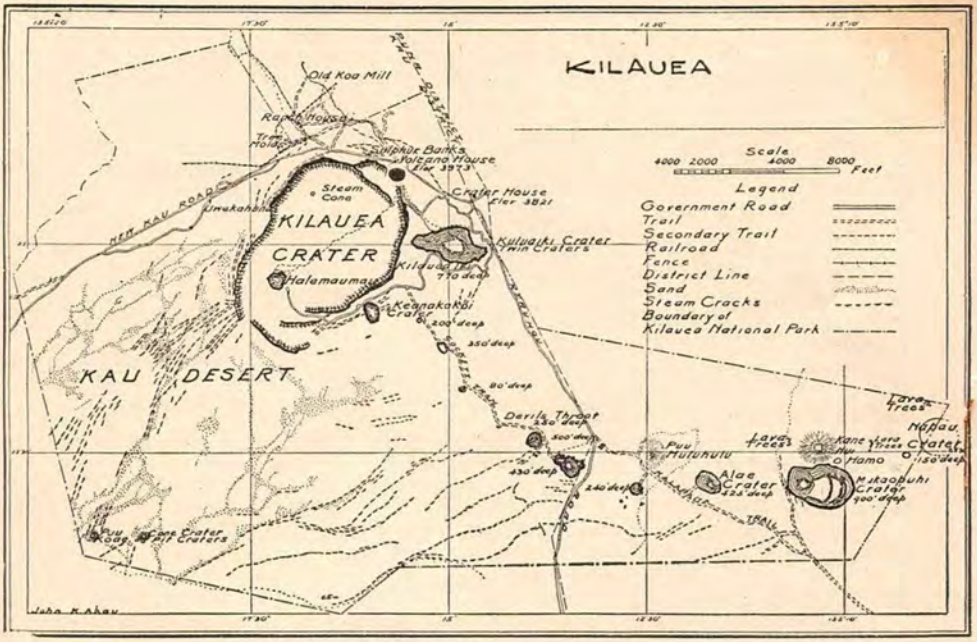
Microseismic motion was normal during the month except at the first and last parts of the month, when microseisms were slight.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change and direction of motion of the plumb line:

April	3-9	0.7 second	SE.
"	10-16	0.5 "	NW.
"	17-23	2.0 "	SSW.
"	24-30	0.6 "	W.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism, (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, MAY, 1929 No. 5

CONTENTS

VOLCANIC CONDITIONS IN MAY

Activity of Halemaumau and General Notes

The month of May produced nothing to suggest volcanic activity on the island of Hawaii. There was a group of local earthquakes about the middle of the month which appeared to be centered in the Puu o Keokeo district of the southwest rift of Mauna Loa, and with them came some reports of smoke in that vicinity which failed of verification.

The measured cracks of the east rim of Halemaumau have shown a slight widening. There have been the usual small slides from the walls of the pit, some of the rocks rolling out on the February floor. At the end of the month avalanches scarred the northwest wall all the way up to the pit rim, and new debris so overlapped the February floor there as to indicate that these were the biggest slides that had occurred since the February activity.

Seismic activity was ordinary, a shock was felt at Kilauea May 12, and one at Hilo May 28. Otherwise the disturbances were very feeble.

JOURNAL MAY, 1929

May 6. At 9 a. m. Halemaumau was observed to be making a slight increase in white stain at the foot of the south talus, and fresh red scars appeared in the wall north.

May 8. At 9 a. m. an avalanche was observed at the north wall, the material falling from near the top and striking the talus at its lowest point of contact with the wall. The yellow stain was increasing at the west end of the north lava heap of February, 1929.

May 15. From 9:30 to 10 a. m. the pit was quiet and the only steaming was from a vigorous area of hot vapor on the south talus. The north wall appeared more freshly scarred than elsewhere.

The cracks at the east rim were measured at the eleven marked localities, and all of these showed very slight widening since March 29, the greatest increase amounting to 0.11 inch. This was at point No. 14, near where the large crack emerges at the pit wall.

At 5:30 p. m., with the sunlight just removed from the pit and the bottom in shadow, a sharp ringing snap was heard from the bottom like deep cracking due to cooling after sundown. This had not been heard here recently. About 6 p. m. a normal raincloud was observed over Mauna Loa with sunset light below, but over this a veil appeared in one place that resembled blue-brown fume.

May 17. One of the periodical rumors of smoke from the southwest rift of Mauna Loa was in circulation. The foreman of Honomalino Ranch, John Gouveia, was questioned and said that the mountain was now clear, but there had been some appearance of smoke from the direction of Puu o Keokeo.

On this day at 4 p. m. a slide was reported from the east rim of Halemaumau which made dust and left a scar.

May 18. At 8 p. m. a telephone report from the foreman of Honomalino Ranch stated that the Puu o Keokeo district had been inspected, that the sulphur patch of 1926 at 8,000 feet elevation was fuming a little, but that the smokiness which had been reported all appeared to be coming from over the top of Mauna Loa. Honomalino had felt a sharp earthquake about 6:15 a. m. May 14, which was recorded on the Kilauea seismographs and indicated distance of origin 30 miles, and another indicating 35-mile distance was registered near midnight May 14-15. These distances agree with the Puu o Keokeo district.

May 19. At 2:30 p. m. one very small fall of rock was heard at Halemaumau, and dust seen rising at 9 a. m. from the north corner of the pit was probably started artificially.

May 20. At 9 a. m. no change was observed in Halemaumau, but it was seen that the heads of the north and northwest taluses lead up to gulches that were deepening their respective trenches in the upper half of the pit wall. The suggestion is that the buttress between these two trenches may some day make an avalanche.

May 21. At 5 p. m. it was observed that some fallen stones now lie on the east side of the 1929 floor.

May 24. At 2:20 p. m. fresh debris was seen at the top of the north talus, the rocks being somewhat larger than surrounding portions of the slopes, and the wall directly above maintained a fresh, red scar. Small rocks had rolled well out on the February floor to the southeast.

May 27. At 12:05 p. m. an avalanche was reported from the north wall of Halemaumau and dust was seen rising there at 1:35 p. m.

May 30. At 5:50 p. m. the whole northwest talus was seen to be covered with new gray debris overlapping the lava floor of February, 1929. The wall was scarred above this slide all the way up to the rim, and the facts indicated that this was the largest avalanche that had occurred since February.

SEISMOMETRIC RECORD

There were 28 local earthquakes and two teleseisms recorded by the seismographs during the month ended at midnight May 31, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibrations set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

May		May		May	
1	5:39 a.m. vf.	14	6:16 a.m. vf. △38 fl	27	7:44 a.m. vf.
5	9:08 p.m. vf.		Honomalino	28	4:07 a.m. vf. △21 fl
6	5:54 a.m. vf.	15	12:05 a.m. vf. △31		Hilo
7	9:31 a.m. vf.	19	9:00 a.m. vf. △34	29	3:09 p.m. vf.
	10:38 p.m. vf.		12:46 p.m. vf.		4:21 p.m. vf.
9	3:06 a.m. vf.	20	1:45 a.m. vf. △28		4:52 p.m. vf.
	3:00 p.m. vf.	21	11:03 a.m. vf.	30	11:32 a.m. vf.
10	8:22 a.m. vf.	25	9:08 a.m. vf.		10:14 p.m. vf.
12	5:54 a.m. s. △	26	12:55 p.m. vf.	31	11:57 p.m. vf.
	epicentral		1:44 p.m. vf.		
	12:37 p.m. vf.		1:58 p.m. vf.		

Teleseisms

May 19
? 6:40 p. m. Very feeble record.
May 26
P 12:17:33.6 p. m.
S 12:25:43 p. m. Distance 6,610 km.

Harmonic Tremor

This type of tremor was absent throughout the month.

Microseismic Motion

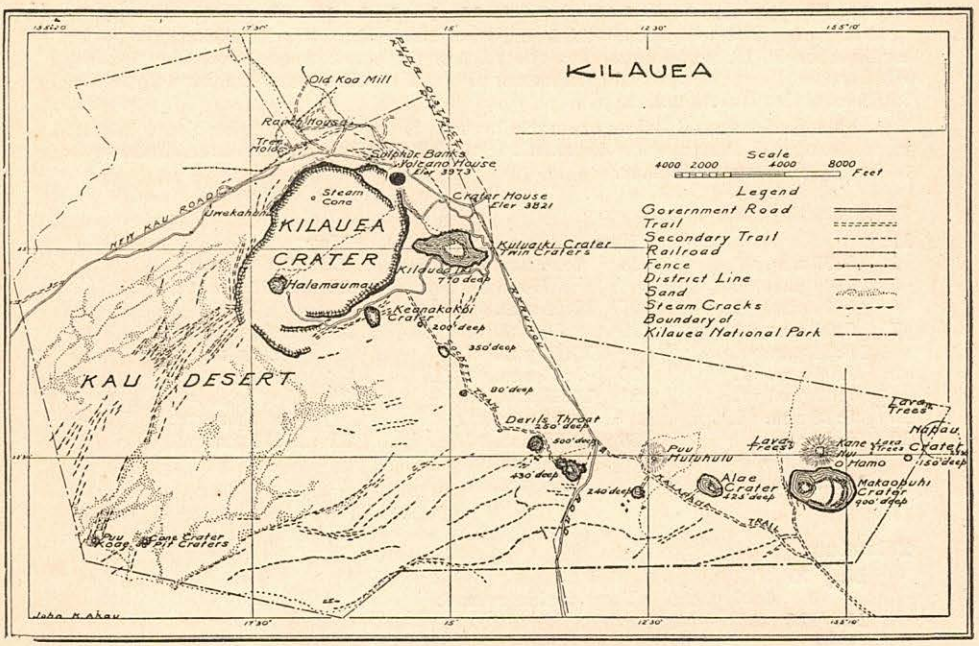
Microseisms were slight during the month.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change and direction of motion of the plumb line.

May	1-7	1.0 second	SSW.
"	8-14	1.3 "	NE.
"	15-21	1.3 "	W.
"	22-28	0.6 "	W.
"	29-June 4	0.7 "	NNE.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism, (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, JUNE, 1929 No. 6

CONTENTS

VOLCANIC CONDITIONS IN JUNE

Activity of Halemaumau and General Notes

There were large avalanches in Halemaumau pit at the beginning of June and in the middle of the month, but otherwise nothing occurred suggesting any volcanic stress. On June 18 there were two felt earthquakes in the morning which dislodged slides in Halemaumau and on the west wall of Kilauea Crater. The second of these earthquakes was unusually heavy, being strongly felt southwest of Kilauea and also at Hilo. The tilting of the ground throughout June at the Observatory was strikingly northward as though the Halemaumau center were rising. Conditions were quiet during the last 10 days of the month.

JOURNAL JUNE, 1929

June 3. At 8:45 a. m. a large dun-colored dust cloud from an avalanche rose from almost half of the Halemaumau orifice on the northwest side.

June 5. At 2 p. m. it was evident that slides had been renewed from above the northwest talus, and larger bowlders lay on the floor beneath.

June 8. At 9:20 a. m. small slides fell at the south talus. Otherwise the pit was very quiet.

June 12. A small rockfall at the north occurred at 10 a. m., and another at 2:15 p. m.

June 13. At 12 noon fresh red and gray areas were observed at the otherwise dusty north wall, and from the middle of the wall at the northeast fresh red debris had fallen on the talus below.

June 18. About 8:42 a. m. and 9:31 a. m. strongly felt earthquakes increasing in energy occurred, the second being felt in Hilo where articles were dislodged from shelves in shops. Avalanches were caused in Halemaumau, and slides fell from the face of Uwekahuna Bluff. This second earthquake was felt by observers in the Kau Desert near the Halfway House accompanied by a rumbling noise and sufficient energy to cause the trees to wave back and forth. The sensation at the Kilauea Observatory was a prolonged east-west swaying.

At 11:40 a. m. Halemaumau showed a gouge where fresh rim-rock had fallen at the west wall. Small trickling slides were heard in action north, west, and south. A fresh avalanche scar showed on the west wall of Kilauea Crater north of Uwekahuna.

June 20. At 3:45 p. m. one or two rocks were heard falling at the south in Halemaumau.

June 24. At 11:45 a. m. a stiff northeast breeze was making whirlwinds of dust in the desert and blowing dust from the walls of Halemaumau on the northeast and at the south, and there were whirlwinds of dust on the edge of the pit. Some rock falls were started at the south and southwest, and a dusty slide at the northeast occurred at 11:55 a. m. At 5:10 p. m. there was thin dust in the pit.

June 26. At 2:45 p. m. there had been recent caving away at the southeastern rim cracks, and at the middle of the north-northeast wall of the pit a new scar and streak below led to a pile of fresh gray debris.

June 29. 9 a. m. White dust resembling steam rose at the northeast side of Halemaumau.

SEISMOMETRIC RECORD

There were 38 local earthquakes and three teleseisms recorded by the seismographs during the month ended at midnight June 30, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibrations set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf, very feeble; f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

June		June		June	
3	8:41 a.m. vf.	10	8:08 a.m. vf.	19	5:18 a.m. vf.
	12:06 p.m. vf.		10:56 a.m. vf.		6:33-6:34 a.m. *
5	1:27 p.m. vf.		3:00 p.m. vf.	21	10:00 a.m. vf.
6	8:17 a.m. vf.		3:02 p.m. vf.		9:05 p.m. vf.
	9:39 a.m. vf.		11:06 p.m. vf.	22	12:16-12:18 a.m. *
	11:39 a.m. vf.	11	8:58 a.m. vf.		5:45 a.m. vf.
	3:00 p.m. vf.	12	10:38 a. m. vf.		12:03 p.m. f. △9 fl.
7	7:38 a.m. vf.		2:19 p.m. vf.		3:06 p.m. vf.
	10:30 a.m. vf.	16	3:29 a.m. vf.	25	10:48 p.m. vf.
	2:24 p.m. vf.	17	1:26 a.m. vf.	26	5:26 a.m. vf.
9	11:31 a.m. vf.		4:46 a.m. vf.		5:38 a.m. vf.
	11:26 a.m. vf.	18	8:42 a.m. s. fl. △11 d.		11:40 a.m. vf.
			9:31 a.m. m. fl. △44 d.	27	12:01 p.m. vf.
			4:25 p.m. vf.	28	5:14 a.m. f. △17

Teleseisms

June 12
? 11:06 p.m. No distinctive phases.

June 16
P 12:28:46 p.m. Distance 8110 km.
S 12:38:13 p.m.

June 27
P 2:36:53 a.m.
S ?
L 3:32 a.m.

Microseismic Motion

Microseismic motion was light, becoming slightly stronger at the end of the month.

Harmonic Tremor

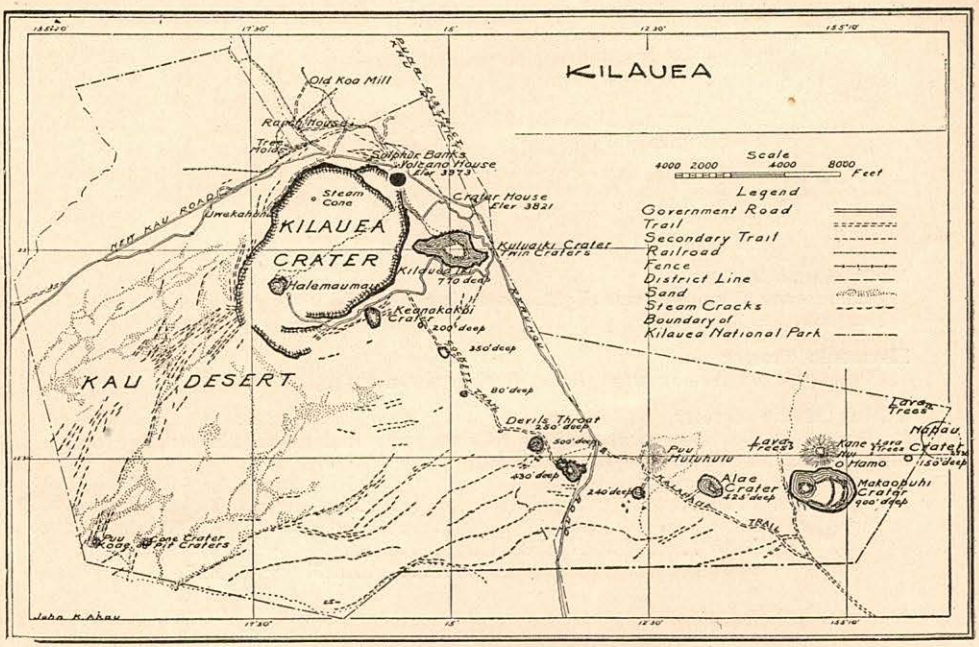
This type of tremor was absent during the month.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change and direction of motion of the plumb line:

June 5-11	0.6	second	N.
" 12-18	0.9	"	WNW.
" 19-25	1.3	"	N.
" 26-July 2	0.5	"	NW.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism, (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.

MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by the

Hawaiian Volcano Research Association

VOL. XVII HONOLULU, HAWAII, JULY, 1929 No. 7

CONTENTS

VOLCANIC CONDITIONS IN JULY

Activity of Halemaumau and General Notes

July started quietly at Halemaumau pit, the week ending July 3 producing only eight very feeble local seisms. The following week produced 29 shocks, one of which was perceptible, and this was the largest number for one week since November, 1928. The tilting of the ground for the first half of July had changed to southerly. The measurement of cracks at the eastern edge of the pit July 7 showed chiefly a widening or tendency to open in the direction of the pit center since May 15.

Nothing of importance happened until July 25 when, about 4:35 a. m., as shown by a series of earthquakes and easterly tilt, lava again broke out at the west edge of the floor in the bottom of Halemaumau. This was verified by observations at the pit, and the eruption assumed the same general characters as the one in February, but endured more than twice as long. The center of activity proved to be a fracture through the talus tangential to the bottom plug making big fountains at the base of the large, western, slide-rock slope. The tilt phenomena at the seismograph close to the southeast rim of the pit differed from the motion of February in that there was some inward tilt toward the center on the first day of activity, followed by outward tilt thereafter. As before tremor was registered continuously while the lava fountains were in action. The eruption ceased on the evening of July 28.

The lava fountains were of Mauna Loa type flinging up brown basaltic pumice, building up a spatter bank against the talus, and sending a flood out over the February floor which increased the size of the bottom enormously. There was some fracturing of the shell of the February floor, followed by eruptions of lava fountains along the fracture, but this quickly declined, and the influx of lava came chiefly from the west border. The first day produced 44 feet of fill, this had increased to 77 feet the second day, and at the end of the eruption the liquid lava before freezing was 94 feet deep. As before the central floor settled about 30 feet after solidification. It was estimated that 97,360,000 cubic feet of lava poured into the pit in 85 hours. The middle of the new floor was left 1,050 feet below the observation station on the southeast rim. The net accumulation of tilt at the Observatory during the week of the eruption was moderate to the south, whereas the ground had tilted moderately to the north during the preceding week.

At the end of July there remained, as usual with these eruptions, some visible glow at night from numerous scattered points among cracks in the floor of the pit, but none of the outbreaks of this type since and including July of 1924 have left any hissing gas cones or other signs of continued activity. The eruption stops abruptly and the new layer of lava cools off quickly.

JOURNAL JULY, 1929

July 1. At 10 a. m. Halemaumau was obscured by rain and fog, but no sounds were heard in the pit.

July 3. At 2:30 p. m. a small dust cloud from slides rose from the pit.

July 7. At 12:30 p. m. much dust from an avalanche rose from the pit orifice, and other slides followed, one occurring about 2 p. m., and a larger one before 3 p. m.

July 8. The top quarter of the north talus was covered with fresh material.

July 10. At 11:30 a. m. after several hours of rain following a prolonged dry spell at Kilauea, Halemaumau exhibited rising steam which was densest at the east. At 3 p. m. many active steam jets rising straight upward had been produced by the rainfall at the Halemaumau bottom.

July 13. At 5:15 p. m. the south talus was observed to show a vertical, linear fissure near the top that was steaming. At the top of the big west talus a semicircle of moisture like an arch lay just below the uppermost point of the talus, which as a whole is shaped like an inverted V. This crescent-shaped crack emitted vapor and appeared to mark a deep break in the talus cone, and there were other steaming spots in the middle of the talus slope below.

July 17. At 3 p. m. there was slight increase of vapor at the middle of the west talus.

July 24. At 11:15 a. m. the pit was quiet and dry and no active vapor jets were noticed. There were hardly any changes in the bottom since the February activity, and there had been few rim changes. Stones had rolled out on the floor at the southeast and northwest sides. The old 1927 southwest cone was red in contrast with the 1929 lava which covers the northern base of the old cone.

On this morning one or two falls of rock were heard and a very faint odor of sulphur dioxide was perceptible.

July 25. At 4:35 a. m. the seismographs at the Observatory registered a series of very small earthquakes a few minutes apart, each accompanied by a tilt to the east, the north-south component showing almost no tilt and registering a very feeble tremor for each shock. The lines of the east-west component widened out for each shock, and immediately thereafter a tendency to spasmodic tremor developed in the record, becoming a strong continuous tremor after 6:30 a. m., and so continuing during the remainder of the day. This is the familiar volcanic vibration which accompanies fountains in the pit.

At 6:10 a. m. a fume cloud was seen rising from the north corner of Halemaumau, and this was discovered to come from two fountains of lava, as seen

at 6:40 a. m. in the bottom of the pit, rising through vents above the lower edge of the middle of the large western talus, the stream pouring down to form a pool on the surface of the large depressed floor which had been created by the outflows of February 20-21, 1929. The evidence from the tilt and tremors shows that the outbreak began between 4:35 a. m. and 6:30 a. m., when there was a rush of gas through the talus bringing with it increasing volumes of lava, the disturbance probably originating in the rift under Kilauea that trends northeast-southwest, so that the upward pressure was accompanied by the same eastward tilt that was noticed at the beginning of the February outbreak.

After 7 a. m. a convection cloud rapidly formed owing to the uprush of heat.

At 7:20 a. m. two groups of fountains flinging up pumiceous frothy lava at the base of the west talus produced high jets of bluish smoke and occasional spurts of brown fume. The old cone of 1927 lay just to the east of the new outbreak. The fountains at times were more than 200 feet high, the southern of the two groups being the most vigorous; this had been the later one to develop. Lava was oozing up through the talus and trickling down to the floor between the two groups of fountains; this eventually developed into a cascade which later crusted over, leaving a glowing hole at the top and a bright cavern at the foot. Out of the cavern a steady stream swept forward into the new pool.

About two-thirds of the floor was covered at this time. The regions not yet covered were a white stained area at the south-southeast, the floor at the base of the northern taluses, and a rounded peninsula extending out to the center of the pit at the east. At two places in this older floor curling steam jets were emerging. At a ridge along the south edge of the new fill small flows of pahoehoe were pouring down among the talus rocks and making festoons. Blue fume developed on the east side of the middle of the floor.

At 7:45 a. m. steady blasts of gas were audible above the pounding of the fountains as though it were rushing through a small hole in the top of a spatter cone, or from a crack in a crust. The steam jets stopped soon after the roaring began, leaving whitened cracks where they had been.

At 8 a. m. with a roar sputtering lava fountains broke through cracks at the edge of the old floor at the eastern peninsula. The line of fountains at the west lowered slightly and made more smoke. The new fountains probably were flaming as each burst sent up brown, hot looking fume, and occasionally there was loud roaring. The western fountain source was jetting less than half as high as at first. At 8:16 a. m. it was evident that a crack had formed through the center of the swollen peninsula, and this area was becoming an island surrounded by new lava.

At 8:35 a. m., with a change of wind, fragments from the big source fountains at the west were falling forward on the new lake instead of on the built-up slope behind them. It was now evident that lava was flowing under the old February crust which could be seen in the crack, and finally fountains spurted up through the upper end of this crack. This crack extended across the February floor from west to east, that is, from the fountain source to the peninsula. Festooned flows were spreading right and left on both sides of the fountaining crack, and spatter edges were being built along the crack. Tropic birds were flying around in the pit. The previous evening these birds had been noticed flying around the Kilauea Military Camp making loud calls as though disturbed by fumes.

At 9:45 a. m. new lava was pushing into the old grotto niche of February at the north edge of the floor. The big fountains were observed to lessen their activity, and then to increase in spells of enhanced gas pressure.

At 10:20 a. m. the whitened old rampart at the south was still showing, and there were three localities of strong fountaining action, two at the west niches at the border of the new lake, and one in the center from the submerged crack, all three of these sending up steady jets. The central fountain was linear in plan, thus marking the course of the crack, with its highest jets very noisy with gas rushes and detonations and lying towards the eastern part of its area of action.

At 12:45 p. m. the older floor was nearly covered, but a part of the whitened area at the south still persisted. This February rampart stood approximately 30 feet above the sunken central area of the floor before the present eruption. There had thus been a wide flat at elevation 2,546 feet above sea level, 1,500 feet long by 1,000 feet wide, with a terraced margin standing 30 feet higher. This margin had been the spatter rampart around the edge of the February lake, and to it had been added fault cliffs which were left when the February lake solidified and subsided. Thus the new fill had 30 feet more filling to do over all the middle region than around the edges. The whitened rampart above referred to was a portion of the high edge, its elevation about 2,575 feet above sea level at the south and 2,617 feet at the north where the greater February fountain had built up a high bank. The highest constructed heap of that fountain stood 2,635 feet above sea level at the north corner of the February floor. The highest constructed heap of 1927 stood 2,643 feet above sea level at the south corner of the floor area and outside the edge of the February lava. These two eminences were thus bench marks for measuring the rise of the new fill.

At 12:45 p. m. there were whirlwinds at the edge of the pit created by the tremendous updraft over the hot lake, and pellets of brown pumice sometimes one to two inches long were falling to leeward on the Kilauea floor southwest of Halemaumau. Also great quantities of Pele's needles and Pele's hair were falling, some of this material making clustered accumulations of hair in linear sticks resembling golden straws. The pumice was quite like that ejected from the high Mauna Loa fountains and gave evidence of intense inflation of the lava with sulphurous gas. Indeed, the character of the activity in Halemaumau of 1927 and 1929 was of Mauna Loa type. The smell of the smoke to leeward was strong of sulphur dioxide.

Over the crack near the center of the pit a small bean-shaped lake delevoped, with a high margin, and this showed fountains that made dome bursts and were only occasionally sputtering. There was now little brown fume and the gas blasts had stopped, the noise being the ordinary roar of fountains. This noise resembled surf on the rocks to an observer looking over the edge of the pit, but a deep rumble was heard when one stood back from the edge. There was a steady doming fountain to the west of the little pond, a crust heap occupied the middle of the northern half of the new fill, and the pond showed a spatter slope on its southern bank.

At this time began a phenomenon destined to continue for two days, namely, the pouring of cascades over ramparts along the southern and eastern edges of the new fill, the lava trickling into the base of the talus. The suggestion was that the northwestern side of the fill was beginning to crust over and lift, whereas the southeastern side built rampart edges and overflowed them.

The western source fountains were beginning to build up grotto niches in horseshoe form at the northern one, and a crescent-shaped spatter wall with a tendency to cave in around the big southern group of jets. There was a small spatter cone at the base of the wall between the two areas, showing a fountain in a round hole.

At 1:30 p. m. the crust on the lake was cracking and foundering. At 1:45 p. m. one of the numerous tropic birds which had been flying around the interior of the pit was trapped by the gases, fell into the lava lake, and burst into flame. When the observers walked around the pit by way of the south margin, a steady fall of pumice was noticed and much Pele's hair was floating through the air. There was strong continuous fume at the upper southwestern rim of the pit rising from the big fountains. From the western verge of the pit broad spatter banks were visible, built back of the large fountain group.

At 2:50 p. m. a large piece of the spatter bank of the big fountains was seen to cave in. The white area at the south was now drowned. At 3 p. m., from the northwest edge, the central small pond was seen to be almost full of lava, with a sputtering fountain at its southwestern end. The dome fountain at the center of the pit farther west was still playing steadily. The line of small fountains which had been playing along the crack east of the pond had shortened.

At 3:13 p. m. the small pond was overflowing toward the west. At 3:16 p. m., during high fountaining, at the southernmost group of source fountains, the bank there caved in. The sputtering crack east of the pond had ceased action. At 3:45 p. m. only a faint horseshoe outline of the east side of the central pond remained visible, and the doming fountain west of it had been replaced by a new one farther west. There were now three distinct big fountains which had built up spatter banks at the base of the west talus, one in a grotto on the north side, and two in a wider grotto south. At 4 p. m. rocks fell from the north wall of the pit.

At 4:25 p. m. an extra small fountain in addition to the three already mentioned was observed in a grotto at the southern end of the source fountain group. The floor or crust of the lake was so swollen that lava was cascading down toward the base of the talus, especially at the east. At 4:40 p. m. the lake was rising and spreading out, the white-stained areas south and north were covered, and now only the steepest sides of the summit of the old 1927 cone remained above the flood. There was only small bubbling at the center of the pit. High grottoes had been built on the west side of the source fountains, and their activity appeared less vigorous than in the morning. Some yellowish fume was mixed with the blue smoke.

After 6 p. m. the rising of the lava in the pit was steady and continued all night with pulsations. The source fountains were constant in their activity. A few small rock slides fell from the north wall, especially at 11 p. m. and at 1 a. m. July 26. At 6:30 p. m. July 25 the pit as seen from the Observatory showed diminished fume and a cumulus cloud above, and at 6:45 p. m. the faint glow from the lava was reflected by the cloud above. At 8:20 p. m. the roar of the fountains was audible at the Observatory, two miles away. At 9 p. m. the glow over the pit was dull, and at 9:35 p. m., seen through mist, it was very dull.

July 26. At 9:30 a. m. the east side of the lake seemed to spread out more rapidly than the remainder, and at 10:30 a. m. several large tongues of lava were observed extending themselves into the east talus. Fountaining continued at the source cones. The lava had surrounded the 1927 cone summit at the south, and it half surrounded the February cone at the north. Crusts were piled up in patches or islands at several places in the lake. The skin of the pool showed a radial pattern of lines from the source fountain region as a center. There were many cascades over the eastern ramparts.

At 2:20 p. m. there was a glowing rim around the edge of the lower northern fountain at the source locality, and the crust of the lake in front of it cracked concentrically so that the fragments streamed into the fountain. At the northeast a bright cascade poured over the floor margin for a half hour. Between the two fountaining niches at the west stalactites were hanging under a point of fresh lava which had been built out by spatter. Eight tropic birds were seen at one time within the pit. At 2:50 p. m. cascades from the edge of the lake northeast increased and sent flows both northward and southward into depressions at the foot of the talus. At 2:57 p. m. a block of the built-up niche on the north side of the source fountain heap fell, leaving a glowing wall like a bed of coals. At 3 p. m. there was some cracking and foundering of crusts on the lake, and lava toes were pushing over its western margin.

At 8 p. m. the fountains remained in strong action, radial bright lines extended out from them, there was sluggish overflow around the east border of the lake, glow could be traced to the extreme edge, and there were no central fountains. There was not as yet any appearance of lowering.

July 27. The source fountain jets were now in three principal units, like three armchairs or thrones, the larger fountains occupying the middle of the group, frequently double, making a continuous roar like surf, and closely resembling the Alika source fountains of 1919 on Mauna Loa. The material was in stringy blobs of a color orange to blood red in daytime and golden yellow to orange at night. The highest fragments floated up rather lazily, all of the material being light and pumiceous in the center of the jets. The lava would slop down, making a glistening incandescent bank against the west talus. This

bank preserved its relative height while the lake was filling, the bank encroaching on the talus above as the pumice from the highest fountain jets built up the heap. Back of the fountains the bank was eternally breaking down in landslides of cherry-red lava. From the base of the fountain group the lake streamed away very slowly with a pattern of radial and concentric bright lines, past a few irregularly clotted crust islands here and there. There was no trace of central fountaining.

During the night July 26-27, the high northern spatter bank of February last was overflowed, indicating that the lake had there reached a level of 2,623 feet above sea level, implying a depth of new lava of 77 feet above the lowest sag of the center of the February floor. The peak of the 1927 cone in the south cove of the new lake still stood 15 feet above the new lava, encircled by rampart material of border overflows. In the course of this day the hole in the south side of this cone was invaded and buried, but the cone was not covered up, and the elevation of the whole new floor was now proceeding by rampart overflow into the talus slope. The floor area was steadily increasing horizontally, but its rise vertically had now greatly slowed down owing to the vast size of the new fill. This was roughly 2,100 feet long in a northeast-southwest direction by 1,700 feet wide. The floor was shaped like an ivy leaf, with the stem to the southwest, and was dominated by an enormous heap of pumiceous spatter backing the source fountains in a semicircle up the middle of the big west talus. The points of the leaf were produced by the sags between the several taluses, eight in number. The actual wall of the pit was in contact with the new fill at the west-northwest.

The mechanism of action during July 27 did not change, but the big fountain jets were no longer showering any considerable quantity of pumice over the country to the southwest, though Pele's hair continued to be manufactured. Ramparts and islets covered with piled crusts from the outward streaming action in the lake were being formed around the lake edges north, northwest, northeast, and southeast. This made an overflow margin from 50 to 400 feet wide outside of the lake proper, the greatest width of this margin being at the northeast on the side remote from the fountain source.

Overflowing was not so conspicuous and it was not limited to the eastern region. Occasional overflows indicated that the rampart had a strong outward slope. The throne behind the biggest fountain jet tended to break down so as ever to widen the crescent of the spatter heap. At 8:30 p. m. there were three separate and distinct fountain niches, and looking across at them from the east rim of Halemaumau, the one on the left was seen to be in a small grotto, the central one was much the highest and without any overhanging arch, and the right-hand fountain made dome bursts rather than jets.

At 8:50 p. m. there was much cracking and foundering of crusts back of the 1927 cone as the lava worked into the depression between the south and west taluses.

Between 7 and 8 p. m. the big fountain was spouting to heights over 200 feet almost continuously, and a strong border filling was going on at the south. At 8:30 p. m. the vigor of the big fountain had decreased. At 9:15 p. m. a strong flow spread around the 1927 cone south. Between 9:30 and 10 p. m. the north fountain revived and threw jets higher than at any time during the preceding 48 hours. About 10 p. m. several huge slabs spalled off the throne back of the large fountain.

This action of the fountain indicated that toward the end of the eruption there were spells of waxing and waning gas pressure. At times the jets were 225 feet high. The pit seen from the Observatory was at these times very bright whereas at other times it was very dull.

During the three days of activity there had been strong volcanic vibration registered by the seismographs, and the instrument standing back from the south-east rim of the pit had indicated some reaction of inward tilt during the 25th, followed by outward tilt during the 26th and 27th. The instruments at

Kilauea Observatory and at Uwekahuna Observatory were registering tremor continuously while the fountains were in action.

July 28. In the morning the fume was very thin, only a slight column of blue smoke rising above the western wall of the pit, and a pale brown veil with intense boiling of hot gas, appearing behind the pit against a background of sky. On the evening of the previous day this boiling in the air had been very conspicuous owing to condensation of rapidly moving gray vapor, formed from atmospheric moisture, that made a crown above the fume column about 6 p. m. Later in the evening of the 27th this cumulus disappeared.

On the morning of the 28th the floor was about 2,100 feet long by 1,700 feet wide. The fill was approximately 84 feet deep. Its surface was 2,630 feet above sea level, and as the rim at the tourist station has elevation 3,640 feet, the depression of the lake was now 1,010 feet below the rim. The fountains at the west had adopted a rythmic interval of about 30 minutes between maxima. At 8 a. m. the big fountain group was low and quiet, with jets about 50 feet high. At 8:15 the jets were from 200 to 300 feet high. At 8:30 a. m. they were lower again, at 8:45 high and noisy, and at 9:00 they were again low.

At 8:20 a. m. the big fountain at the base of the west talus sent up individual jets more than one-quarter the height of the wall behind it. There was a small fountain in the grotto next south of it. Next to it on the north was a moderate fountain of the Kilauea type in a niche. The spatter banks showed lines of breakdown and the big fountain was splashing against a rounded elephant's back continually bombarded and repeatedly breaking away. The pumice beds extended up the talus at least 250 feet above the lake.

A broad stream of lava swept straight across the lake from the large fountain to the east talus. The peak of the 1927 cone still protruded about 10 feet. At the edge of the lake ramparts of piled slabs were well defined SE. and NE. A peninsula of bench magma protruded into the lake area NE. The bank was lower NW. The general effect was like 1915 activity, with the west fountain replacing the west pond of that time, and the lobate fronts at the east and north appearing like a lava flow. Cracking and foundering of crust was in progress E. and NE. Around the borders the lava was encroaching on the talus by flows pushing through the ramparts. Bowlders which had been used as landmarks for a survey July 27 were now buried S., NE., and N.

The biggest rampart of piled slabs lay directly opposite the source fountains at the east side of the bottom.

There was white steam in the talus at two places E. and SE., some fume at the southeast rampart and also northeast. White milky stain had appeared on the crust of the lake NE. One island NNE. showed yellow stain on a small crag of bench magma. There was the usual steam on the upper talus slopes.

The marked contrast between the present situation and the leaf-shaped lake of 1915 is that in 1915 the source pool was quiet and fountaining grottoes occupied the lobes of the opposite end of the lake: now the only fountain is a gigantic emission of gas of the Mauna Loa type at the source end of the lake, while elsewhere there is only quiet cracking and foundering of crusts with marginal overflow. The lake within its rampart was now shaped like an ivy leaf with the stem near the source fountains. The small fountain north of the big one showed the flinging type of action photographed in 1917. The breaking bank back of the big fountain showed a cherry-red wall like incandescent coke, and made angular breaks when it caved in. The caved-in material must have been worked over or else thrust out into the lake, making part of the clotted gas-free crust that piles into the islands, very much like the rafts in Mauna Loa flows. At the distance observed, the lava appeared to be a rough pahoehoe, but it may have some aa details.

At 9 a. m. the source fountain was frequently less than 50 feet high. There was streaming from it toward the grotto next on the north, and the latter was sucking in crusts from all sides and puffing up yellowish sulphur smoke. The smallest grotto at the south had blue fume rising from the bank above it and sent a continous festooned stream of lava off to the east.

At 3:15 p. m. the smaller source fountains were dwindling because of rise of the lake level, and the middle fountain was as strong as ever, and at times detonations were very loud.

At 4:23 p. m. the middle fountain dwindled to a height nearly as low as the others and something of the same sort was reported for 8 p. m. of the previous day. There were now four fountains all about equal, the northern three showing variations.

At 4:27 p. m. the large fountain recovered a little and then became quiet again. At 4:31 p. m. there was another partial recovery. At 4:37 p. m. the site of the large fountain was the smallest area of activity and the northern fountain was the greatest. At 4:39 p. m. there was very small action at the big fountain site and the bank behind it was caving in at intervals in what looked like red-hot cascades of large and small fragments. At 4:44 p. m. the middle fountain was gradually recovering, at 4:46 it was making high jets and spattering over the bank behind it, and now the northern fountain had dwindled.

From 4:50 p. m. until about 7 p. m. the spouting continued with constant force, then gradually decreased until fountaining ceased entirely at all the source niches at 7:42 p. m.

The maximum elevation of the lake surface, when it was hot and inflated, after 85 hours of flowing, was 2,640 feet about sea level, the surface standing 94 feet above the low portion of the February floor. When such an eruption comes to an end withdrawal of the molten lava down the vents and also shrinkage accompanying crystallization causes a settling of the middle area of the lake, with terraces around the border outlined by the ramparts.

At 7:20 p. m. Halemaumau as seen from the Observatory showed only dull glow and the fume had decreased.

At the pit at 8 p. m. a small double fountain played occasionally at the site of the northern of the four source vents. At times the outbursts were audible. The lava appeared very stiff. There was a little bubbling at the base of the black point protruding between two of the niches, and there was some bubbling in cracks of the lake crust.

Cracking and foundering was going on sluggishly in the lake crusts at intervals, the places being the edges of the lake and at the radial bright lines crossing the lake. During an hour the bright-line pattern changed not at all. One small cascade poured into the base of the north talus. There was very little fume. The tip of the 1927 cone still showed.

About 8:15 p. m. the spatter material on the wall of the large niche, which still exhibited glowing spots, began falling off in trickles of small red and black fragments, and once or twice larger masses fell. These broke through the crust of the lake. This caving away lasted only a few minutes, but some glowing spots remained in the wall an hour afterwards.

At 10:30 p. m. the pit as seen from the Observatory showed a dull light on its wall and on the cloud above.

July 29. At 4 a. m. no glow could be detected above the pit. At 7:15 a. m. all was quiet at the pit and some glowing places were visible. Much of the floor in the vicinity of the source fountains site was swollen up into crust heaps, and one such cluster near the west wall emitted vapor as did other crusty islands on the floor. There was a steaming area where the edge of the floor touched the south talus, and there were the usual talus vents higher up. Occasionally the floor could be heard cracking.

July 30. In the forenoon inspection of Halemaumau showed that a small rock slide during the previous night had fallen from the northwestern cliff so as to scatter a few bowlders on the surface of the new lava. The cooled lava surface was still cracking occasionally, and there was slumping of material from the infacing steps around the margin of the central floor, these being formed by the settling of the lava lake. No important avalanching was noticed from the walls of Halemaumau.

A survey of the pit made the previous day showed that the central floor stood at elevation 2,600 feet above sea level and that the in-facing fault scarps

around it were from 20 to 30 feet high. The narrow lake margin between these scarps and the pit slopes varies in elevation from 2,615 to 2,630 feet. The area of the entire new floor was approximately 50 acres and about eight million tons of rock had been added to the bottom of the rock.

July 31. At 11:15 a. m. sounds of cracking or of rocks falling were occasionally heard. The weather was sunny, and the only steam about the floor was at its southern edge.

SEISMOMETRIC RECORD

There were 91 local earthquakes recorded by the seismographs at the Hawaiian Volcano Observatory during the month ended at midnight July 31, 1929. These and other phenomena are listed below. The time used is Hawaiian standard (time meridian is 157° 30′ W.), which is 10 hours and 30 minutes slower than Greenwich time.

The greater number of the very feeble local shocks are partly true earthquakes and partly tremors, which are sometimes due to vibrations set up by avalanches in Halemaumau. Protracted tremor is not uncommon, but this has distinctive characters which are harmonic and continuous when lava fountaining starts in Halemaumau pit.

Abbreviations used below are as follows: vf. very feeble, f, feeble; s, slight; m, moderate; d, instruments dismantled; fl, felt locally; △, indicated distance in miles; *, continuous tremor.

Local Earthquakes

July		July		July	
1	8:33 p.m. vf.	10	2:20 a.m. vf.	22	8:53 a.m. vf.
2	10:51 a.m. vf.		1:27 p.m. f. △10 fl.	23	8:51 a.m. vf.
	5:17 p.m. vf.		6:29 p.m. vf.		9:36 a.m. vf.
	5:18 p.m. vf.	11	4:04 p.m. vf.		9:43 a.m. vf.
	6:46 p.m. vf.	12	6:10 a.m. vf.		10:27 a.m. vf.
3	2:58 p.m. vf.	13	5:01 a.m. vf.	24	5:32 a.m. vf.
	7:10 p.m. vf.		11:51 a.m. vf.		10:49 a.m. vf.
4	4:37 a.m. vf.		12:01 p.m. vf.		12:47 p.m. vf.
5	4:35 a.m. vf.		5:16 p.m. vf.	25	4:20 a.m. vf.
	4:52 a.m. vf.		11:16 p.m. vf.		4:21 a.m. vf.
	7:51 a.m. vf.		11:26 p.m. vf.		4:24 a.m. vf.
	11:41 a.m. vf.	14	12:17 p.m. vf.		4:26 a.m. vf.
	12:19 p.m. vf.		6:39 p.m. vf.		5:12 a.m. vf
	12:53 p.m. vf.	15	10:00 a.m. vf.		5:31 a.m. vf.
	1:48 p.m. vf.		10:01 a.m. vf.		1:43 p.m. vf.
	2:41 p.m. vf.		10:02 a.m. f. fl.		2:47 p.m. vf.
	5:54 p.m. vf.		1:07 p.m. vf.		10:01 p.m. vf.
	7:08 p.m. vf.	16	9:00 a.m. vf.	29	8:45 a.m. vf.
6	5:59 a.m. vf.	17	5:14-5:16 a.m. *		1:08 p.m. vf.
	12:07 p.m. vf.		2:20 p.m. vf.	30	3:55 a.m. vf.
	12:56 p.m. vf.		2:21 p.m. vf.		(with E. tilt)
	3:32 p.m. vf.		2:29 p.m. vf.		7:08 a.m. vf.
	6:59 p.m. vf.	18	7:00 a.m. vf.		(with E. tilt)
7	12:27 a.m. vf.		7:01 a.m. vf.		10:28 a.m. vf.
	11:54-11:56 a.m. *		8:10 a.m. vf.	31	5:02 a.m. vf.
8	11:59 a.m. vf.		8:49 a.m. vf.		(with E. tilt)
	5:53 p.m. vf.		10:33 a.m. vf.		12:58 p.m. vf.
	10:10 p.m. vf.	19	4:45 p.m. vf.		2:50 p.m. vf.
9	9:44 a.m. vf.	20	4:40 a.m. vf.		4:52 p.m. vf.
	10:22-10:23 a.m.*		8:18 a.m. vf.		
	10:36 a.m. vf.	21	10:16 a.m. vf.		
	12:43 p.m. vf.		1:16 p.m. vf.		
	11:04 p.m. f. △23 fl.				

Harmonic Tremor

Accompanying the lava outbreak tremor was continuous after 6:32 a. m. July 25, became stronger July 27, ceasing entirely 7:42 p. m. July 28.

Microseismic Motion

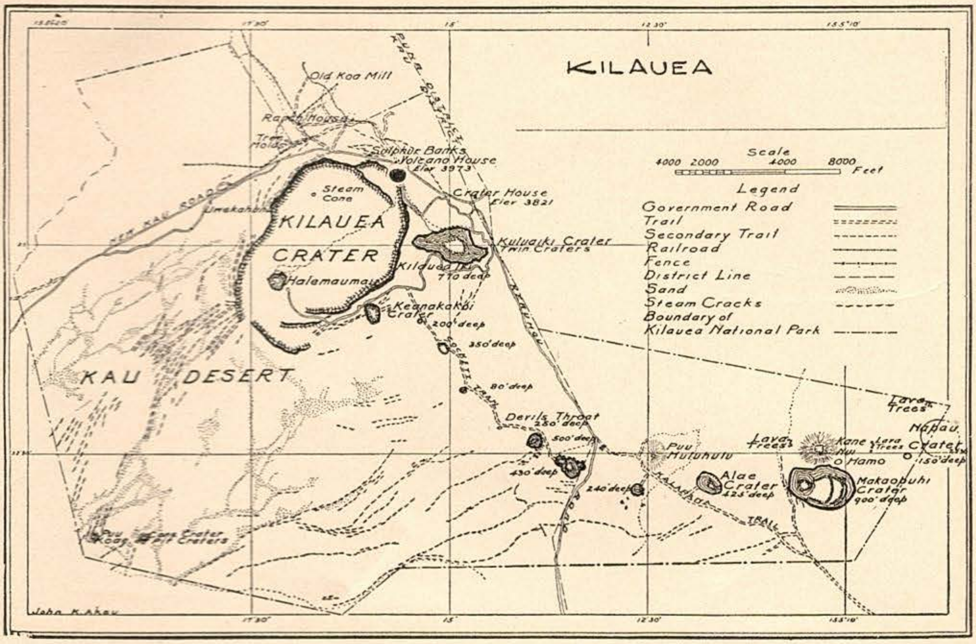
Microseismic motion was very slight throughout July.

Tilting of the Ground

By weeks this movement was as follows, expressed as angular change and direction of motion of the plumb line:

July	3-9	0.6 second	NW.
"	10-16	0.3 "	SSE.
"	17-23	1.0 "	N.
"	24-30	0.5 "	SW.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

All exchanges, gifts to library, news notes about Pacific volcanic and seismic events, and correspondence should be addressed HAWAIIAN VOLCANO OBSERVATORY, Hawaii National Park, Hawaii.

The Observatory is operated by the U. S. Geological Survey, and its work is supplemented by the Hawaiian Volcano Research Association. The main station is on the northeast rim of Kilauea Crater. Subordinate seismograph stations are operated by the Research Association under the direction of the volcanologist in Kona and Hilo.

The Kilauea station operates horizontal pendulums of the Bosch-Omori type and receives time by wireless from the Honolulu Naval Station. Observatory Lat. 19° 25′ 54.3″ N.; Long. 155° 15′ 39.6″ W.; elevation cellar 1214.6 meters (3985 feet). The Hilo and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

The Hawaiian Volcano Research Association founded the Observatory in 1911, transferring the plant to the Government in 1919, but continuing cooperation in experimental work by furnishing funds and apparatus and workers as needed by the Government Volcanologist. It is a corporation under the laws of Hawaii, governed by a board of directors, and financed by the subscriptions of its members and patrons. Its aims are identical with those of the Observatory, namely, (1) To keep record of Hawaiian volcanism, (2) To attract volcanologic specialists to Hawaii, and (3) To promote worldwide knowledge of volcanoes and earthquakes and the foundation of more volcano observatories.