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CONTENTS

VOLCANIC CONDITIONS IN JANUARY

Activity of Halemaumau

The year of the explosive eruption of Kilauea, 1924, left the lava pit Halemaumau an oval 3000 by 3400 feet in plan, 1280 feet deep, with a remnant of lava floor overlapped by talus slopes. The lava had poured into the bottom in July, 1924, from a lateral cone in the talus, but this had quickly ceased and avalanching demolished the cone in November and throughout the last half of 1924 built up the talus slides.

The only activities at the beginning of 1925 were hot steam jets from the talus, walls and bottom mixed with sulphur gas and hydrogen sulphide, local seismic movements and avalanches, and vaporing from cracks moderately hot outside of the pit and parallel to its rim. There were also tilts fluctuating from week to week as measured by the seismographs at the Observatory two miles from the pit, and these tilts are known to vary, in a manner not simple, with the upward pressure of lava under the mountain. The avalanching also

in times past has been observed to vary with the increase and decrease of this pressure as recorded at those times by increase and decrease of noise from gas hissing. The increase of gas pressure meant rising lava and less avalanching; its decrease meant sinking lava and unstable walls.

Unfortunately at the beginning of 1925 there was no such hissing wherewith to diagnose lava pressure. The only direct evidences of such pressure were tilts toward or away from Halemaumau, and possibly increases and decreases in avalanching. The increases or decreases in solfataric deposits were hard to gauge, because they varied with the coatings of dust derived from avalanches, and with rainfall that dissolves them in part. Local seismic movements registered on seismographs are also diagnostic of underground lava change. Their interpretation, however, is difficult, as Halemaumau avalanches produce prolonged seismographic tremors of amplitude as great as that of local earthquakes. Kilauea is encircled with faults. Fault movement-making earthquake may be induced by subsidence. Avalanches may be induced by the same subsidence owing to the tipping in of the pit walls. On the other hand, avalanche vibrations may act as trigger for earthquake strain, or earthquake vibrations may act as trigger for avalanche strain.

From this it appears that the only motion that may be considered diagnostic of the fluctuation of unseen lava is a proved subsidence, or the reverse. The proof is clearly a matter of judgment depending on all the observed changes of condition.

During the first week of January a pinnacle at the south rim of Halemaumau fell in, but avalanching decreased. Twenty-two earthquakes and northeasterly tilt were registered. About half the earthquakes were of the avalanche type and two noisy avalanches were heard the forenoon of January 3.

The second week was rainy with 5.88 inches of rainfall January 6-9 and strong northeasterly wind. This produced snow and electrical storms on Mauna Loa and Mauna Kea. Vapor greatly increased in the bottom and walls of Halemaumau. The seismographs recorded change of tilt from northeast to southwest January 12 and on the same day there were noises heard at the pit repeatedly about noon that suggested puffing. Avalanches decreased during this week and the number of local earthquakes was only 13. On successive weeks beginning with that ending December 3 the earthquake numbers were 19, 41, 50, 33, 30, 22 and 13, showing how strikingly and gradually the maximum was reached at the solstice.

The third week produced 27 local shocks; about half of them were of the avalanche type, three were felt and 14 occurred on January 17. Northerly tilt was resumed on the 16th and on that day between 5 and 6 p.m. an echoing hiss was heard inside Halemaumau about every ten minutes, each time ending with the rattle of sliding rocks. This was followed by an avalanche roar at the pit at 7 p.m. and the next day was the date of the 14 seismic movements.

The last week of the month produced whitening of the walls of the pit due to the efflorescence of salts after the dry spell. This was different from the sulphur and sulphates deposited about the live vents at the bottom. These last deposits are bright yellow, cream colored, greenish and pink. The hot steam makes dry patches in the midst of stones dark with condensed moisture round about.

During this week some depressions were detected in the debris of the pit floor, which may or may not have been new. Eleven local earthquakes were registered, one of them at 6:42 a.m., January 26, showing indicated origin 11 miles away, probably southeast. Tilting was south-southwest. There were small rock slides, mostly at the north sill. After the 29th there was some increase in avalanching, and the ash southeast of Halemaumau was broken at the rim cracks, showing that wall of the pit to be in motion. A fresh sulphur deposit was noticed at the south margin of the bottom lava.

DISCUSSION OF SPECIAL FEATURES

Temperatures of Vapor Cracks

Using a Centigrade maximum mercurial thermometer, the writer measured the temperatures of several cracks near Halemaumau on the forenoons of January 24 and 25. These are cracks concentric with the rim of the pit or with the outer edge of the floor of Kilauea crater, and most of them are new cracks formed by inward slumping toward the Halemaumau center in May, 1924.

Translated into Fahrenheit and summarized, these measurements from rim of pit outward from Halemaumau gave 162° F. at south rim, 167° west rim, 169° southeast rim, 187° at a purring vent 100 feet back of southwest rim, 189° at road terminus 2000 feet back of rim southeast, and 194° at old sulphurous crack on the south margin of the Kilauea floor at the contact of lava and gravel. This last place was also blowing. If we go still farther outward to the Sulphur Bank at Volcano House back of the Kilauea rim we get 204°, which is the boiling point of water for this elevation. Thus at present the cracks are hotter the farther we go from the volcanic center. In general this would imply that the encircling rings or crescents of broken rock that slip down toward the crateral hollow are funnel-shaped. The cracks bounding the outermost ones go deeper than those bounding the inner ones and so approach nearer to the hot lava below, or rather, the hot ground-water heated by the lava.

This, however, is not an invariable rule. For many years we had the Postal Crack with a temperature over 300° Cent. (570 Fahr.) only a few hundred feet back of the north rim of Halemaumau, while the two sulphur cracks above mentioned were at the same temperatures as at present. There may still be some vents discoverable on the northern Kilauea floor hotter than those yet measured. These would be over the red hot intrusive sill which the collapse of 1924 has revealed in the north wall of Halemaumau, its top 650 feet below rim of pit. In fact, the revelation of these hot intrusives in the prism of lavas that has filled the Kilauea sink during the nineteenth century is probably a clue to the diversity of temperatures which the floor of the greater crater has shown. This is also the clue perhaps to the excessively high temperature of the air vent on top of Mauna Iki, the slag heap of 1920 in the Kau Desert. There the heat is so great that a stick of wood is easily lighted in the cracks of the rock, though the place does not steam or give off any solfataric odors. Perhaps there are intrusive sills in Mauna Iki still incandescent and close to the surface.

Lava Fountains of 1790

The investigation described in the Journal of January 20, showing bowlders of 1790 on top of pumice, is of great interest in giving a clue to an additional detail of the 1790 explosive eruption.

On January 20 a gulch in the southwest wall of Kilauea was followed up, for it was noticed that a fan-cone of wash at the foot of it was covered with basaltic pumice. The gulch is a short one formed by torrential drainage from the upland above, its head a small amphitheatre scoured by waterfalls and showing U-shaped gullies above, now dry. In this amphitheatre is shown a thick section of ash, bowlders and pumice, the individual layers much thicker in the gulch than on the upland above. This shows that the gulch was there when this particular mass of debris drifted in, probably in 1790. The pumice alone in places is three feet thick and the whole section about eight feet thick. There are some big bowlders beneath the pumice, but on the upland flat there are numerous large ones above the pumice which have indented the pumice with their impact pits. These impact pits prove 1790 origin. There is not much 1790 ash or gravel above the pumice at this particular place, though in other places farther to the east the pumice is not represented and ash takes

its place. In other words, the pumice drifted in banks locally to leeward of big lava fountains of the Mauna Loa type, throwing their spume of molten glass up into the air to be carried away by the wind.

Now the interesting thing about this section is that three or four feet of bowlders, gravel and ash were hurled out tumultuously in the first phase of the 1790 eruption; that thereafter the big lava fountains played; and that finally a recurrence of explosion was mixed with the receding lava so as to hurl big angular bowlders a mile from the pit. With this phase we know at the southeast gravel flat many bombs fell, rock fragments encased in lava and rolled into spherical forms. We know nothing of the intervals between the three phases, but the descriptions of natives who were with the Keoua party indicate that they saw lurid fires and brilliant glow. Keoua's people, therefore, were probably overwhelmed by the final mixed phase.

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January 1. At 11:30 a. m. there were occasional slides north and west and possibly some purring in the bottom. It was worthy of note that the steaming in the talus was of two kinds, dry and wet, the dry certainly the hotter. Up the southwest talus in the middle lay a wet streak steaming idly. Up the south talus lay a dry streak steamingly hotly, densely and sulphurously. Like this also were the dry steam jets at the west pocket, the central floor and the east edge of the lava. In the north talus the vapor appeared less hot and the ground wet.

January 3. At 9 a. m. slides were heard occasionally and the north talus appeared to be piled higher than ever. The noise of big slides was heard about 10:30 a. m. and 12:15 p. m. In both the north and northeast high walls marked greenish areas of solfataric decomposition had developed during the previous weeks.

January 4. At 6 p. m. it was dark enough to make glow visible if it existed. No sign of it was detected at the base of the east, west or south talus in the fume cracks or in the north or west intrusives. There was more steam hanging above the pit than in daytime. An odor from the pit suggested carbon bisulphide. Large rocks tumbled noisily toward the south and toward the north.

January 5. The day was rainy with northeast wind. At 2:15 p. m. one or two rocks were heard falling and there was much steam. Several notches and protuberances in the west wall were seen to have developed at the south base of the northwest talus. Above the north sill a section showing altered rocks and unconformities had been revealed by the stripping of the wall which appeared like the east side of a U-section, in addition to the marked solfataric zone of unconformity over the east horn of the sill.

January 7. At 11 a. m. a circuit of the pit starting at the south side revealed the fact that the south pinnacle at the rim had fallen in and all that was left of it was a slender spire below the rim. This must have fallen the forenoon of December 31. The south-southwest rim exhibited a new pinnacle slab hanging out over the pit showing that the southern walls had been working. There had apparently been some falls of rim rock northwest, as steam cracks next the rim identified a week before had disappeared. An avalanche was seen to fall from the middle of the north sill. The lower part of the 1920 rift in the southwest wall appeared to have fallen away; the upper tunnel appeared to be an arcade at least 80 feet high and there were two cavernous openings below that.

January 8 and 9. A northeasterly rain storm occurred with thunder and lightning which were intense at Hilo and snow appeared on Mauna Loa down

to the 10,000-foot level. The pit was overhung with vapor and the seismograms indicated little avalanching activity.

January 10. At 10 a. m. there was abundance of steam and only one fall of rocks was noticed from about the southwest tunnel. The densest cluster of steam tails on the bottom was at the west pocket. Steam outlined the front of the landslide terrace. The walls of the pit were wet, and vapor from the wall itself rose through the outcrop of the tangential cracks northeast and southwest, which do much steaming as rim cracks on top.

Examination of the wall at the south-southeast corner of the pit where the pinnacle had fallen showed that a slice of rock remained on the face of the wall with two slender spires rising from it.

January 11. At 9:30 a. m. there was abundant vapor at the west pocket and the south talus, and a line of jets up the edge of the talus at the north corner. Yellow salts were reappearing at the base of the southeast wall. No rocks were heard falling and the seismogram of the previous day showed not a single avalanche tremor. The pit appeared stationary, the tendency of tilt was to the northeast, the weather was cold, and snow on Mauna Kea was abundant.

January 12. The wind was light from the southwest so that the smell of hydrogen sulphide from the pit was strong at the Observatory. This gas was undoubtedly mixed with the bottom steam, for in sunlight the sulphurous steam shows bluish edges at the hottest dry places, notably along the east border of the lava floor at the south and west vents in the talus near the bottom, and across the middle of the floor from south to north. Single rocks were seen sliding occasionally at the northwest and southwest walls.

The pit in plan has spindle shape with flat ends. In profile the flat ends northeast and southwest are the walls most nearly vertical. The longer walls northwest and southeast are curved in plan and terraced below. The west wall is characterized by its red boss. The southwest corner by its big talus cone and steam cracks at the rim. The south-southwest wall by the rift tunnels, great steepness and a talus heap under the rift. The south corner by an angle in plan and talus below with dense sulphurous steam at the bottom. Southeast and east walls are a continuous curve in plan with little talus and numerous terraces of rock. At the base of the wall south-southeast are gulches made by oblique protuberances of the wall below. At the bottom of the pit on the east side lies the biggest unburied remainder of the July lava floor, the east talus at its margin being yellow with sulphur and steaming hotly. At the very base of the southeast wall there is a smooth rock bank stained with sulphur.

The plan of the pit at the northeast exhibits another corner above the east horn of the big hot sill which is surmounted by a vertical belt of solfataric stain. The north-northeast wall is very steep, the big sill lying below, thickest at its east end and overlaid by a fossil talus slope in its western half.

Next comes the north corner of the pit with white stain on the wall below. The upper part of this northern wall is greenish-yellow where the blue smoke came out from June to November. At the base of the north-northeast wall there is a broad talus under the west horn of the big sill. This sill is shaped like a hammock with upturned points at each end, these being the horns. Up through the middle of the sill cuts the northeastern extension of the 1920 rift dyke thinning out three-quarters of the way up the wall above.

The northwest wall is characterized by an S-shaped talus bordered by a promontory and taking its origin at the top in another fossil talus section notched out of the wall, about the same height as the northern one but smaller. Near the top this wall shows traces of an old shallow niche of saucer shape

in cross section, with the lava veneer of the old saucer outlining it below. At bottom the northwest talus reaches the edge of the hot, dry, densely steaming flat called the west pocket. Out in front of the west pocket is the landslide terrace or lobe of bowlders and gravel with its steaming front which on November 28 was created by a breakdown of the big southwest talus conoid, destroying the lava conelet of July and burying three-quarters of the lava flat of that period. The densest steam here comes from a patch of yellow stain in the lava floor at the base of the landslide terrace nearly in the center of the pit.

At this time the steam at the west pocket did not show the blue sulphurous edges characteristic of that at the east and south.

At the upper rim of the pit the conspicuous vapor cracks were at southwest and northeast corners and all along the east and southeast edge.

At 12:15 p. m. there came a whistling noise in a short blast seemingly from the west pocket followed by a light sliding of rock from the walls north and south-southwest. At 12:18 the noise was heard again in the same place and followed by a light northern slide. It came again at 12:21 with a still lighter slide at the north. At 12:29 came another puff, if such it was; at 12:33 another prolonged puff followed by a similar sound a minute later.

At 6 p. m. a second visit was made to the pit on account of this supposed puffing. Heavy rains in the afternoon had made water puddles all over the gravel flats where the fine ash of 1924 made an impervious bottom to the old impact pits of 1790.

Halemaumau was found just as in the morning, the air was very still and no puffing sounds were heard. There was very little movement of rock slides. The jets of vapor in the bottom rose silently and for the greater part of fifteen minutes the pit was completely quiet. Owing to still air a vapor column condensed and rose rapidly to a great height above the pit. The steam cracks at the northeast edge made a cascade of vapor over the rim and downward to replace the upward convection in the center. At dark no glow could be seen.

January 13. At noon and thereafter the mouth of the pit was mostly clear but a very high vapor cloud condensed in the air above. Shreds of vapor rose inside the pit which diffused and left blue fume. The wind was southwesterly and hydrogen sulphide odor reached the observatory.

At 2 p. m. the steam jets of the bottom were all drawn southward by the eddy. No blowing noise was heard. Blue fume mixed with steam was conspicuous along the east side of the bottom where much of the talus was stained salmon pink.

The whitening of the north and northeast walls with kieserite or gypsum above the upper contact of the big sill was conspicuous in large patches especially over the east end of the sill. The salts effloresce mostly in ragged horizontal streaks. Some of this whitening could be seen near the west boss and above the northwest intrusives but not much elsewhere. It appeared as though the hot intrusives were still centers of gas emanation.

Falls of rock were noted at the north at 2:10 and 2:30 p. m., and at the southwest at 2:20, all small.

With the southerly wind an interesting phenomenon at the road terminus was observed when the engine of the motor car was started. A few feet to leeward lay the steaming cracks of 1924 with a temperature of about 86 degrees C. For a distance of 100 feet from the car all the cracks, which had shown little vapor, instantly steamed up densely as the exhaust products from the muffler blew across them. As the car started and the exhaust fume was blown across other cracks, these in turn exhibited their vapor where before they had shown hardly any. This was a clear case of nucleation by carbon particles, just as when the Italian guides at Solfatara produce visible vapor

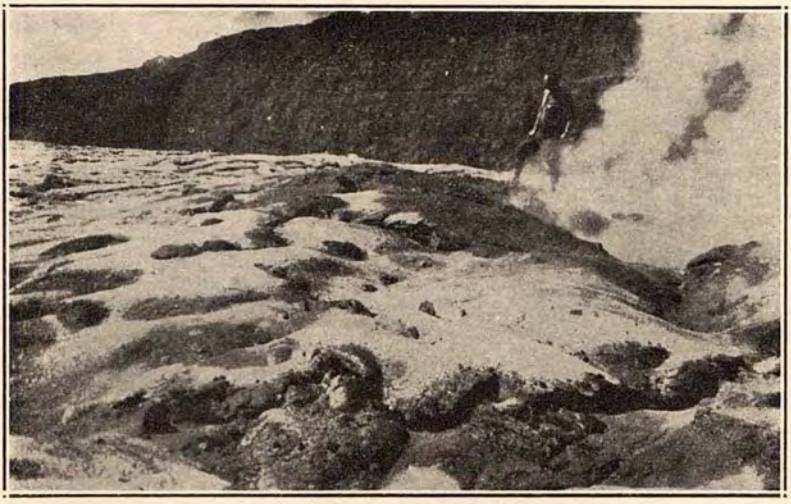

Figure 46. Ash and sand from the May eruption of 1924 on the pahoehoe lava of the Kilauea floor, west of the Volcano House trail and about 3000 feet from the edge of Halemaumau. Photo Boles.

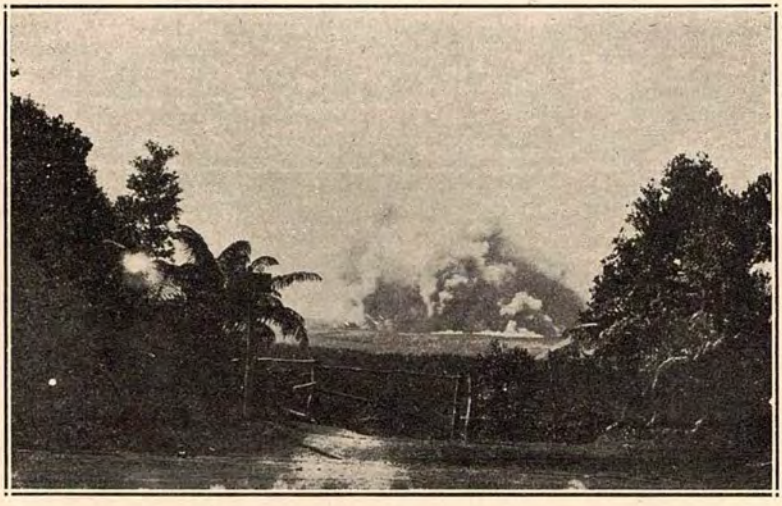

Figure 47. Dust clouds from the great avalanche in Halemaumau at 12:50 p.m., November 28, 1924, as seen from the road look-out on the northeast side of Kilauea Iki. This avalanche started the inner landslip that destroyed the July lava conelet. Photo Boles.

with torches. The particles of a fume become centers of condensation for water which otherwise does not condense, but is taken up by the atmosphere.

January 14. At 9:30 a. m. a small slide of rocks was heard at the north and the yellow salts at the foot of the southeast wall were again seen to be developing bright colors. On the 13th the tilt had changed from northeast to south-southwest.

January 15. There were thunder storms in the afternoon and at 5:40 p.m. the walls of the pit were wet and the air was very calm. Slight dust from avalanches had been seen at the pit in the morning. The volume of steam in the west pocket appeared less than before and in general the bottom vapor appeared more idle than usual. In 15 minutes two avalanches were seen at the north wall. In the calm weather echoes from the crash of a falling bowlder were heard about the pit more noisily than the direct sound, suggesting that part at least of the recently noted puffing or grating noise might have been due to echo.

The pit was very quiet. No blowing noise was detected. The only condensation above Halemaumau was high up at the cloud level.

January 16. At 5:15 p.m. general conditions appeared the same and the arrangement of steam jets on the bottom of the pit suggested a Z in shape, the west arm being the less sulphurous line of jets trending northeast-southwest, the diagonal, more sulphurous, crossing the pit from north to south, and the east arm being the most sulphurous, trending southwest to northeast along the east margin of the lava floor.

The sliding noise with its echoes was pronounced this evening, occurring every five or ten minutes. The wind was northeast and the sound was like a deep sliding of ribbons of talus. There were some definite avalanche crashes that were different, identified with falling debris at the north or at the southwest tunnel. The sliding noise on the other hand would prolong itself until the clatter of broken rocks was easily distinguished, though at first the noise sounded like blowing. It seemed to come from a line of dense steam jets up the west side of the north talus, and at the bottom of the northwest talus, where it reached the heavy steam of the west pocket. The phenomenon was noisy but the moving rock could not be seen.

There were gravel scarps facing northeast and west in the avalanche debris covering the west side of the bottom of the pit which suggested engulfment of the broken material in chasms below. These were like low dirt cliffs, but there was nothing very remarkable about them. A big noisy avalanche occurred about 7 p.m.

January 17. At 10 to 11 a.m. there were small avalanches from the north and southwest walls, and although humidity was low the steam at the west pocket was voluminous and rising rapidly.

January 18. At 7 p.m. in the course of a half hour there were many small slides and one large slide from the north wall. What at first sounded like a hiss with an echo was believed due to puffs of wind.

January 19. At 5 p.m. steam was rising briskly in three lines, trending north and south across the bottom and along a line lengthwise of the southwest talus. Much white stain was noticed on the walls above the east end of the north intrusive and west of the west end.

January 20. At 10:30 a.m. a fresh notch in the wall was observed at the top of the northwest talus. There was flocculent dense steam at the west pocket without the blue edges characteristic of sulphurous gases, but the central steam was bluish. Slight slides occurred mostly at the southwest rift.

The notch of that rift in the wall of the pit was increasing above the tunnel. Sulphur stain patches were observed at the base of the southwest talus.

The southwest rift out into the Kau Desert was followed from the rim of the pit across the Kilauea floor to the steaming vertical crack in the border cliff and beyond the top of the cliff toward Cone Peak. No motion was detected in this 1920 rift, for there was no cracking of the new ash. A gulch was climbed in the southwest wall of Kilauea and thick deposits of the upper basaltic pumice on top of the 1790 ash and gravel were found. This pumice, in beds two to three feet thick in some places, has been somewhat of a puzzle as to its age. It differs from the "thread-lace scoria" underlying the whole ash section on the Kilauea Iki side, in being more membranous and in lying at the top of the pre-1924 ash section. It occurs altogether on the leeward or southwest side, and in sporadic patches.

It has been thought that the southwest pumice at Kilauea might be of 1823 or 1868 age, representing the froth from lava fountains blown over from Halemaumau. On this day bowlders and their impact pits of unquestionable 1790 age, which could not possibly be 1823, 1868 or 1924, were found on top of the pumice. Other coarse gravel and bowlders of 1790 lay under the pumice. This discovery is of importance, for it means that the 1790 eruption threw out several feet of gravel and ash first, then lava fountains occurred on a big scale, of the Mauna Loa type, throwing up lava froth that was deposited a mile to leeward, and finally some broken bowlders of great size were ejected a similar distance in the closing stages of the eruption.

This checks with the notion that the 1790 eruption was of mixed ash and lava, otherwise proved by the bombs coated with contemporaneous lava and the descriptions of red fire and lava which have come down from the natives of the time.

January 21. At 2:15 p.m. a notable discovery was that the east side of the pit had been avalanching, an unusual place for such caving in. The east station flag, which had been on an unstable block of the cracked rim but nevertheless immobile, had fallen in.

Fresh cracks in the surface ash parallel to the rim and newly opened chasms back of the east rim were found beginning a short distance north of the southeast rail terminus.

There was fresh northeast wind and the vapor on the bottom was less abundant, but the steam was notably flocculent amid fresh talus bowlders from the new eastern rock falls, which overlapped the east edge of the lava floor. Slight falls of stones were seen, mostly at the north. The increased whitening of the wall over the north sill was conspicuous, an efflorescence of salts. Still higher the walls above the east and west horns of this sill were decomposed and stained yellow and green.

January 22. At 2:15 p.m. of a dry sunny afternoon the visible vapor was much thinner, though the jets in the shadow at the south talus were more flocculent and dense than those in the sunshine in the center and at the west. The bottom of the west pocket was seen to be a flat muddy saucer. A yellow sulphurous patch had developed in the steam at the foot of the new eastern talus, showing how quickly the sulphur deposited. Small avalanche slides occurred northeast and west, and trickling slips from several places. The air above the pit was quite clear.

Very white chalky salts stained the gulch ledges at the bottom of the south wall and at one spot higher up, probably mostly magnesium sulphate, like that over the north sill. The sill itself was stained in places, and nowadays in wet weather showed more wetness than six months ago, as though it were less hot. When first seen it was red hot. The south talus was now dark with wetness from condensation at the sides, and dry up the middle where dry steam jets were coming forth.

January 24. At 9:15 a.m. a few rocks were heard sliding in different places and at 11:13 a.m. there was a dusty avalanche at the north corner of the pit. Sulphur yellow stain was noticed on the gravel at the northern front of the landslide lobe of November 28. This yellow stain was where steam emerged near the foot of the north talus. White salts had deposited at the bottom of the steaming west pocket. Some slides occurred at the northeast and southwest. Those at the north were from the west horn of the big sill itself. Steam appeared hottest and most flocculent at the south, northeast and west vents.

January 25. At 9:30 a.m. and thereafter a few small slides were observed at the middle of the north sill and over the southwest talus. The west horn of the sill had been caving away, and these slides made small cauliflower clouds when they struck the talus.

The morning light on the bottom of the pit as seen from the southwest, showed at the west pocket a north-south depression baout 20 feet wide like a sunken block. The mud of the landslide terrace east of it had drained toward it. East of this the line of bowlders on the terrace appeared to form a ridge rather than a flat, as though its west side had slumped. This may have been the place where the recent sliding occurred.

January 26. At 9:30 a.m., with southwesterly drizzle, much more vapor condensed in the bottom of the pit and in lines of jets up the talus slopes, the most flocculent steam being at the west pocket. There was no noise of blowing.

Rocks were sliding from the walls a little at the north sill and above the southwest talus. The gravel of the bottom was dark and wet with rain, but the steam vents across the middle from south to north were lighter colored, owing to the dry heat.

January 27. At 9:30 a.m. the weather had cleared after rain, the wind was northeast and the walls of the pit were wet. The large areas of wall surface that had been covered with white salts now showed almost none of the whitening, indicating that the efflorescence had been a product of the preceding dry spell. The taluses were wet and the steaming zone dry. The walls north and northwest were making small slides and a loose block in the north wall 20 feet above the middle of the big sill had created a black gaping crack about one foot wide. A crack lined with yellow sulphur was visible at the southeast edge of the floor, the deposit being different from the pale sulphates on the bank above.

There were greenish-brown decomposed areas in the north and northeast walls over the two horns of the north sill. The northern one lay under the region of the postal-crack solfatara that was a landmark on the surface outside of Halemaumau for many years and the northeastern one under a similar solfatara which was conspicuous near the Volcano House trail until the winter of 1924.

January 28. At 9:30 a.m. there were trickling slides at the northeast wall of the pit, vapor was abundant owing to drizzling rain and white salts had begun to reappear on the walls.

There were now three bottom solfataras showing sulphur or yellow sulphates at the foot of the south and southeast walls; eight similar places in the bottom of talus slopes west, southwest, south, southeast and east; and two places in the floor area at the north and in the center of the pit.

January 29. At 5 p. m. it was evident that the whole east side of the pit wall rock had been working a little, for cracks one-half inch wide had opened in the ash over the steam fissures 100 feet back of the rim southeast. They appeared to represent an extension southward of the cracks previously noticed back of the east station. They could be traced southward almost to the south station. The pit showed nothing remarkable, the walls were wet and the

vapor dense after rain. Most of the time the walls were quiet with very little motion of sliding stones.

January 30. At 5 p. m. there were slides northeast and elsewhere. The vapor jets were very voluminous. The cracks back of southeast rim had not changed. About 7 p. m. a roar was heard and an avalanche tremor was recorded by the seismograph.

January 31. At 2:30 p. m. with light southeast wind the pit was much drier and the jets thinner. There were small slides at the middle of the north sill and on the east side of the rift tunnels southwest as though the 1920 rift was working. The denser vapor was at the south talus and the east edge of the floor. At this last place athwart the base of the east talus lay steaming vents that deposited fresh sulphur of bright yellowish green color. One slide fell at the northwest talus. Blue fume filtered out of the vapor rising above the south talus as the moisture dissipated upward. White salts were reappearing on the walls. Some fresh cracks in the dirt were observed close to the rim southeast.

SEISMOMETRIC RECORD

During the month ended midnight January 31, 1925, 94 local earthquakes and two teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 m. slower than Greenwich.

Abbreviations have meanings as follows: Vf=very feeble; f=feeble; s=slight; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

January		January		January	
1—	7:33 a. m. vf.	10—	6:29 a.m. vf.	17—a	4:48 a.m. vf.
	3:28 p. m. vf.		6:33 a. m. vf.	a	5:20 a. m. vf.
	4:15 p. m. vf.		11:19 p. m. vf.	a	5:38 a. m. vf.
	7:45 p. m. vf.	11—a	2:07 p. m. vf.	a	5:47 a. m. s.
	7:47 p. m. vf.	a	3:34 p. m. vf.	a	9:45 a. m. f.
2—	9:22 a. m. vf.	12—a	6:15 p.m. vf.	a	1:53 p. m. vf.
3—a	1:56 a. m. vf.	lasts for two minutes		18—	7:50 a. m. vf.
a	12:06 p. m. vf.	a	6:42 p. m. vf.	19—	2:19 a. m. f.
a	2:31 p. m. vf.	a	9:18 p. m. vf.		8:29 p. m. vf.
a	11:09 p. m. vf.	14—a	2:09 a. m. vf.		8:30 p. m. s fl△3
a	11:17 p. m. vf.	a	8:29 p. m. vf.	20—a	5:14 p. m. vf.
4—	7:02 p. m. vf.	a	8:48 p. m. vf.	21—	2:41 a. m. vf.
	10:25 p. m. vf.	a	9:05 p. m. vf.	23—a	7:12 a. m. vf.
5—	7:37 a. m. f.	15—	7:41 a. m. vf.	24—	3:27 a. m. vf.
	7:38 a. m. vf.	16—a	6:56 p. m. vf.	a	8:06 p. m. vf.
6—	2:51 a. m. vf.		8:26 p. m. f., fl	a	9:31 p.m. vf.
a	7:39 a. m. vf.		10:01 p. m. vf.		11:27 p. m. vf.
a	7:43 a. m. vf.	17—a	1:20 a. m. vf.	25—	3:52 a. m. vf.
a	8:33 a. m. vf.	a	2:11 a. m. vf.		3:55 a. m. vf.
a	8:50 a. m. vf.	a	2:20 a. m. vf.	26—	6:42 p. m. f△11
7—	9:46 a. m. vf.	a	4:19 a. m. f.	a	6:51 p. m. vf.
	10:16 a. m. vf.	a	4:25 a. m. vf.	a	6:53 p. m. vf.
8—a	10:32 a. m. vf.	a	4:28 a. m. f.	27—a	6:25 a. m. vf.
9—	1:16 a. m. f.	a	4:40 a. m. vf.		
10—	4:51 a. m. vf.	a	4:42 a. m. vf.		

January		January		January	
29—	12:29 a. m. vf.	29—a	2:45 p. m. vf.	31—	12:09 a. m. vf.
	5:33 a. m. vf.		3:22 p. m. vf.		4:25 a. m. vf.
	5:46 a. m. vf.	30—a	6:08 a. m. vf.		3:15 p. m. vf.
a	8:23 a. m. vf.		10:34 a. m. vf.		5:58 p. m. vf.
a	9:01 a. m. vf.	a	12:57 p. m. vf.	a	10:27 p. m. vf.
a	9:04 a. m. vf.	a	4:16 p. m. vf.	a	10:28 p. m. f.
a	10:33 a. m. vf.	a	7:11 p. m. f.	a	10:29 p. m. vf.
a	10:45 a. m. vf.				

Teleseisms

Jan. 18.....2:45 a. m. slight, △3600
30.....7:19 a. m. slight.

Harmonic Tremor

This type of tremor was absent throughout the month.

Microseismic Motion

The amplitude of microseisms was slight in January.

Tilting of the Ground

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

Jan. 4-10..... 2.2 seconds NNE.
11-17..... 1.5 seconds SW.
18-24..... 1.0 seconds NW.
25-31..... 3.0 seconds S.

T. A. JAGGAR,
Volcanologist.

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CONTENTS

VOLCANIC CONDITIONS IN FEBRUARY

Activity of Halemaumau

There were dusty avalanches February 1 and three pronounced local earthquakes registered the following night were coincident with strong avalanche signs discovered at the southwest wall. Adjacent to the tunnel of the Kau Desert rift, in the wall of the pit, the whole upper part of the precipice was freshly broken away, and one of the signal flags was gone. On the bottom were fresh fragments, and clouds of dust had powdered all the solfataric deposits, obscuring them. The ash soil was newly cracked for 100 feet back of the rim all along the southwest side of the pit. The rock there is heavily crevassed. Thereafter the slides decreased and the pit became quiet.

At the beginning of the month tilting of the ground was away from the pit toward the east and north. There were thirty-four local seismic movements for the week ending February 4, of which only eight had conspicuous amplitude on the seismogram and only a few had the sudden beginning of local earthquakes. Their correlation with avalanching was striking. It will be made a subject of investigation whether the avalanches directly cause the tremors, or whether both are due to a common cause.

The following week 26 local movements were registered, tilting was to the west and an earthquake was felt at 1:34 p.m. on the 8th. There were ten movements on the 9th, but all that was noticeable at the pit was the disturbance of the sand and dust by a brisk northeast wind, the smell of spicy sulphur from a bright yellow patch at the foot of the east talus and the seeming growth of this gas at the expense of hydrogen sulphide. On February 6 and 7 the wall north-northeast had scaled off, on the 9th there was continuous rattle of falling stones at the southwest and the wall there showed sign of increased stripping. Fresh movement of cracks back of the southeast rim was observed. At about this time some vertical cracks gaping open were observed in the north-northeast wall about the middle of the big sill which seemed also to fracture the cake of talus at the bottom.

Thirty seismic movements were recorded the third week, two were felt and tilt was to the south-southwest. There was continued peeling of the pit walls and a loose inner ledge below the tourist station southeast fell in. Between the 15th and the 17th a promontory of the lower northwestern wall became cracked, developed avalanches and fell away until it was stripped bare. An extension of the sulphur in the east talus was observed.

Toward the end of February the avalanching decreased and much of the time during visits to the pit the big cauldron was quiet without any noise of sliding rocks. On dry days the eastern sulphur holes amid fallen bowlders of December avalanches were conspicuous because not obscured by condensation of the steam that rose through them. Even at the top of the talus there was some sulphur stain. These places were quite different in appearance from the deposits of waxy white sulphates in the center of the pit and the streaked yellow ones on a bank at the southeast.

Different from all these places of solfataric deposit were the densely steaming slopes and mud flats of the south and west, where the vapor rises through dry patches in moist ground and deposits almost nothing. This vapor curdles flocculently and rises rapidly, appearing very hot. It seemed to be extending itself to the upper parts of the talus slopes and even to the walls.

Seventeen seismic movements were registered during the week ending February 25, of which one was felt and partially dismantled the seismograph at 10:20 a.m., February 23, with apparent origin 13 miles from the observatory. Another at 10:18 a.m., February 18, was felt in Kohala. A distant strong earthquake at 1:31 p.m., February 23, showed origin 4250 miles from the station, but was not accordant in either time nor distance with the destructive shock reported from Seward, Alaska. Tilting was moderate to the north-northwest.

DISCUSSION OF SPECIAL FEATURES

Spasmodic Tremors Related to Avalanches

In the December Bulletin the list of local earthquakes had a new symbol **a** against many of them, meaning "avalanche seism". Every tremor that the seismogram shows is entered on the list, and some of those of small amplitude are identical with what in the older Bulletins of the station were mentioned as spasmodic tremors. With the many avalanches of the big pit of 1924-5 we have come to associate these tremors with avalanches. This does not imply that spasmodic microtremor of past years was always due to avalanches. Nor is it proved that the present ones are always so related.

In December there were some of the long drawn out seismic movements that may not have been accompanied by avalanches. And there were several avalanches that were not preceded or accompanied by seisms. Many of the larger observed avalanches, however, were correlated to measured seisms in time of occurrence. The new notation is equally applicable to all the months since the May explosive eruption.

It should be remarked that a 25% correlation between avalanches from an unstable wall and occurrence of seisms would be high when one considers both large and small avalanches, and only the large ones capable of seismic effects. Observations at the pit are infrequent in proportion to the frequency of slides. Therefore, apparent correlation between avalanches and seismograms is naturally poor.

The new feature of 1924 has been the large number of these peculiar seisms registered as prolonged tremulous ground movement of much greater amplitude than was formerly classified under microtremor. During the explosion period these movements became very large indeed, characterized by gradual increase of amplitude from small beginnings. In the true local earthquake there is a suddenly begun preliminary tremor, followed by a still more sudden set of long waves, which then exhibit a decay curve rapidly declining. The avalanche seism has no definite boundary between preliminary and long waves, and has more gradual decay, sometimes swelling out several times in the course of several minutes before dying away. The amplitude is that of a feeble or slight earthquake. There is no question but that all the very big avalanches of 1924 have been accompanied by these peculiar seisms.

It is this fact that makes it nearly certain that the a seism when coincident with avalanche is its product and not its cause. If it caused the avalanche there is no reason why it should not have the characteristic phases of any earthquake. And a second fact confirmatory of this is that there has been during these months no apparent reason for unusual seismicity and only a usual number of common earthquakes. On the other hand, there have been large numbers of avalanches and of a seisms.

JOURNAL, FEBRUARY, 1925

February 1. The day was sunny and Halemaumau pit was clear. From time to time dust rose in thin veils above the level of the pit rim, showing that avalanching occurred.

February 2. The seismogram showed three local earthquakes, two of them of the avalanche type. At 9:45 a.m. Halemaumau showed plainly where the avalanches were occurring. A large notch had been made in the southwest wall of the pit, next east of the 1920 tunnel, and the talus below was covered with freshly broken fragments. There had been two flags above this place, one the Observatory flag and the other about 300 feet farther west. This second stake had fallen into the pit with that portion of the rim that held it.

All the southwest rim region showed frsh cracks in the ash parallel to rim of pit; 100 feet back from the rim they measured ⅛ inch across, and close to the rim 1 inch or more. On a person sitting on the southwest rim there was a perpetual shower falling of coarse sand blown by the northeast wind up the newly broken face of the cliff below.

The ground for 50 feet back of this southwest rim was heavily crevassed between the southwest station and the western corner of the pit, all of these chasms showing new motion. The southwestern slides in the pit had been big enough to cover the bottom with brown dust so as to partially obscure the sulphurous patches. The north talus showed some fresh-fallen debris, and at the time of visit rocks were sliding a little southwest, west and north. About 1 p.m. occurred a slide big enough to send up a dust cloud at the southwest wall.

During the previous eight months there had now been movement on cracks back of the rim of the pit all the way around, accompanied by avalanching. The maximum motion had been above the two intrusive bodies north and west which were glowing after the explosive eruption. The minimum was on the opposite side of the pit near the tourist station southeast.

February 3. The day was sunny and it was noticeable on such days that the gravel and sand fields northeast and southwest of Halemaumau, as seen

from a distance to the east were notably more white with salts than the trail region immediately southeast of the pit.

At 11 a.m. the pit was dusty, more rock had fallen from the region of the southwest rift and the vapor jets were thin except at the south and west. The pit exhibited hardly any sliding of rocks in progress, and less dust was being blown up the southwestern wall, although the day was windy.

February 4. At 9 a.m. fresh debris was seen on the talus under the west horn of the north sill. Sulphates were beginning to reappear through the dust at the bank on the foot of the southeast wall of the pit, and white stain was reappearing on the walls at the northeast, north and south. A few rocks were sliding at the north and northwest. A line of vapor jets extended up the middle of the south talus through hot fry ground for a width of about 10 feet, and the slope on both sides was wet. Here and at the mud-covered west pocket of the bottom of the pit the greatest volumes of flocculent steam vapor were rising.

February 6. At 3 p.m. in dry weather a yellow sulphur patch was conspicuous at the steam vents of the lower part of the east talus. The north-northeast wall showed fresh notching back on the west side of the rift dyke. One avalanche and several small slips were seen at that place.

February 7. At 1:15 p.m. a noisy avalanche fell from the north wall of the pit and dust rose at the southwestern corner; there were others about 1:17 and about 1:26.

At 2:30 p.m. two places at the base of the east talus were observed to be coated with bright yellow sulphur crystals. There was fresh debris on the northeast talus. The walls showed whitening at the north, northeast and south. A pinnacle rock stood out at the southwest rim west of the rift line. Slides were seen at the lower eastern wall and also at the north and southwest walls.

February 8. An earthquake was felt at 1:35 p.m. At 2:45 p.m. the odor of spicy sulphur was perceptible at the east rim of the pit, probably from the yellow patches of the east talus, which were becoming bright colored. Slight slides occurred at the lower southeast cliff and there was new evidence of a breaking away of the western horn of the north sill. Fresh cracks were seen in the ash back of the rim southeast.

February 9. At 3:45 p.m. the odor of spicy sulphur was pronounced and no odor of hydrogen sulphide was perceptible. There were strong northeast winds and clouds of ash dust were blowing in the desert and on the Kilauea floor. There was a continuous rattle of falling stones at the southwest and west. There had been more stripping of the southwest wall, this time on the west side of the rift tunnel, where also fresh talus debris appeared below. There was other fresh debris on the north talus under the west horn of the sill.

February 11. At 9:30 a.m. again was seen fresh avalanche material on the southwest and north taluses, and fresh dust on the bottom of the pit. Next to the tunnel rift there was more notching of the wall. Vapor was hot and dense at the usual places. Some rocks were heard moving, mostly towards the northwest.

A number of features were observed in the north wall about the middle of the big sill, and in the talus below, that suggest an upright crack. In fact two vertical cracks were observed extending up and down from 50 to 100 feet, about 75 feet apart, and the first of them 125 feet east of the big rift dyke. These are thus in the same region relative to the rift as the fresh avalanche stripping of the southwest wall. The western of the two appeared to be a reddish dyke in its upper part, but to stand open as a chasm about a foot wide below, and to extend as a line of breaking and staining all the way down to

the talus level. Below this in the talus itself there were marks like a zigzag trail up the slope, suggesting incipient landslip, and there was some faint sign of a crack athwart the lava floor in the same northeast-southwest line. These breaks are possibly traces of slight movement along the desert fractures, and the fresh breakage of the southwestern wall near the tunnels may be occasioned thereby. There are other small vertical cracks in the north wall close to the dyke and east of it.

The dyke itself had recently been cleaned off by avalanching at both the northeast and southwest walls. In the northeast wall it appeared to be a composite dyke, thinning above, with light rock at the sides and dark down the middle. Between the two tunnels at the southwest wall it appeared as a massive gray fine-grained rock, split up with several parallel small dykes beside it. Where it peters out in the southwest wall upward, above the big tunnel, it becomes two dykes with a horst of country rock between them, showing rather confused fissuring.

There was odor of hydrogen sulphide at the south station. At 10:10 and 10:24 a.m. there were small avalanches above the northwest talus, making red cauliflower clouds. Several small slides occurred on the northeast, south and southwest sides of the pit. At 11:30 a.m. the northwest talus region was sliding almost continuously, a noisy slide occurring at 11:34. A protuberance of the cliff on the south side of the top of this talus appeared to be unstable and ready to fall.

February 12. At 2 p.m. in the light of a cloudy day the lower part of the southwest wall under the rift tunnel showed striking red color due to iron oxide. Some small slides occurred. Fresh talus lay under the southwest rift.

February 14. At 9:30 a.m. the inner ledge at the tourist station was found to have fallen in. Here there had been loose blocks a few feet below the southeast rim hanging out into the pit as a slab half detached and backed by a vertical crack that continued northeastward as one of the tangential cracks of the pit rim. It was this slab and its attendant bowlders which had fallen. No fresh cracking was observed back of the rim at that place. No slides were heard during the visit.

February 15. At 4 p.m. there was light southerly wind and fog and the pit was full of vapor. A clatter of rocks was heard toward the north and a little sliding at the southwest. The promontory south of the northwest talus showed a new vertical crack about 150 feet long and the scar above indicated that wall was avalanching.

February 17. At 9:30 a.m. the northwest wall was working steadily and at 9:41 an avalanche occurred there. The wall above the talus appeared to be peeling and extending its notch southward. At 9:50 rock falls were heard along with a general purring noise, and at 9:53 and at 9:54 there were northwestern avalanches. Some slides occurred at the north wall and the talus cone was piled higher against the middle of the big sill. The southwest wall east of the tunnel showed deeper notching. At the base of the east talus a third sulphur patch was observed in a new place, a few feet north of the southeast sulphate bank.

With reference to these sulphur deposits about where the east talus overlaps the lava floor, it is remarkable how contrasted with them are the densely steaming hot solfataras at the south talus and the west pocket, in that these two places deposit nothing at all.

February 18. At 9:25 a.m. the steam jets were very abundant and voluminous, although there was no record of recent rain. The vapor came out of the rock wall itself at the south and was conspicuous up and down the southwest talus. A new pile of small fragments had fallen from the sill northeast.

The southerly wind brought the odor of hydrogen to the Observatory. No rocks were observed in motion, but the place where the long crack had been on the northwest side of the pit was now stripped bare. There was possibly a slight noise of steady blowing.

February 19. At 2:45 p.m. with northeast wind and very dry weather, there was no trace of cloud over the pit and the steam jets were thin. The northwest talus notch now showed jagged abutments on the south side of the slide. There were fresh scars on the upper wall over the west boss, where rock had fallen away. There was very little motion.

Whitish sulphates formed a conspicuous patch at this time in the center of the floor, five sulphurous vents half encircled the floor at the east and north, and the sulphate bank southeast was streaked vertically with white, yellow and brown.

February 20. At 8 a.m. small avalanches were frequent at the north wall, faint hissing came from the bottom of the pit, and the odor of hydrogen sulphide was perceived at the southwest rim.

At 3:20 p.m. from Uwekahuna a small fall of rocks was heard at the pit and from this viewpoint the recent stripping of the northeast wall was conspicuous. At 8:45 p.m. at the Observatory three deep detonations were heard.

February 21. At 3 p.m. vapor jets on the Halemaumau floor were thin, the sulphur patches at the east talus plainly outlined the edge of the lava floor buried beneath the talus, and the chalky white stains on the wall of the pit were conspicuous. There was very little sliding and no blowing noise was detected.

February 22. At 5:30 p.m. there was steam at the top of all the taluses and most of the time the pit was very quiet. There were small slides northeast and northwest. In addition to the sulphates already enumerated there were white deposits near the base of the southwest talus, and chalky salts on the west wall.

February 23. At 5:30 p.m. the southeasterly wind made an eddy which drew the vapor in the pit toward the south and west so as to reveal at the foot of the north talus a mud flat stained yellow white with salts. Across the center of the pit the bottom vapor was less dense than at the south and west vents. The deposits at the northern front of the landslip debris on the lava floor and at the foot of the south talus were greenish with sulphur, and not bright yellow like the patches at the base of the east talus.

There were now three mud flats on the bottom, the northern one just mentioned and the west pocket, both of these steaming and stained with salts, and one at the base of the southwest talus of reddish aspect and without salts. Only one small slide was seen from the northwest wall.

A steaming crack in the talus at the bottom of the north-northeast slope was seen, trending northeast and almost under the rift dyke. There were three other such upright cracks in the top of the north talus, the debris breaking like a cake and the crack standing at right angles to the wall behind the talus.

February 24. At 11:30 a.m. there were trivial slides occasionally toward the southeast, north and west, but most of the time the pit was remarkably still. The air was dry, the vapor jets thin and the eastern sulphur spots conspicuous.

February 25. At 9 a.m. after a cool morning there was steam on the taluses and abundant flocculent vapor rising at the four main bottom localities, south, east, center and west. A little sliding occurred at the north.

Figure 48. Bottom of Halemaumau from south rim showing July conelet and lava flow, photographed November 18; northwest talus in the background. Note the large bowlders of southwest talus overriding the cone on left. The slide of November 28 there buried the cone and covered west half of floor. Photo Jaggar, 1924.

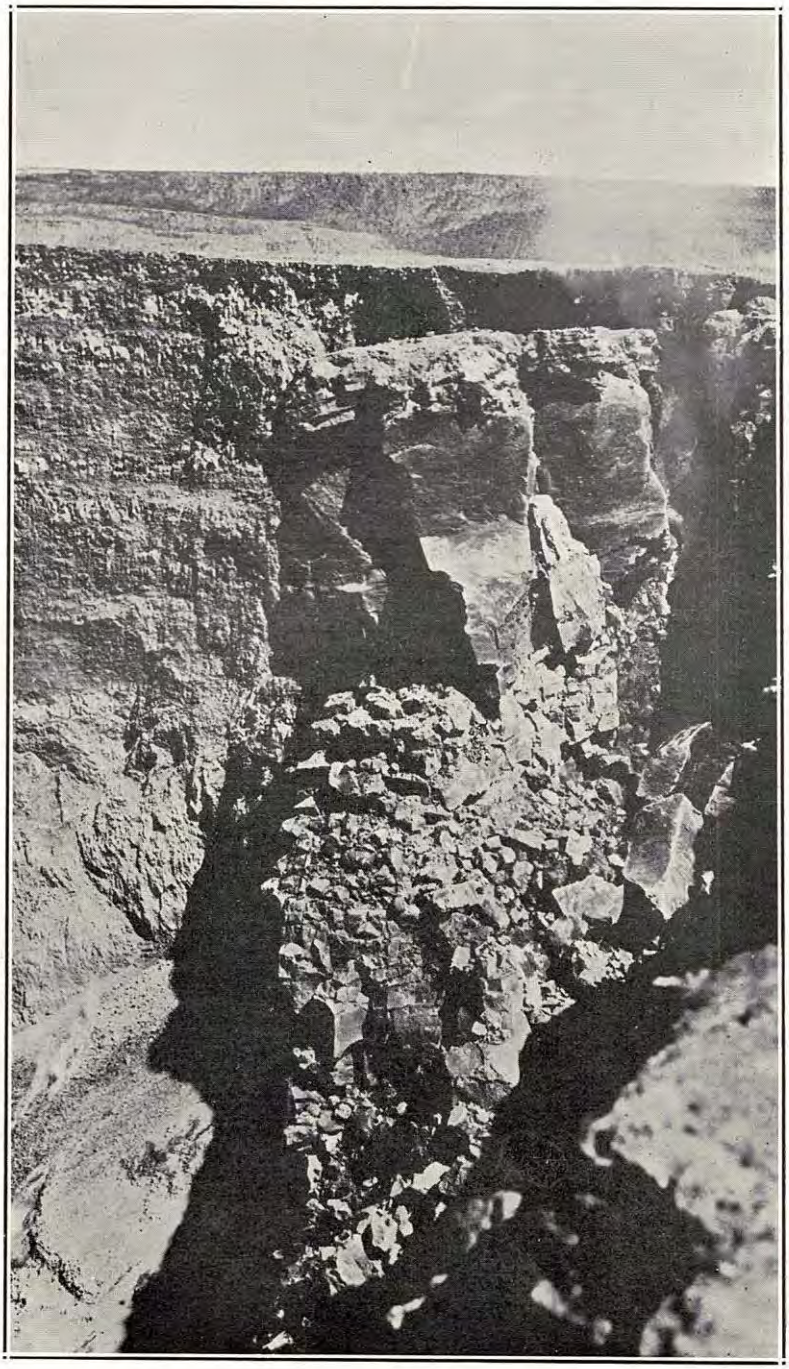


Figure 49. Pinnacle hanging out from south rim of Halemaumau, looking northeast. Volcano House in distance left. This pinnacle fell December 31, 1924. Photo Jaggar, November 18, 1924.

February 26. At 3:15 p.m. there were a few little slips of debris from the walls at the north and northwest, and at noon avalanche dust had been seen rising from the pit.

The details of the three sulphurous areas at the base of the east talus were plainly seen to consist of six principal sulphur spots. Each of these was a hole between bowlders where vapor emerged and stained the adjacent rock surfaces with the development of sulphur crystals. It was noticeable that a little sulphur stain existed at steam vents at the very top of the east talus, and this place was far outside of the limits of the buried lava floor. No such sulphur at the top of the talus was seen anywhere else.

The appearance of caverns or lava tubes emerging at the precipitous wall of the pit had increased during the caving away of the rim in the last few months. There were now ten caverns around the pit, all in the upper 50 feet of the bounding walls, and most of them big enough to permit a man to stand erect inside. In two or three cases there were caverns one above the other. All of the tunnels here mentioned are distinct from the southwest rift tunnels, which are over 300 feet below the rim, on the line of the big dyke, and the upper one an immense arcade 70 or 80 feet high. These are distinctly rift conduits of the lava which flowed from Halemaumau to the Kau Desert in 1920, whereas the others were left by overflow streams, each tube capped by the stream crust and representative of the flow channel. The absence of this type below the immediate vicinity of the upper rim means that all such tunnels that existed when the lower lava flows were formed have since been filled up, owing to the repeated risings of liquid lava at the volcanic center. In the same manner any new rising of liquid lava in the present pit, when the lava lakes get to within 50 feet of the top will flood the existing tunnels and fill them with intrusive basalt. Most of these tunnels must represent the flows of the last decade.

February 28. At 10 a.m. there was hardly any sliding of rocks and the pit appeared to be as nearly stationary as it has been at any time since the great eruption.

SEISMOMETRIC RECORD

During the month ended midnight, February 28, 1925, 94 local earthquakes and two teleseismas were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 m. slower than Greenwich.

Abbreviations have meanings as follows: Vf=very feeble; f=feeble; s=slight; m=moderate; d=instrument dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes.

February			February			February		
1—	3:08 a. m.	vf.	2—a	6:20 p. m.	vf.	9—a	12:17 a. m.	vf.
a	9:55 a. m.	vf.	5—a	9:20 p. m.	vf.	a	12:18 a. m.	vf.
a	1:53 p. m.	vf.	6—a	5:13 p. m.	vf.	a	12:19 a. m.	f.
2—a	2:55 a. m.	vf.	7—	12:13 a. m.	vf.	a	12:22 a. m.	vf.
a	3:01 a. m.	vf.	a	1:36 a. m.	vf.		1:08 a. m.	vf.
a	3:02 a. m.	vf.		8:27 a. m.	vf.	a	1:23 a. m.	vf.
a	3:11 a. m.	vf.		1:18 p. m.	vf.	a	2:36 a. m.	vf.
a	3:16 a. m.	vf.		2:24 p. m.	vf.	a	8:07 p. m.	vf.
a	3:17 a. m.	vf.	8—	1:34 p. m.	s, fl, △1	a	9:26 p. m.	vf.
a	3:17 a. m.	vf.	a	9:23 p. m.	vf.	a	10:33 p. m.	vf.
a	8:28 a. m.	vf.	a	11:48 p. m.	vf.			

February
10— 12:26 a. m. vf.
1:12 p. m. vf.
10— 5:56 p. m. vf.
a 10:01 p. m. vf.
11:09 p. m. vf.
11—a 2:55 a. m. vf.
a 11:30 a. m. vf.
a 11:31 a. m. vf.
a 11:32 a. m. vf.
12:05 p. m. vf.
12— 6:43 a. m. f, fl, △2
a 8:38 a. m. vf.
a 11:29 p. m. vf.
13—a 3:07 a. m. vf.
a 6:12 a. m. vf.
a 11:10 a. m vf.
a 8:03 p. m. vf.
14—a 10:14 p. m. vf.
lasts over two min.
15—a 4:33 a. m. vf.
a 5:34 a. m. vf.
a 1:08 p. m. vf.

February
15—a 1:09 p. m. vf.
a 1:11 p. m. vf.
a 1:20 p. m. vf.
a 1:40 p. m. vf.
a 2:06 p. m. vf.
2:11 p. m vf.
a 3:06 p. m. vf.
a 3:22 p. m. vf.
16— 12:53 a. m. vf.
a 2:22 a. m. vf.
a 9:41 a. m. vf.
17—a 12:45 a. m. vf.
a 2:39 a. m. vf.
11:36 p. m. vf.
11:52 p. m. s, fl.
18—a 9:42 a. m. vf.
10:18 a. m. f. Probably in Kohala
1:46 p. m. vf.
20—a 10:42 a. m. vf.
21— 10:39 p. m. vf.

February
21— 10:52 p. m. vf.
11:13 p. m. vf.
11:30 p. m. vf.
23—a 6:33 a. m. vf.
10:20 a. m. d, △13
a 11:24 a. m. vf.
a 2:14 p. m vf.
3:17 p. m vf.
11:57 p. m. vf. △9
24— 1:22 a. m. vf. △2
a 11:32 a. m. vf.
25— 3:50 a. m. vf.
26—a 4:36 a. m. vf.
6:35 a. m. vf.
27—a 12:07 a. m. vf.
a 12:08 a. m. vf.
a 4:08 p. m. vf.
a 8:41 p. m vf.
28— 7:00 a. m. vf, fl
a 8:51 a. m. vf.
a 3:21 p. m. vf.

Teleseisms.

Feb. 1.....10:48 a. m. slight.
23..... 1:31 p. m. slight, △ 4250.

Harmonic Tremor.

This type of tremor was absent in February.

Microseismic Motion.

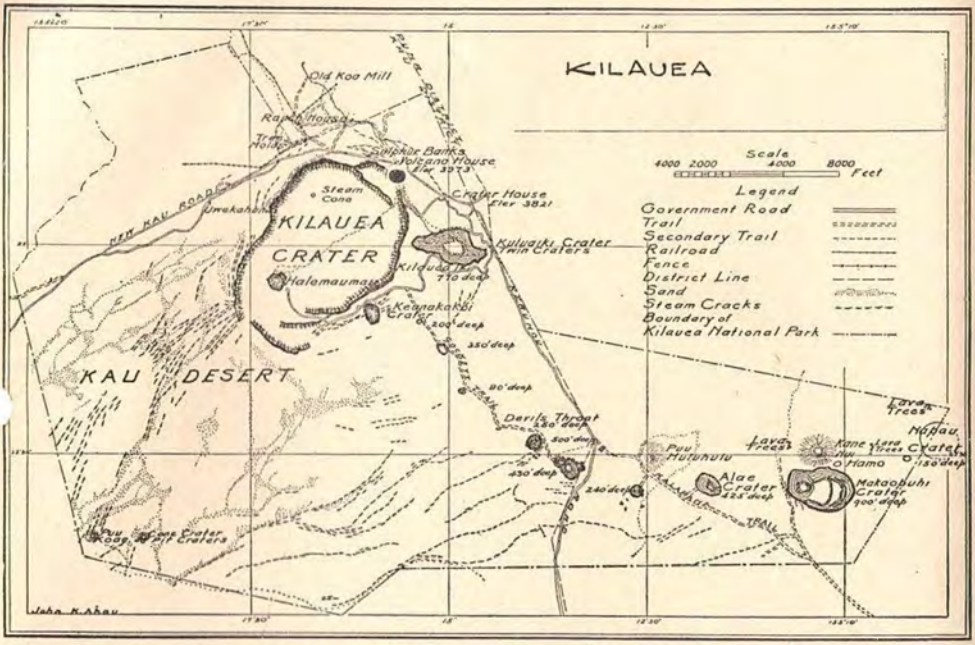
The amplitude of microseisms was moderate from Feb. 9 to 13 inclusive, and slight on other days.

Tilting of the Ground.

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

Feb. 1- 7.....3.0 seconds NNE
8-14.....3.9 seconds SSW
15-21.....1.2 seconds WNW
22-28.....1.1 seconds 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, Volcano House, 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, Hilo and Hilea.

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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo and Hilea stations operate normal pendulums and the Kona station a horizontal pendulum. 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

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CONTENTS

NATIONAL STANDARDS OF VOLCANO AND EARTHQUAKE RESEARCH

By T. A. Jaggar

Address March 12, Annual Meeting Hawaiian Volcano Research Association in Honolulu

The Hawaiian Volcano Research Association has now been at work fifteen years contributing its mite—spell the word as you will—to the world's learning about itself. And about the world much is unknown. San Francisco and Messina and Yokohama have been demolished and born again—so has all Europe by a different kind of volcanism—and our Pan-Pacific volcano studies have quietly ploughed on, adding a sprout here and a seed there, and uprooting all sorts of flowery weeds. Science is like that, and even weeds serve as food for whole generations.

I recently read an editorial on the conflict between science and philosophy, wherein was much talk about science being materialistic and philosophy meta-

physical. I doubt the antithesis. Men of science are essentially philosophical, but the distinction of their art nowadays from that of philosophers and humanists, is that they insist upon a background of measurement as necessary for giving truth to the splendid color and imagery that they paint.

Numbers, distances and time intervals are the stock-in-trade of science. Much of philosophy, economics and ethics would be improved if it were based on number. All business is based on number, and modern business is scientific.

In the study of the processes of the earth for human betterment, the standard of achievement is based on measurement. Keeping careful records of an active volcano or an earthquake disaster so as to avoid hysterics, demands ceaseless attention to the exact facts. Exactness needs comparisons. And comparisons require numerical dimensions. Therein lies the scientific method.

We may carry this one step farther, without being accused of too much metaphysics. If we are to locate the exact place in the earth where an earthquake impulse starts, or where a lava column is smouldering underground, and if we are to communicate to others the method of such location, we shall set up a standard of measurement. Scale of work, precision of work, instrument used, and method of using it, are defined and by method and results are we judged.

Methods, measurements and communications, then, are the national standards by which the work of any station is gauged. And as this or that station or individual creates a successful instrument, fundamental formula or a new type of publication that proves useful, the result is adopted and becomes international. In such measure as we may set national standards that become international are we useful on the propaganda side of our work.

ACTUAL WORK OF ASSOCIATION

The aims of the Volcano Research Association are first, the keeping of records, second assisting other workers to study Hawaiian volcanoes, and finally, the promotion of volcano laboratories elsewhere. When we started there were no standards to speak of. We kept a volcano diary and measured everything measurable such as temperature, movements, areas and bulks of lava; and the tremors, quakes, tides and tilts of the earth. We tried to improve methods as we went along, and we religiously published a little record to let others know what we were doing.

Speaking of bulk, or volume measurement, it may interest you to know that by computing the volume of Halemaumau pit before and after the explosive eruption of May, 1924, and then computing the volume of the ash and bowlders ejected, from the measured thicknesses, we have discovered the remarkable fact that over 250 times as much material was engulfed into the depths as was thrown out explosively. And by carrying this sort of calculation further, we have found that in the last century fully as much lava has poured into the greater crater of Kilauea as all the Mauna Loa flows put together. These facts are surprising and illustrate the benefits to clear thinking that come from measurement and expressing the results in cubic feet. Such facts are very disconcerting to those who measured the amount ejected in some of the great historical eruptions by the void that was left in the crater. Explosions may make a big show while engulfment is doing all the work. And lava flows may make a big show while quiet crater filling is making just as much output.

THE WORK OF 1923-4

What the Hawaiian observatory at Kilauea now actually does may be illustrated by what it did in 1923 and 1924. The details you may read in the monthly bulletins. The staff consists of a volcanologist, a seismologist, a volunteer recorder and a messenger. We are our own mechanics, typists, photographers and chemists. A research fellow of this Association was appointed for a year in 1923 to carry on some special work in chemistry. We finished a

series of borings that showed the ground to be variously hot near Kilauea, but not excessively so. I went to Tokyo and found out what I could about the holocaust there, and then to Washington and other cities for conference, publication, and lectures.

From a practical standpoint the Observatory was of considerable value to the community during the explosive eruption of last year. It has been the source of many photographs published in scores of magazines; it has supplied materials to the transportation companies for publicity; its Volcano Letter and Bulletins go to travellers and hundreds of libraries and institutions all over the world to tell them of Hawaii. Its correspondence continually calls for and supplies educational material, and its scientific investigations are necessarily adding to the sum total of standards that will teach science eventually to predict earthquakes.

The lava activity reached a crisis of subsidence in April, 1924, and in May, Kilauea exploded disastrously, repeating in a measure the event of 1790 when Keoua's soldiers met with calamity. Since May we have been watching Halemaumau narrowly, and using the interval of quiet to bring publications up to date, and to start a new weekly leaflet.

The issuance of the Volcano Letter has been well received. The move to make volcanology known popularly and scientifically, carried out by sending the director of the Observatory to Sakurajima in 1914, to New Zealand in 1920, to Tokyo in 1923, and to the eastern United States in 1916 and 1924, is in line with the original policy of the Association when at the outset Mr. F. A. Perret drew attention to the value of experimental work at volcanoes with his weekly letters and fine photographs.

Prompt publication of the Hawaiian record, and development of volcano science around the Pacific, are the two main motives for the existence of the Hawaiian Volcano Observatory. The weekly Volcano Letter reviews the progress of volcanology, keeps the staff keyed up, and produces a quick give and take with other students.

WORK OF ASSOCIATION IN 1925

The work now authorized and in progress under the Research Association is as follows:

(1) Improving and making uniform the instruments and time service of the outlying seismological stations Hilo, Hilea and Kona, in their co-operation with the central station Kilauea, for locating Hawaiian earthquake centers.

(2) Acquiring accessions to the Observatory library, this being designated as a Pacific library of volcanology by the Central Volcanologic Bureau of the International Geophysical Union.

(3) Experiments with a shock-recorder of simple design to be used as a portable seismometer, or to be supplied to large numbers of volunteer observers.

(4) Compiling and publishing data on hand from the seismological stations.

(5) Publication of a popular book on volcanism.

(6) Publication of the Volcano Letter and the Monthly Bulletin.

(7) Securing the services of co-operative workers in the chemical laboratory of the Observatory, and in the laboratory for steam experiments built over the bore-holes at Sulphur Bank.

WORK OF THE GOVERNMENT IN 1925

Compared with the foregoing, the work now in progress under the U. S. Geological Survey at the Observatory is:

(1) Keeping a daily journal, supplemented by photographs and measurements, of Halemaumau pit, and of other Hawaiian vents when active.

(2) Keeping daily seismograms and recording their measurement in the Whitney Laboratory of Seismology.

(3) Preparing and issuing the weekly press report on Hawaiian activity.

(4) Preparing and issuing the Monthly Bulletin of the Hawaiian Volcano Observatory, containing summary of volcanic conditions, discussion of special features, journal, illustrations, lava measurements and seismometric record.

(5) Preparing and filing in duplicate the annual record-book of the Observatory, one copy going to Washington.

(6) Inspection of Mauna Loa at least once a year.

(7) Maintaining plant, office work, photography, time-keeping, drafting, co-operation, expeditions, collections, analyses and experiments.

(8) Preparing materials for government professional papers.

PERFECTING VOLCANOLOGIC STANDARDS

The activities outlined for the Research Association in the next two years involve consolidating and perfecting our standards.

Nearly everything that has been urged upon this Association in annual addresses in past years is in the way of attainment. Mauna Loa will soon have a road and the National Park will soon have a museum. Even Pele the fire goddess came to time and verified the conception of a 130-year interval between big eruptions, an idea announced in one of these addresses some years ago.

Merely perfecting standards of work sounds at first like a simple, inexpensive matter. But the imperfection of the past involves an imperfect personnel and an imperfect plant. The discoveries here of tidal phenomena in the lava, of excessive tilting in the ground, of earthquake centers deep and difficult to locate, of very erratic temperatures, of very difficult physical chemistry, of the need of distributive observations and more precise instruments —all of these matters interest the world of science and lead to the query "What is Hawaii going to do about it? Are you going to have an enlarged laboratory and an endowment, and increase your equipment and personnel? The world of science is looking to you for some real standards in volcanology. You have the finest natural site in the world. You have wealth, but of course if you are going to do anything fundamental, you must add to your staff another physicist, an engineer, a chemist and an instrument maker."

It must be borne in mind that an equivalent laboratory of research in medicine, biology, engineering or any other experimental science on the mainland would have a large staff, an endowment of at least half a million dollars, and a hundred-thousand-dollar plant. Nothing less would nowadays be considered fitting for the dignity of research science. We have a few shacks, some home-made instruments, and a scientific staff of two. We have ten thousand dollars from the government for the salaries and recording. The rest has come from the continued loyalty for many years of the patrons and members of the Hawaiian Volcano Research Association.

The goal before us in Hawaii, in order to make our standards worth copying, is to improve our seismological instruments, our time-keeping service, our experiments with steam, with power, and with gas chemistry, our library and our publications. Everything has been rather experimental, home-made and not standardized. Results indeed have been attained, but others wish to know how to test their volcanoes by the same standards. More than once I have had inquiries about volcano seismographs, from New Zealand, from Java and from Japan.

TIME-KEEPING

Time-keeping seems a simple thing. But to locate an earthquake center accurately requires uniform time at three stations to a hundredth of a second delivered mechanically and automatically.

I propose that the Research Association undertake this by sending out a time signal to all our stations by short-wave radio once a minute. The

mechanical minute-marks must be actuated by the same time-piece at the same instant at stations eighty miles apart. This is not a simple thing, but radio-dynamics can do it. The outfit will cost about $5000 and the upkeep about $2000 per annum. The results should enable us to map out with some accuracy the depth and position of the rock surfaces underground whose sudden motion makes an earthquake.

SHOCK RECORDER

It is a truism today to insist that the study of local earthquakes at the place where they happen is the greatest need of seismology. It is not so easy as it sounds to design a shock recorder that shall be as simple as a thermometer, so that if any one of this audience saw it in a shop window he would wish to buy one and set it up in his dining room. There is no such standard instrument as yet in existence.

I have a design for such an instrument. At the Observatory we have the experience for tests and an ideal testing cellar, where we can count on several real earthquakes a week for calibration purposes.

I propose that the Research Association build such models, and when they are proved efficient that we sell a hundred of them in the islands, and get reports on earthquakes, little and big, wherever they may occur, night or day, from an instrument that will give something better than personal impressions; an instrument that will give us measurements. When standardized in the islands, we can sell a thousand in Italy or California or New Zealand.

LIBRARY AND PUBLICATIONS

The International Committee has done us the honor of voting at their meeting in Rome "that the Kilauea observatory should be accorded facilities for the continuation of its work" and that a "branch of the Central Bureau of Volcanology, with an international library, should be established at the Hawaiian Volcano Observatory."

This Central Bureau at Naples has recently started an international quarterly of volcanology. In Geneva the Red Cross league has started a new magazine devoted exclusively to natural catastrophes and their alleviation. This is all good, and there is surely need for a book in English telling something of progress to date in volcano research the world over. Your directors have authorized the preparation of such a book and some chapters of it have been finished.

CONCLUSION

The meetings of the International Committee at Rome and Madrid were attended by delegates from many countries, and their action and discussions showed that the science of volcanology now commands serious attention by geodesists, astronomers, oceanographers, meteorologists and seismologists, and that they recognize in Italy, Japan and Hawaii the three natural laboratories of the science. It was clear to me in visiting American cities last winter that all over the country there is not only a tourist interest in Hawaii, but a popular interest that is widespread in the work of the Hawaiian Volcano Research Association.

We cannot maintain a worthy American standard in volcano research unless we build, operate and put out good instruments, improve our publications, and above all things draft fresh brains into volcanology at a worthy wage. We can set an example that is excellent only with new workers, new work, and new equipment.

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VOLCANIC CONDITIONS IN MARCH

Activity of Halemaumau

During the week ending March 4 there were few avalanches in the pit and on some days the visitor, during a short stay, heard no rocks sliding. At

noon of March 2, during fresh squally northeast wind and very dry weather, the northeast corner of the pit started caving away. The air became charged with dust so that the whole orifice was outlined by the swirling veils. The talus next day was covered with fresh red fragments, and a notch several hundred feet high was left in the wall above.

Six sulphur-lined holes venting steam followed the bottom of the east talus where it overrides the lava floor and there was some sulphur at the top of the talus. Vents that appeared hotter gave up dense flocculent steam at the south and west taluses, but these were depositing no sulphur.

The northeast wall, since the breakdown of 1924, had avalanched more than any other. This and the southwest wall have breakage lines up and down that the other walls do not have, traces apparently of the Kau Desert shear zone. It is difficult to say what starts the avalanche notches to working, as on March 2, but in general the seismometric records indicate more local earthquakes during avalanching spells than at other times. It may be that the Kau Desert zone moves seismically.

In this northeast wall is the big intrusive sill rising into horns at each end, and irregular large red bodies of jumbled appearance lie within the upper part of the sill rock. A still larger red mass of this kind, the west boss, overlies similar intrusive rock on the west side of the pit. These red bodies appear as though they might have been crags in an ancient pit of which the sills form the bottom, intrusive beneath the talus slopes of that time. The middle of the northeast sill has an upward extension in section shaped like a mushroom, and fossil talus slopes appear in cross section on each side, the western one being well marked with beds dipping 30 degrees, and overlaid by the horizontal lava flows of the rest of the wall. The way the horns of the sill are shown in section rising behind these fossil taluses, suggests the vents that we have seen so often breaking out from the top of a debris slope.

During this first week of March there were seventeen local seisms, twelve of which appeared to be avalanche tremors. One at 7 a. m. February 28 was felt and had indicated origin two miles away. Tilt was moderate to the northeast.

Until March 10 conditions were quiet, but on that day spectacular avalanches occurred. One, at 12:51 p. m., sent up hard-edged cauliflower clouds, and another at 5:09 p. m. crashed to the bottom with a deafening roar. The air in the pit was more or less dusty from small avalanches all day.

Local earthquakes increased in number at the time of the avalanching. Thirty-two earthquakes were registered for the week ending March 11, and twenty-three of them were between 10 p. m. March 9 and 6 a. m. March 11. Four of them were perceptible. One of these, at 8:15 a. m. March 10, was felt as a distinct vertical jolt and its indicated distance of origin was about one mile. Another at 1:06 a. m. March 11 had about the same indicated distance, dismantled the seismographs and awakened sleepers. Just before the earthquake spell tilting of the ground changed from moderate southeasterly to moderate northeasterly and for the week as a whole the tilt was east-northeast.

A general rainstorm on March 7 and 8 took the form of heavy snowfall on Mauna Kea and Mauna Loa. After the rain the Halemaumau walls showed deep red color of velvety appearance possibly due to iron salts brought to the surface and oxidized as the rain water percolates through the rock. The bright color persisted for but a short time.

During the third week of the month the pit became quieter. The steam rising from cracks concentric to the southeast rim of the pit is nucleated and made visible at once if a lighted brand or the gas from an automobile exhaust is brought near to the steam cracks on the windward side. The steam inside the pit produces great clouds of vapor on rainy days. The sulphur-stained area at the southeast border of the floor of Halemaumau, which had been obscured by avalanche dust, was again visible March 18.

During the week ending on that date, thirteen earthquakes were registered, none of them perceptible, and seven of them tremors without phases. Tilting for the week was moderate south-southwest.

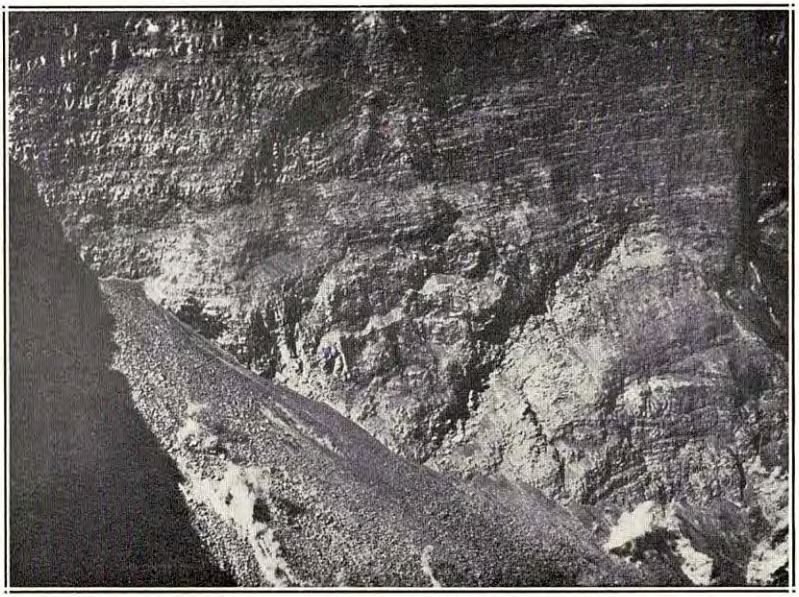


Figure 1. November 18, 1924, west wall of Halemaumau from south station. Massive intrusive body of the red boss, and lava layers thicker bedded upward. Apparent unconformity upper series on lower at the right. Photo Jaggar.

Figure 2. North-northeast wall of Halemaumau November 18, 1924. Below is the long north sill in U-shape. Above its left end is a fossil talus slope in section. Still higher are 600 feet of lava flows, an old pit fill. The columnar part of the sill at right was red hot in July. Photo Jaggar.

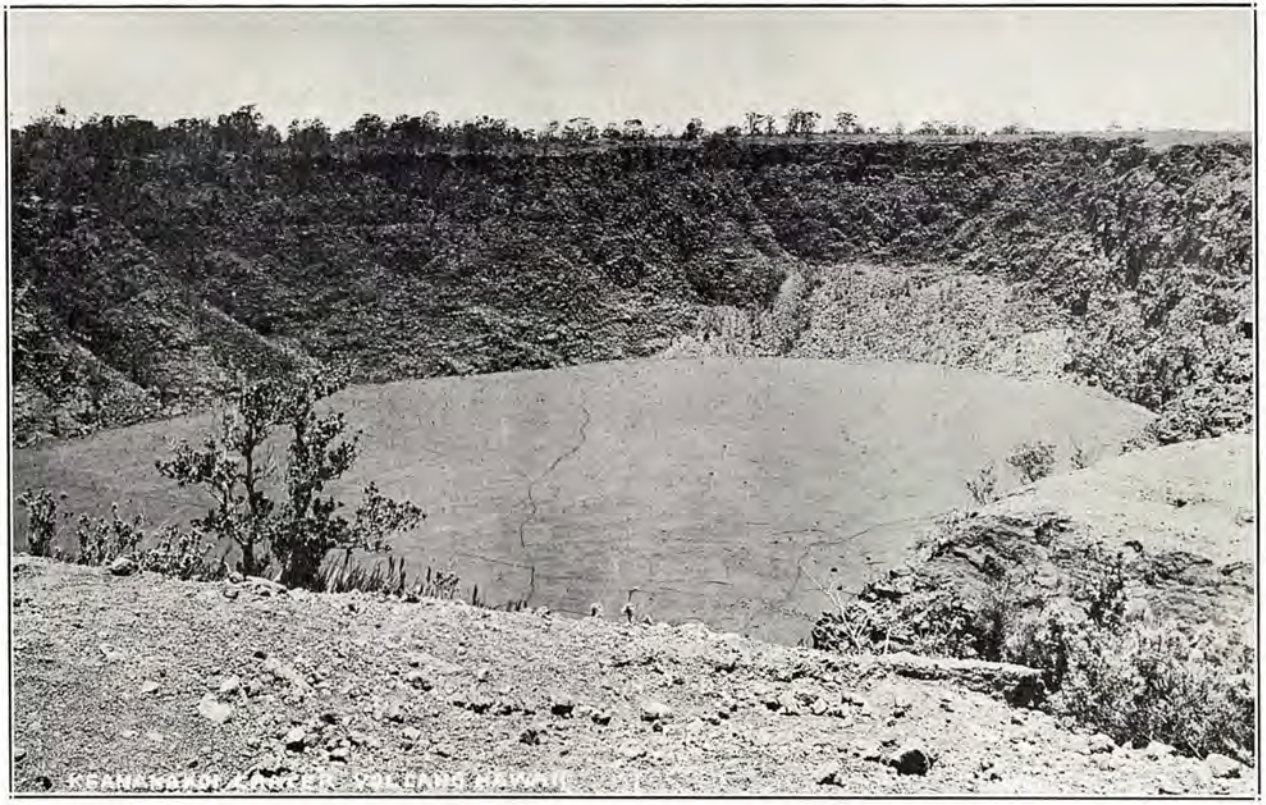


Figure 3. Keanakakoi crater, southeast of and adjacent to Kilauea, looking east. Floored with the smoothest kind of pahoehoe lava which welled up in 1877, and buried most of the debris slopes. Only small stones fell on this floor, in small number, in May of 1924. Dr. F. Omori in 1920 sounded the 3-inch crack across the bottom, and found it 15 feet deep, indicating that the floor is a columnar slab that thick. Photo Kanemori.

Figure 4. Aa lava and channel of 1919 Alika Flow, South Kona. Typical aa texture. The lump on the left was one of the stranded basaltic rafts that came down the lava river and was thrown over the edge at one of the overflows. Photo Kanemori.

No volcanic crisis appeared at the equinox, unless the fact that the week ending March 25 was the quietest since November can be considered such. A little avalanching occurred on March 20 and 21 and most of the few earthquakes of the week occurred on those days. A large piece of the eastern end of the northeast sill broke off on March 20, making a fresh gray patch on the talus below. There was slight avalanching north and northeast on March 25.

Tilting for the week was slight to the east-northeast. Only eight earthquakes were recorded, seven of them very small and three without phases. A perceptible shock occurred March 20 at 5:34 p. m. with indicated origin distance four miles. A teleseism with poorly developed preliminary tremor indicating origin distance 3600 miles began at 10:28 p. m. March 21, reported possibly near Kamchatka.

During the last week of March there were few slides. Some new-fallen fragments were observed on the northeast talus. A dry patch with sulphur stain on the high north wall, where the rock all around was wet with rain, appeared to be hot and to mark the site of the blue fume vent which disappeared during a November avalanche. The steep cavern in cracked ground north of the Halemaumau rim had recently collapsed, and was now found close to the rim, so much had the edge caved away.

The week was extremely rainy and again the wetting of the walls brought red iron oxide into prominence, more conspicuously above the intrusive bodies than elsewhere. The bank of yellow and white sulphates at the base of the southeast wall of the pit lost all its color after the rain and the alums and other soluble salts at the eastern edge of Kilauea crater were also washed down into cracks. There must be a concentration of these soluble products underground.

An examination of the gulch leading from Keanakakoi to Kilauea was made March 28. It showed new erosion stimulated by the grit of the 1924 ash and the increased run-off due to the impervious surface of that ash. At the mouth of the gulch a new debris fan was deposited on the Kilauea floor. On the Kilauea Iki floor new white spots were observed occasioned by rain wash hollows filled with the ash mud of the 1924 eruption.

During the week ending April 1 fourteen local seisms were registered, five of them, very small, occurring on March 31. Seven of the tremors were without phases, and possibly occasioned by avalanches. A perceptible shock, its origin apparently a mile away, occurred at 12:03 a. m. March 29. Tilt was slight to the east-northeast.

JOURNAL, MARCH, 1925

March 1. The day was dry and windy making dust clouds on the Kilauea floor and in the Kau Desert. Vapor jets in the bottom of Halemaumau at 3 p. m. were thin. The sulphur stains appeared dull, probably from a coating of dust. There was little movement in the pit and no fresh avalanche scars or talus were apparent.

March 2. An examination of the survey stations around Halemaumau, of which there were nine in July, 1924, showed that only four were left, namely south, southwest, northwest and the southeast tourist station. The others have been carried away by avalanches during the year.

At 9:15 a. m. fresh northeast wind was blowing and no slides were seen, conditions appearing as completely stationary as at any time in the last nine months. The sulphur patches and the southeast sulphate bank at the bottom of the pit were dull and wet. About noon avalanches started on the northeast side and the pit appeared dusty, as did also the Kilauea floor and the desert.

March 3. At 6 p. m. there were rain and mist. Slides were more or less continuous at the north side of the pit, and the northeast talus was covered with fresh red fragments. A new notch in the wall above the eastern bend of the northeast sill revealed decomposed red rock with a fissure-like jointing extending up and down the wall as though belonging to a rift trending in the Keanakakoi direction. The notch was rounded and corresponded in its general habit with the one above the west horn of the sill.

March 4. At 10:45 a. m. a few small slides occurred. The whole northeast wall in the morning light showed signs of having been freshly stripped recently, and the solfataric patches at the bottom of the pit were dusty. Above the east horn of the sill the northeast notch was dark red earthy looking rock with traces of bedding. Towards the top the notch showed veins and thick irregular masses of greenish brown and white minerals. This appeared solfataric but was not steaming. The jointing differed from the unconformity of the west horn. It appeared rather to be a wide fault zone extending from the top of the talus two-thirds of the way up the wall and striking east. The zone passed right through the bend in the sill where it extended into a narrow intrusive sheet in the east wall.

The jointing in both southwest and northeast walls shows traces of continuous vertical cracks going through all beds alike, and this cracking is parallel to the 1920-rift dyke. It does not show on the east and west walls which are themselves parting planes on this northeast-southwest system of rifting. In the upper northeast wall was observed a cross-section that appeared to be a buried slag-heap dome.

March 5. At 2:45 p. m. no slides were in progress, the weather was cloudy and dry and the vapor jets were thin. Some yellow stain had appeared in the lowest sulphate patch of the southwest talus. Above the northwest talus the wall had stripped all the way up to the rim at one place. There had been fresh stripping above the west horn of the northeast sill and the wall bedding there appeared confused. The new northeast notch showed bright colors in red, yellow, pink, buff and orange.

March 8. At 4 p. m. the walls were bright red, except for a few spots towards the northeast, and steam was abundant, one line of it crossing the lava floor and continuing clear to the top of the southwest talus.

March 9. At 5 p. m. there were few rock falls, the wall above the west horn of the northern intrusion was coated with white salts and a similar deposit appeared on the new ash outside of the pit.

March 10. There were numerous avalanches. One at 12:52 p. m. sent up large cauliflower clouds above rim of pit. Another large one at 5:09 p. m. sent big cauliflower clouds across the bottom of the pit, but these rose above the rim in a diffuse condition. The falls were from the north corner and covered the northeast talus with red dust. The odor of hydrogen sulphide was faintly perceptible.

March 11. At 11 a. m. the pit was very quiet but there was debris on the southeast sulphate bank in the bottom of the pit.

March 12. At 5 p. m. a thunder storm was in progress and the pit was so full of vapor that the bottom could not be seen. No sound of slides was heard.

March 14. At 10 a. m. no rock falls occurred. The vapor from the bottom rose more rapidly than usual, holding hard outlines for some distance upward. The steam cracks at the southeast rim seemed unusually hot.

March 15. At 2 p. m. temperature measurements of cracks along south and southeast rim of pit, where there had recently been movement, gave the following values:

On the trail	171° F.
North of trail	173° F.
South of trail	183° F.

The jostling of rim blocks that revealed such temperatures underground suggests a fill of plastic material that yielded and caused the slump of 1924. There are some cracks all the way from the parking place to the rim and the hot moisture rises through the opening of these cracks.

March 16. At 4 p. m. there were no noises from slides. Abundant steam rose from the bottom but sluggishly and without hard outline. Some fresh material had fallen from the southeast wall.

March 17. At 10 a. m. the pit was quiet, odor of hydrogen sulphide was perceptible and the sulphur stain at the southeast side of the bottom was again visible after having been buried by the avalanches of March 10 and 11.

March 18. Since last observation fresh debris had fallen from the north and northeast walls. The sulphur-stained patch southeast was again prominent through the fresh talus.

March 19. At 3 p. m. during a rain storm the interior of the pit was obscured by vapor clouds, but no noises were audible.

March 21. At 9 a. m. the pit walls were quite red and wet except at the intrusives and at places above the east and west horns of the northeast sill. From the east end of this sill fresh avalanche debris had fallen on the talus below. At 5 p. m. during native ceremonies at the edge of the pit a very small avalanche occurred.

March 22. At 4 p. m. the pit was quiet; steam rose abundantly, especially along a line up the southwest talus.

March 23. There was much steam in the pit, the walls had lost some of their redness and the line of jets up the southwest talus and across the floor was notably dry as though excessively hot.

March 25. At 2:20 p. m. there was fresh northeast wind and sunshine. Rocks were sliding a little on the northeast and north walls. The fresh talus northeast made a high cone at the east end of the big sill. The northwest talus gorge had lost all the promontories of rock on its south side; these had become a smooth rock slope.

There was steam on the bottom in moderate volume. The southeastern sulphur spots showed plainly. A dyke or fracture zone could be discerned in the southwest wall 200 feet west of the southwest tunnel. There was fresh avalanche dust on the wall above the southwest talus north of the pit corner. Salts had increased at the base of the southwest talus.

March 27. At 4:15 p. m. the weather was rainy, the walls were wet and red, there was much steam from the bottom of the pit, that at the south talus showing the blue edges characteristic of sulphur gases. The southeast bank at the base of the wall, usually covered with sulphates, showed no color. Some upright bands athwart the northeast sill, notably a wide one near its west end, remained dark gray and wet, whereas the adjacent rock was lighter in color and dry. No rocks were observed sliding and conditions appeared quiet.

March 28. At 11 a. m. the weather was a little drier, steam was abundant and no slides were heard.

March 29. Between 2 and 4 p. m. the circuit of the pit was made by south and west sides. Slight slides were heard twice. The walls were wet and the red oxidation appeared most brilliant in the north and west walls over the intrusive bodies. Two well-marked gray dykes were noticed in the southwest wall west of the southwest tunnel. There was much steam including some rising from the top of the north wall. At the west cracks back of rim of pit the steam had diminished in heat and volume. The cavern north-northeast of pit had caved in and the region between it and the pit had so fallen away that the remains of the opening were now close to the rim.

The fresh pahoehoe exhibited here in a faulted wall was notably different from the rocks thrown out as fragments in May, 1924. The few vesicular rocks thrown out appear less glassy and many of the fragments are mottled like amygdaloid, as though the vesicles had been filled. Then there are the banded fragments seemingly showing gas fluxing along the glassy bands. This all seems to show that the vesicles, cracks and caverns all tend to become filled when buried by magmatic percolation or by gas fluxing.

March 30. At 4:30 p. m. it was rainy, the pit was full of vapor and no slides were heard.

March 31. At 11:40 a. m. the weather was sunny and clear, but the walls of the pit remained wet except for one spot about 200 feet across on the north wall near the top, exactly where the blue fume was in 1924. The middle of the dry area appears yellow as though with sulphur and apparently this is still a hot spot.

There were the usual vapor jets on the bottom and some fresh red talus had fallen northeast from a very red area over the eastern bend of the north sill. No rocks were heard sliding.

It was noticeable on this day that most of the red areas were also vertically scored shoulders, as though parts of buried slopes overlaid by the beds next above. This is true of the western red boss, the three red patches in the upper part of the north sill, a reddish slope west of the southwest tunnel, another at the base of the south wall, and probably also of the sulphate bank at the base of the southeast wall. All of these and some other places have the aspect of veneered walls of a larger funnel containing the beds piled up to fill it. The present collapse has cut sections through these in a circle exhibiting steeper walls, thus revealing the shoulders of the wider and flatter funnel. The vertical scoring or slickensiding on these appears to extend in over the underlying beds. This scoring was probably made by slip-faulting of the fill acting on a wall-veneer of bench magma.

SEISMOMETRIC RECORD

During the month ended midnight March 31, 1925, 79 local earthquakes and one teleseism were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard 10 h. 30 m. slower than Greenwich.

Abbreviations have meanings as follows: Vf=very feeble; f=feeble; s=slight; m=moderate; d=instruments dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with less amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes.

March
1— 11:24 a. m. vf.
2—a 12:06 p.m. vf.
12:13 p. m. vf.
4:07 p. m. vf.
3—a 9:41 p.m. vf.
a 10:02 p.m. vf.
4—a 7:46 a. m. vf.
5— 9:44 a. m. vf.
6—a 10:06 a. m. vf.
a 3:43 p. m. vf.
7— 2:09 a. m. vf.
a 10:58 a. m. vf.
a 2:00 p. m. vf.
8— 3:06 p. m. vf.
9—a 12:17 a. m. vf.
7:03 p. m. vf.
for 20 minutes.
10:16 p. m. vf.
a 10:38 p. m. vf.
10:46 p. m. vf.
10—a 12:35 a. m. vf.
a 12:47 a. m. vf.
2:13 a. m. vf.
2:13 a. m. s, △13.
a 2:48 a. m. vf.
8:14 a. m. s, fl, △1.

March
10—a 8:38 a. m. vf.
9:47 a. m. vf.
10:00 a. m. vf.
a 12:52 p. m. vf.
a 2:46 p. m. vf.
a 3:52 p. m. vf.
a 5:09 p. m. s.
a 8:15 p. m. vf.
a 8:17 p. m. vf.
a 9:40 p. m. vf.
a 11:08 p. m. vf.
11— 12:40 a. m. vf.
1:06 a. m. m, d, △1.
4 vf. tremors between
1:10 and 6 a. m.
a 12:32 p. m. vf.
4:00 p. m. vf.
12—a 11:14 a. m. vf.
a 3:52 p. m. vf.
4:38 p. m. vf.
15—a 7:11 a. m. vf.
7:15 a. m. vf.
7:20 a. m. vf.
11:21 p. m. vf.
felt, Kealakekua.
16—a 6:28 p. m. vf.
6:30 p. m. vf.

March
16—a 11:06 p. m. vf, lasts 3 min.
18—a 2:27 a. m. vf.
a 10:41 a. m. vf.
20— 5:34 p. m. s, △4.
a 7:31 p. m. vf.
21—a 10:06 a. m. vf.
2:40 p. m. vf.
23— 2:57 p. m. vf.
24—a 9:45 p. m. vf.
9:51 p. m. vf.
25— 2:35 a. m. vf.
6:49 a. m. vf.
27—a 12:11 a. m. vf.
a 12:45 a. m. vf.
28—a 1:35 a. m. vf.
4:16 p. m. vf.
5:41 p. m. vf.
29— 12:03 a. m. s, △1.
30— 1:17 a. m. vf.
a 10:37 a. m. vf.
11:55 a. m. vf.
31—a 11:48 a. m. vf.
12:45 p. m. vf.
a 9:40 p. m. vf.
a 10:31 p. m. vf.
a 11:39 p. m. vf.

Teleseism.

March 21.....10:28 p. m. slight △ 3600.

Harmonic Tremor.

This type of tremor was absent in March.

Microseismic Motion.

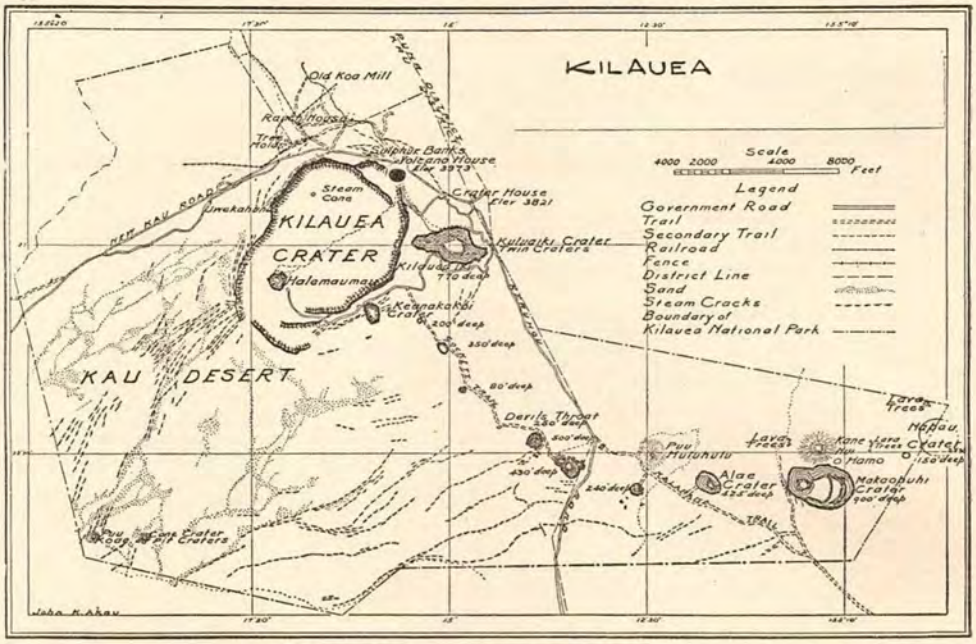
The amplitude of microseisms was moderate on March 9 and slight on other days.

Tilting of the Ground.

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

Mar. 1- 7.....0.7 second ESE.
8-14.....1.2 seconds WSW.
15-21.....0.0.
22-28.....2.0 seconds ENE.

T. A. JAGGAR,
Volcanologist.



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MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by

the Hawaiian Volcano Research Association

VOL. XIII. HONOLULU, HAWAII, APRIL, 1925. NO. 4

CONTENTS

VOLCANIC CONDITIONS IN APRIL

Activity of Halemaumau

The month of April produced some increase in numbers of earthquakes and avalanches, mostly small in intensity. There was no lava activity above the surface of the ground and the tilting tended generally towards the southwest, as is usual here in the spring months.

At the beginning of the month avalanches had been infrequent in Halemaumau since the middle of March. During the first week of April a few avalanches were noted, mainly on the 6th, 7th and 8th. Steam was rising from the floor of the pit, especially at the edges and from concentric cracks in the Kilauea floor outside of the pit. The odor of hydrogen sulphide was very slight.

During a rainy spell the climatic change between the forested belt of trade wind rain northeast of Kilauea and the Kau Desert southwest was illustrated by the simultaneous observation of light rainfall at the Observatory and dust clouds three miles away beyond the southern rim of Kilauea.

Not only was the pit quiet but the seismographs showed diminishing activity. Eleven earthquakes were recorded for the first week of the month, none perceptible; tilt was very slight to the south-southwest.

During the second week avalanches occurred nearly every day, mostly above the northeast sill where in places the accumulation of avalanche material at

the base of the wall buried parts of the intrusive body. A sulphur-stained area at the southeastern edge of the floor was extending itself toward the center on the lava fill. Brisk winds April 15 stirred up heavy dust clouds in Kau Desert and small ones on the Kilauea floor.

For the week ending April 15 local earthquakes were more intense. Of fifteen that were registered five gave records sufficiently pronounced for calculation of source distance. One at 1:37 a. m. April 9 awakened many people and dismantled an instrument. Three shocks April 11 indicated distances of thirteen, six, and two miles respectively. This suggested movement on one of the Kilauea rifts. A slight shock with origin apparently nineteen miles away awakened a few people at 5:28 a. m. April 15. A weak teleseism without good phases occurred at 2:31 a.m. April 11.

The tilting for the week was very slight north-northwest compounded of moderate southeast tilt on the 10th followed by rapid reaction in the opposite direction on the 11th.

The third week of April produced small avalanches nearly every day, but there was no evidence of breaks in the soil along cracks concentric to the rim of Halemaumau to indicate that pit faulting produced the recent earthquakes.

Odors of hydrogen sulphide and some free sulphur were noticeable. Sulphates formed white incrustations on the walls and floor of the pit. The floor deposits were mostly along three parallel steaming lines trending northeast-southwest. During rainy spells the pit was so full of steam that little could be seen and the noise of an avalanche at such a time was impressive.

Seventeen earthquakes were recorded for the week ending April 22 and a teleseism was written on the seismographs April 19 when the newspapers reported a disturbance in Japan. A locally felt shock at 8:52 p. m. April 20 appeared to have its source on Mauna Loa. Other shocks had indicated origins one or two miles away, one of them felt at 12:29 p. m. April 16. Tilting for the week was moderate west-southwest.

The last week of April produced infrequent avalanches, though small slides could be heard during visits to the pit at any time. The densest vapor in the cauldron rose from the lower part of the south talus slope. On dry days much white salt resembling a light fall of snow blossomed out on the ash near the rim of the pit. The spicy odor of free sulphur from the pit was very noticeable.

Twenty-three earthquakes were registered for the week ending April 29, none of them felt, and of these nineteen occurred April 24 and 25. Several of them appeared as though their origins were at about the distance of the northeast rift of Mauna Loa. Tilting was moderate southwest.

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April 1. Between 9:30 and 11 a. m. during a visit at the pit only one small slip of rock was heard, and that in the vicinity of the southwest rift tunnel. It was a sunny day and a dry zone was noticeable from top to bottom of the wall above the west talus where the western steam cracks emerged tangentially into the pit walls. The dryness appeared to be due to their heat, though no steam appeared on the wall face, in spite of the fact that much steam rises from these cracks where they form chasms back of the western rim of the pit.

The northeast talus showed gray rock fragments freshly fallen on top of the red ones of the previous day. The principal steam jets near the bottom of the pit were at the west pocket, the south talus and the northeast sulphur patch. There was a yellow patch in the northeast wall above the eastern horn of the north sill, at about the same height as the similar hot dry patch over the western horn. This northeastern sulphur spot lay in a vertical shear zone. Possibly these two solfataras and the southwest tunnel lie above three main radial cracks leading respectively to the Volcano House sulphur banks, to Kilauea Iki and to the Kau Desert.

April 2. At 2:30 p. m. some whitening was noticeable on the walls of the pit, the southwest talus and the bank at the base of the southeast wall. The

west end of the north sill appeared to have been sliding a little, as shown by dust on the wall and fresh talus.

April 3. At 4:30 p. m. there was some appearance of fresh breaking in the northeast wall and a dusty belt extended up and down the southwest wall. At 1:24 p. m. a dust cloud from a small avalanche rose from this wall.

April 5. During a visit at 3 p. m. no noise even of individual rocks falling was heard. In an upright zone of steaming near the base of the southwest talus a whitish deposit of salts was noticed.

April 6. At 3 p. m. in spite of dry air the cracks at the southeast rim of the pit were steaming voluminously but without noticeable increase in temperature. The air in the pit was dusty from frequent small avalanches mainly from the southeast wall during the term of observation.

April 8. Small avalanches fell from the north wall. Salts were less conspicuous in the bottom region; no odor was detected.

April 11. At 4 p. m. the pit was quiet, with no evidence of avalanching to accompany the earthquakes of this day. Steam was abundant.

April 12. There had been a small avalanche from the east end of the north sill. A large dark patch was noticed, as though the wall were wet on the east side of the southwest rift tunnel.

April 14. Small but frequent avalanches were falling from the west wall. Debris on the talus gave evidence of recent movement at the east end of the north sill. The sulphur-stained area southeast had somewhat extended itself into the lava floor below the talus slopes.

April 15. At 11 a. m. there was brisk wind making light dust clouds in Kilauea and heavy ones in the desert. The odor of hydrogen sulphide was faintly perceptible at the pit. The building up of a high talus cone in the middle of the north sill by avalanche falls had nearly covered that part of the sill to its top contact.

April 17. At 4 p. m. the weather was rainy, the pit was full of vapor and a faint odor of hydrogen sulphide was perceptible.

April 18. At 5 p. m. the pit was quiet, no slides occurred, and the steam vents appeared distributed along three lines trending northwest-southeast.

April 19. At 4 p. m. the odor of hydrogen sulphide was perceptible a thousand feet back of the Halemaumau rim. There was abundant steam from the pit floor and the debris showed that small avalanches had fallen from the north wall.

April 20. At 4 p. m. no avalanches occurred. Irregular white streaks of solfataric deposits with up and down trends like veins were noticed in the north wall. A small area above the west end of the north sill has a white coating and appears to be decomposed rock.

April 21. At 4 p. m. sulphurous odors were noticed at the southeast rim and there were some slides at the east end of the north sill.

April 22. At 3 p. m. in rainy weather seeing was poor. Small avalanches were heard from the north wall and sulphuretted hydrogen was faintly smelled.

April 24. At 5 p. m. occasional rock falls were heard and dense steam was rising from a spot in the south talus near its lower end.

April 25. At 11 a. m. the pit was quiet and white salts were abundant on the ground, a characteristic of a dry spell following rain.

April 27. At 3 p. m. east wind was blowing, the pit was partly obscured by vapor, small rock falls were heard occasionally and the odor of sulphur was noticeable.

April 28. The spicy odor of free sulphur was very pronounced. There was little steam rising from the line of vents up the middle of the southwest talus on the lower half, but it was abundant from the upper half of the talus. On the lower half, however, appeared a heavy deposit of salts.

April 30. At 3 p. m. the pit was quiet and the walls wet and very red except at the north and west intrusives. The talus slopes were mostly wet, but a zone appeared in the upper middle part of the steaming band at the southwest talus, which was dry.

SEISMOMETRIC RECORD

During the month ended midnight April 30, 1925, 70 local earthquakes and two teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 m. slower than Greenwich.

Local Earthquakes.

Abbreviations have meanings as follows: vf=very feeble; f=feeble; s=slight; m=moderate; d=instruments dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

April		April		April	
1—	9:00 a. m. vf.	14—	6:04 p. m. vf.		8:44 a. m. vf.
	3:37 p. m. vf.	15—	5:28 a. m. s, △19.		5:23 p. m. vf.
2—	4:58 p. m. vf.		12:29 p. m. vf.		8:44 p. m. vf.
4—a	9:11 a. m. vf.		3:13 p. m. vf.		8:52 p. m. vf.
a	2:12 p. m. vf.	16—	12:29 p. m. s, fl, △2.	25—	12:09 p. m. vf.
5—	3:26 a. m. vf.		1:25 p. m. vf.		12:24 p. m. vf.
6—	1:01 p. m. vf.	17—	5:29 a. m. vf.		9:25 p. m. vf.
7—	12:26 a. m. vf.		9:54 a. m. f, △1.		10:18 p. m. vf.
	3:56 a. m. vf.	18—	7:01 a. m. f, △1.		10:19 p. m. vf.
	3:05 p. m. vf.		1:15 p. m. vf.		10:21 p. m. vf.
8—	6:07 a. m. vf.		3:40 p. m. vf.		10:23 p. m. f.
9—	1:37 a. m. m, d, △2.	19—	12:31 a. m. vf.		10:33 p. m. vf.
	1:44 a. m. vf.	20—	11:27 a. m. vf.		10:36 p. m. vf.
	11:48 a. m. vf.		12:02 p. m. vf.		10:47 p. m. vf.
	5:20 p. m. vf.		6:12 p. m. vf.		10:50 p. m. vf.
10—	1:16 p. m. vf.		8:52 p. m. s, fl, △21.		10:56 p. m. f.
	11:39 p. m. vf.	21—	5:11 a. m. vf.	28—	6:35 a. m. vf, △2.
11—	9:04 a. m. f, △13.		2:34 p. m. vf.	29—	8:12 a. m. f, △3.
	12:51 p. m. f, △2.	22—	1:21 a. m. vf.	30—	11:30 a.m. vf.
	5:46 p. m. f, △6.		11:30 a. m. vf.		9:45 p. m. vf for 15 min.
12—	1:29 a. m. vf.		11:46 p. m. vf.		10:38 p. m. vf for 22 min.
	2:05 p. m. vf.	23—	1:44 p. m. vf.		
13—	7:43 p. m. vf.	24—	6:48 a. m. vf.		
	10:50 p. m. vf.		7:06 a. m. vf.		
			7:47 a. m. vf.		

Teleseisms

April 11.....12:31a. m., Slight.
19..... 5:27 a. m., Slight.

Harmonic Tremor

This type of tremor was absent throughout the month.

Microseismic Motion

The amplitude of microseisms was moderate on April 13 and slight on other days.

Tilting of the Ground

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

March 29-April 4.....0.8 second S.
5-11.....0.9 second ESE.
12-18.....0.7 second SW.
19-25.....2.6 seconds SW.
26-May 2.....0.4 second NW.

T. A. JAGGAR,
Volcanologist.

Figure 5. The west corner of Halemaumau, the Kilauea wall and distant Mauna Loa November 25, 1924. Shows the big western debris cone which a few days later was converted into a landslip by an avalanche from that wall. Note the "steam spout" on the rim. Photo Jaggar.

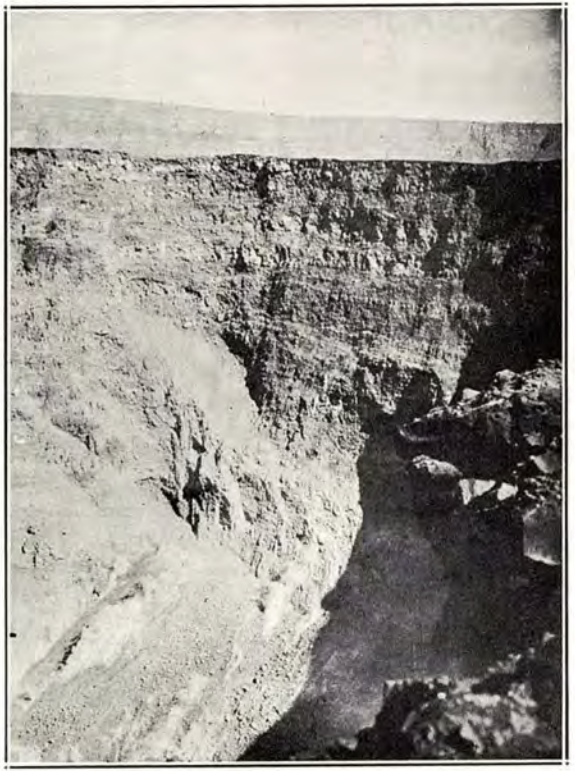


Figure 6. The north corner of Halemaumau, showing the west horn of the big northeast sill, overlaid by an ancient fossil talus section, and lava flows still above that. Photograph November 25, 1924, by Jaggar.

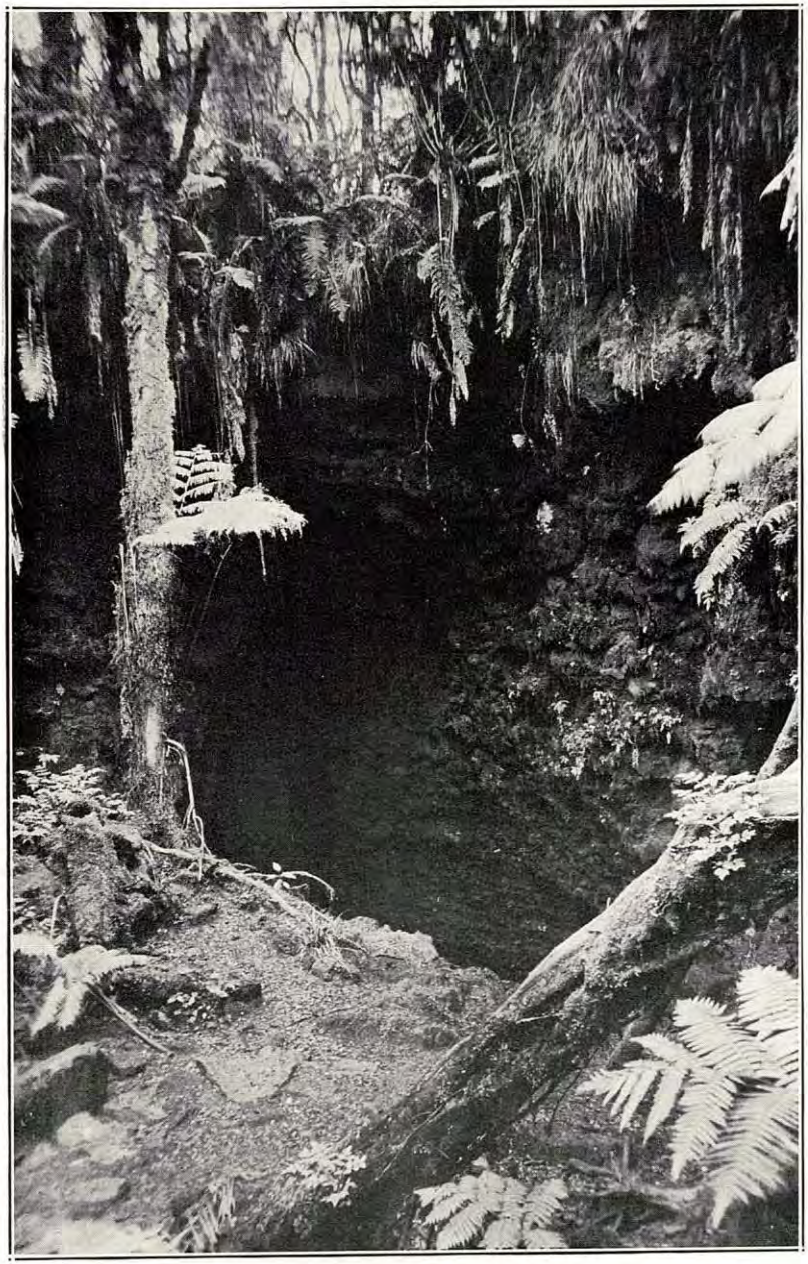
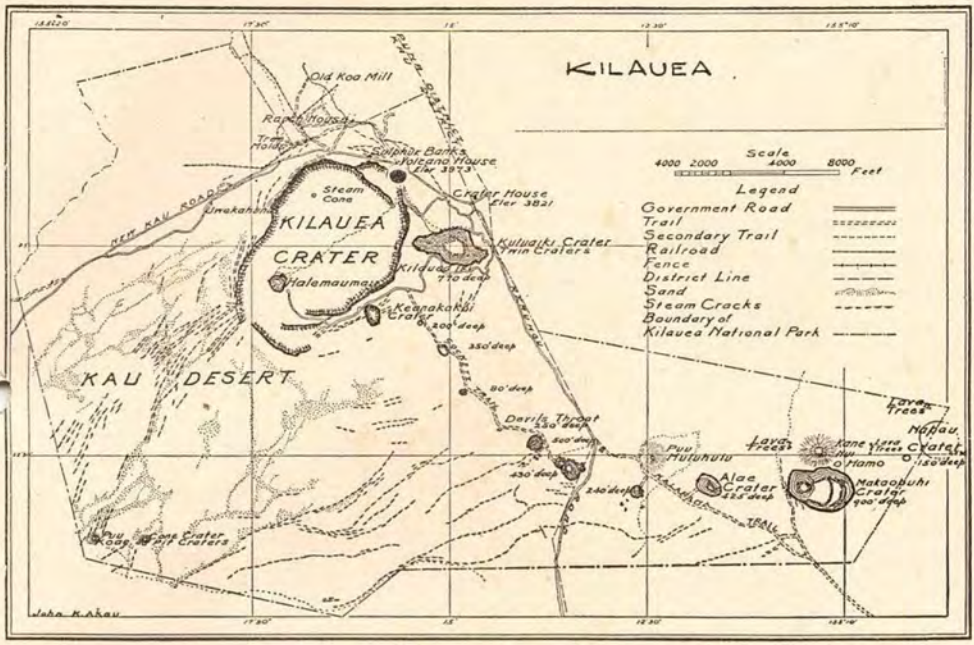


Figure 7. Thurston Tube, a lava tunnel leading from the wall of one of the Twin Craters northeastward from the region of Kilauea Iki. This tunnel was discovered in the summer of 1913. With interruptions it extends several miles down the mountain. It marks the course of an ancient lava river bed. The lava stream crusted over, the lava in the source pit subsided, then the subterranean lava course was drained, and the tunnel was left behind. Photo Kanemori.

Figure 8. Frozen lava cascades which poured into a collapsed tunnel near Halemaumau on the Kilauea floor about 1894. In the distance is a field of semi-aa lava, the festoons of the cascades are typical ropy pahoehoe. Photo Kanemori.



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Published by

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VOL. XIII. HONOLULU, HAWAII, MAY, 1925 NO. 5

CONTENTS

VOLCANIC CONDITIONS IN MAY

Activity of Halemaumau

The month of May, a year after the explosive activity of 1924, produced no recurrence of volcanic activity directly traceable to magma in either Kilauea or Mauna Loa. There was a notable increase of avalanches and local tremors towards the end of the month, but it seems almost certain that many of the tremors are due to the avalanches. Therefore this indicates merely some accelerated settling of the Halemaumau underpinning.

During the first week of May there were slight indications of increased heat in the pit. The heavy steam cloud rising from the south talus had become less conspicuous. The steam line in the southwest talus was steaming less than before, as though the deposition of salts had plugged up the vents below. On May 5 the odor of hydrogen sulphide was noticeable after having been scarcely detectable at all for a few days. During the night of May 4-5 a considerable avalanche fell from the north wall.

During the week ending May 6 nine local earthquakes were recorded, one at 8:12 a. m. April 29, indicating by its seismogram an origin three miles away. There were slight records of three distant earthquakes. Tilting was slight to the northeast.

Avalanches increased during the second week, mostly from the north wall. Portions of the gray intrusive body broke off, though most of the avalanche

material was from decomposed rock higher up the wall. No sulphur odors were observed.

Fourteen imperceptible seismic movements were registered. The tilt changed from northeast to southwest.

Avalanches and earthquakes increased markedly during the third week, most of the slides being from the north wall, though small ones fell from all sides of the pit. Forty earthquakes were registered, half of them of the type of tremor that accompanies avalanches. A slightly perceptible earthquake occurred at 2:02 a. m. May 17 which was plainly felt at Hilea. The seismogram indicated a distance of eighteen miles, and a second earthquake with the same indicated distance occurred at 10:26 p. m., May 19. A distant earthquake was recorded on the 18th. The net result of tilt was slight north-northwest made up of northerly for five days and southerly for two.

During the last week of the month the increase in avalanching continued, some of the slides sending dust clouds well above the rim of Halemaumau. This spell was followed by a reaction to notable quietness.

For the week ending May 27 twenty-three earthquakes were registered, of which six were of avalanche type. A notably felt earthquake occurred at 9:01 a. m., May 26, accompanied by a roaring noise, and dismantling one of the seismographs. The indicated distance was two miles, and a second shock with the same apparent distance, of very small amplitude, occurred at 8:47 p. m. the same day. Tilt was a little stronger than for several weeks, and was moderate to the southwest.

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May 2. At 3 p. m. a heavy steam cloud was rising from the south talus.

May 5. At 4 p. m. the odor of sulphuretted hydrogen was faint 700 feet back from rim of pit. A considerable avalanche had recently fallen from above the east end of the north intrusive. Possibly some of the sulphuretted hydrogen comes from such a place as this where the rock is greatly decomposed.

May 6. Humidity was high but little vapor appeared above the pit rim. A steaming place was visible high up the northwest wall. Though the wind was blowing from the northeast there was a strong convectional indraft toward the pit at the south rim as though the inner air were very hot.

May 11. At 3 p. m. there were signs of recent small avalanches from the north wall. At the time of visitation, however, the pit was quiet.

May 12. At 3 p. m. there was much steam on the floor. No odors were detected. There had been recent avalanching from the north wall, and a small round hole was observed in the northwest wall above the horn of the north intrusive body.

May 13. At 10:06 a. m. an avalanche fell from the northeast wall. A bowlder was found with an agglomeratic layer of gravel running through it and containing free sulphur.

May 15. At 5 p. m. cracks were found back of the south rim of the pit with the dirt freshly moved. Small avalanches had recently fallen from the north wall. Possibly the cracking occurred simultaneously with two earthquakes that were recorded at 6:29 a. m. and 7:03 a. m.

May 17. At 4 p. m. the pit was quiet and a faint odor of hydrogen sulphide was perceptible occasionally. Abundant steam rose, especially at the south talus.

May 18. At 2:40 p. m. an avalanche fell from the northwest wall. Small avalanches fell from all sides, but mostly from the north.

May 19. The pit was quiet in so far as could be determined in the presence of many sailors from warships who were throwing stones and causing artificial slides.

May 23. There were small avalanches from all sides of the pit and a faint odor of hydrogen sulphide was perceived at the north rim.

May 24. About 11 a. m. falls of rock were occasionally heard and the steaming vent in the south talus gave up little more vapor than other places.

At 7:30 p. m. a curious delusion of the return of fire to the pit was occasioned by a burning house in Pahala. The glow lay in the line from Volcano House to Halemaumau, and a faint whitish light was seen in the direction of the pit, which led to a general rush in that direction to see supposed lava. Possibly this phenomenon illustrates what may have happened in some of the ancient accounts of unexplained glows.

May 25. When the pit was visited fresh debris under the middle of the north sill indicated that slides had occurred there. A peculiar foundry odor was noticed with some suggestion of sulphur.

SEISMOMETRIC RECORD

During the month ended midnight May 31, 1925, 83 local earthquakes and four teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 m. slower than Greenwich.

Local Earthquakes

Abbreviations have meanings as follows: vf=very feeble; f=feeble; s=slight; m=moderate; d=instruments dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquake of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

May		May		May	
2—	10:28 a. m. vf.	16—a	8:40 p. m. vf.	21—a	11:14 a. m. vf.
3—	7:52 a. m. vf.	a	10:15 p. m. vf.		7:01 p. m. vf.
4—	11:17 p. m. f.	17—	2:02 a. m. s, fl, strong at Hilea, △ 18.	22—	1:35 a. m. vf.
5—	4:51 a. m. f.		4:41 p. m. vf.		7:05 a. m. vf.
	1:03 p. m. vf.	18—	12:40 a. m. vf.	23—	7:57 a. m. vf.
	4:53 p. m. vf.	a	7:30 a. m. vf.		9:34 a. m. vf.
6—a	9:39 a. m. vf.	a	9:41 a. m. vf.		9:23 p. m. vf.
a	11:26 a. m. vf.	a	9:42 a. m. vf.		10:41 p. m. vf.
a	12:58 p. m. vf.	a	9:58 a. m. vf.	24—	5:46 p. m. vf.
7—	6:25 a. m. vf.	a	10:30 a. m. vf.	25—	5:07 a. m. vf.
8—	6:27 a. m. vf.	a	10:59 a. m. vf.	26—	9:01 a. m. m, d, △1, accompanied by a roar.
9—	7:41 a. m. vf.	a	11:46 a. m. vf.		10:03 a. m. vf.
10—	9:14 p. m. vf.	a	12:36 p. m. vf.		11:24 a. m. vf.
11—	9:59 a. m. vf.	a	2:33 p. m. vf.		8:33 p. m. vf.
12—	2:43 a. m. vf.	a	2:49 p. m. vf.		8:47 p. m. vf, △1.
a	8:39 a. m. vf.	19—	12:24 a. m. vf.	27—	12:41 a. m. vf, △10.
a	11:14 a. m. vf.		5:13 a. m. vf.		1:56 a. m. vf.
	12:15 p. m. vf.	a	8:40 a. m. vf.		10:00 p. m. vf.
13—	2:34 a. m. vf.	a	8:41 a. m. vf.	30—	6:07 p. m. vf.
	7:24 a. m. vf.	a	8:59 a. m. vf.	31—a	9:54 p. m. vf.
	2:47 p. m. vf.	a	9:40 a. m. vf.		11:32 p. m. vf.
	2:51 p. m. vf.	a	9:42 a. m. vf.		
	3:37 p. m. vf.		10:26 p. m. vf, △18.		
15—	6:29 a. m. vf.	20—	4:35 a. m. vf.		
	7:03 a. m. vf.	a	8:46 a. m. vf.		
	8:06 a. m. vf.	a	10:14 a. m. vf.		
	8:21 a. m. vf.		10:15 a. m. vf.		
	9:34 a. m. vf.	21—a	8:39 a. m. vf.		
	11:51 a. m. vf.	a	9:25 a. m. vf.		
	11:22 p. m. vf.	a	11:13 a. m. vf.		
	11:37 p. m. vf.				

Teleseisms

May 3..... 7:03 a. m., slight.
3.....12:48 p. m., slight.
4.....11:47 p. m., slight.
18..... 7:13 p. m., slight.

Harmonic Tremor.

This type of tremor was absent in May.

Microseismic Motion.

The amplitude of microseisms was slight throughout 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 3- 9.....0.8 second NE.
10-16.....1.4 seconds NW.
17-23.....2.6 seconds SSW.
24-30.....0.5 second NW.

T. A. JAGGAR,
Volcanologist.

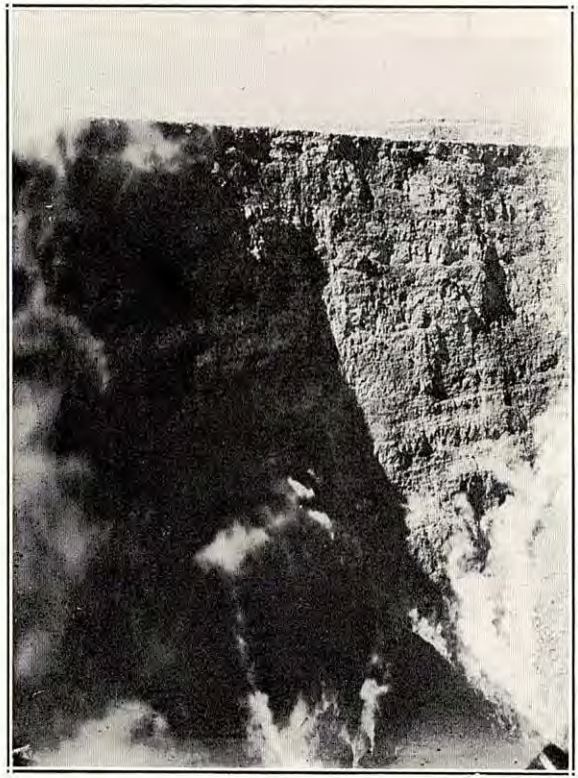
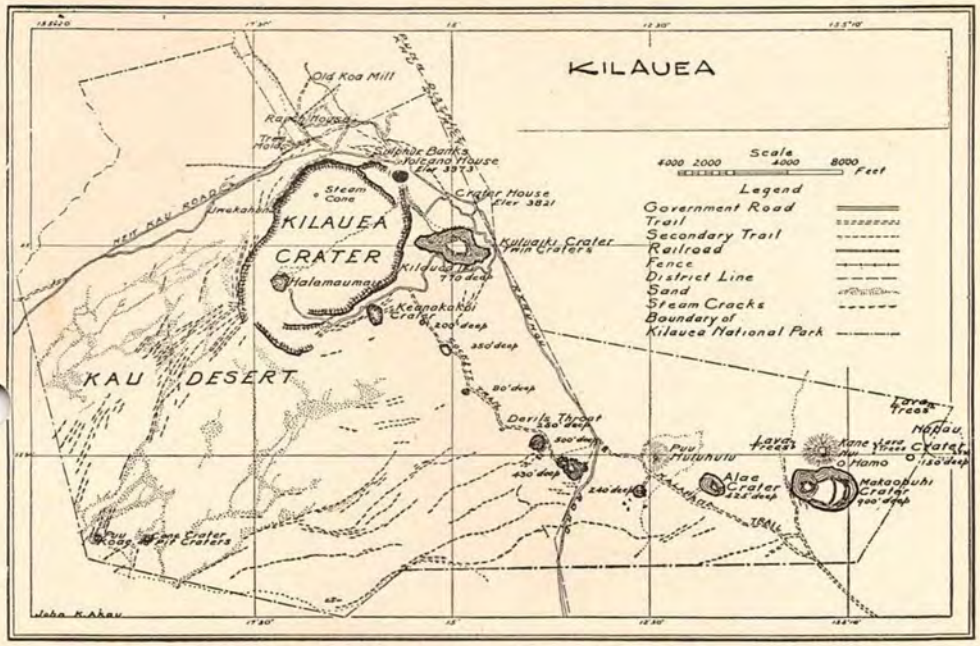


Figure 9. Southwest wall of Halemaumau November 25, 1924. Shows steaming talus at base of wall where the Kau Desert rift tunnel emerges. Photo Jaggar.

Figure 10. Halemaumau, November 18, 1924. Northwest wall and notch at top of talus. In foreground pit floor and west steam pocket at left. Photo Jaggar.

Figure 11. Tree-cast in lava in form of pit about 3 feet across, with the bark pattern moulded on the walls. These hollows are 6 to 10 feet deep. Location Volcano Golf Links at Kilauea. Roots of a modern tree shown above. Here the lava surrounded a tree that burned out. Photo Kanemori.

Figure 12. Lava tree-casts in Puna on Kapoho road. Fifteen feet high. Here the tree was encased in lava with the lava flood at the height shown. Then the flood subsided leaving the cast. Photo Kanemori.



Black spot shows location of Observatory.

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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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo and Hilea stations operate normal pendulums and the Kona station a horizontal pendulum. 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.

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CONTENTS

VOLCANIC CONDITIONS IN JUNE

Activity of Halemaumau

The general situation volcanically of the Hawaiian volcanoes at the end of the year following the great collapse of 1924 was extremely peaceful. During the spring of 1925 earthquakes and avalanches had declined in numbers except for a minor revival in the latter part of May. In June they showed another revival at the solstice, remarkable in that the greatest slides seen here for many months came at noon of June 20.

The depth of the pit has remained unchanged since the slight filling by lava in July, 1924, except for additions to the talus slopes. The surface area of the upper rim has been enlarged by caving away with maximum recession amounting to 10 or 15 feet towards the north. The greatest movement in the cracks back of the rim has been on the northeast and southwest sides. The steam escaping from the floor of the pit has gradually lost the odors of spicy sulphur and hydrogen sulphide, which could only rarely be detected in June.

That month was ushered in very quietly. There were occasional small slides from the walls of Halemaumau, but for the week ending June 3 only six seisms were registered, the smallest weekly total for six months. None was strong enough to be felt and two were avalanche tremors. Tilt was very slight northwest.

For the next week dust clouds from avalanches rose well above the rim of the pit frequently, mostly falls from the north wall, but the seismographs recorded few disturbances that could be correlated with the avalanches.

For the week ending June 10 eight local shocks and two distant ones were registered, none of them perceptible. The teleseism of 3:21 a.m., June 9, had indicated origin 4750 miles away, equal to distance of the Philippines or Formosa.

The seismic lull continued during the middle of the month. There were avalanches during the week less spectacular than those of the preceding week. A stiff breeze on June 15 raised a tremendous wall of dust cloud over the Kau Desert that stood 500 to 600 feet above the ground.

During the week ending June 17 nine local shocks were registered, all very small, seven of them on June 10 and 11, and only one showing positive preliminary tremor as index of distance; this was at 10:09 p. m., June 10, origin distance twenty-nine miles. Tilt was very slight northeast.

On June 18 there were two slides in the pit. In the evening of the 19th another. One occurred about 4 a. m., the 20th, and then began an undermining of the northwest wall with increasing slides from 9:30 to 11:30 a. m. At 11:40 a beautiful avalanche there sent a crescent of cauliflower cloud across the bottom with a roar. Then came the climax at 11:48 a. m. when the whole wall stripped off all the way up to the top with a thunderous crash that could be heard miles away. The entire pit was filled with clouds of red dust for half an hour. Yellow sulphur stain that had been visible on the east side of the bottom became obscured by the dust fall, and the seismographs at the Observatory two miles away registered vibration for two minutes.

The week ending June 24 recorded eighteen earth movements of local origin, of which six were of the avalanche type and five indicated distance of source greater than the two miles between Halemaumau and the Observatory. None was felt. Tilt was slight south-southwest.

The only notable changes for the last week of June were increase in the amount of pit vapor directly caused by heavy rainfalls, after a spell of dry weather when the steam jets on the bottom were only slightly visible.

On June 25 there was fresh debris on the northeast talus and a little sliding was heard at the northwest. On the 27th there were slides west. June 29, in dry weather, two sulphur patches southeast and in the center showed increase of yellow and creamy crystals, without any vapor at these places. The next day after a rainy night the bottom was transformed to a field emitting hundreds of tails of vapor. There were some slides on the north and northeast.

During the week ending July 1 seventeen local earthquakes were registered, five of them of the avalanche type and two were felt, namely, on June 25, with origin distance fourteen miles, and June 26, apparently two miles away. Tilting was slight to the north-northeast.

The beginning of the disastrous earthquake in Montana June 27 was registered here at 3:09 p. m. (6:39 p. m. Montana time). The Santa Barbara disaster recorded its beginning here at 4:20 a. m., June 29 (6:50 a. m. California time), the initial wave taking about six minutes to reach Hawaii.

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June 1. Occasional rock falls were heard and there was evidence in the broken soil that the cracks back of the south rim of Halemaumau had been moving.

June 4. At 4:05 p. m., on a rainy day, an avalanche fell from the west end of the north sill, caused considerable noise and sent up a small dust cloud. Steam in the pit was abundant.

June 6. There were occasional small avalanches.

June 7. Avalanches were larger and a little more frequent, mostly from the north wall.

June 8. At 4 p. m. small slides were in motion, mostly from the north wall.

June 11. At 4 p. m. the pit was quiet and only falls of individual stones were occasionally heard.

On this date the base of Uwekahuna Bluff was visited where the old ash beds were found still well exposed in places. The lens-shaped intrusive body at the base of the wall north of Uwekahuna (Daly laccolith), appears to have been occasioned by rise of lava in a fissure parallel with the wall broken down on the side toward the crater. (Finch.)

June 13. At 10 a. m. the talus slopes showed evidence at the north of considerable recent avalanching.

June 14. At 2 p. m. a brisk trade wind was blowing and dust was in motion over the Kau Desert and sometimes in Kilauea crater. A small avalanche fell from the southeast wall of Halemaumau. The walls east, north and northwest showed scars of avalanches that had fallen since the morning of June 13.

June 15. In the forenoon heavy dust clouds were rising, those in the desert reaching an elevation near 600 feet.

Owing to the position of the sun the fume cloud above Mokuaweoweo, the summit crater of Mauna Loa, could now be seen as early as 2:30 p. m. on clear days.

June 16. At 10 a. m. floor vapor was abundant and small rocks could be heard falling from the walls of Halemaumau occasionally.

June 17. At 3 p. m., at Halemaumau, the odor of hydrogen sulphide was faintly perceived.

June 18. During the day two avalanches were responsible for dust clouds that rose well above the pit rim. They fell from the northwest wall above the west end of the north sill.

June 20. (Notes by Jaggar after two months' absence.) Since March there had developed a notable increase of greenish yellow stain on the bottom lava at the east side of Halemaumau below the sulphur patches in the base of the talus there.

Between 10 a. m. and noon the pit wall was working steadily with slides at the north and northwest. It had been peeling near the northwest talus, and slides occurred every ten or fifteen minutes, some from the top of the talus, some from the upper wall farther north, and some from the gulch above the west end of the north sill. A dust cascade made a continuous vertical striation on a bulge of the wall north of the northwest talus.

The avalanching NNW increased from 10 to 11:30 o'clock, a number of the slides creating brown and reddish cauliflower clouds. There was some tendency for slides to alternate N and NW.

At 11:40 came an immense avalanche NNW tumbling its debris onto the lower part of the northwest talus above the west pocket. It made a half ring of cauliflowers horizontally across the bottom of the pit, fanning out as it went and emitting a deep thunderous roar. It was remarkable that this was all part of a process of undermining that occupied the whole forenoon, and reached its maximum almost at noon on the day representing the solstice.

At 11:50 a. m. came the grand climax in an avalanche that stripped the whole northwest wall up to the top, from the Postal Rift gulch at the rim to the two lava caverns just below the rim farther north, a width of 200 feet. The entrances of the two caverns were entirely changed and a slab of wall rock fell away for some distance back of the rim. There was a loud rumble, the whole bottom was filled with cauliflower clouds, and sliding continued for ten minutes. The pit remained partly obscured by dust for a half hour, the dust settling on the eastern sulphur patches and obliterating them.

This avalanche was the biggest since November 28, 1924, and suggested some process operating to control its occurrence just at noon and on the solstice, but there was no evidence as to what that process might be, unless it were some faint subsidence of matter under the pit. The day was sunny and warm with light southeast wind and cloudy spells. The big slide and others were registered on the seismograms at the Observatory. During the rest of the day dust from small slides rose from time to time.

June 21. Some avalanches sent up dust during the forenoon.

Exploration of the region south of the clump of koa trees in Kau Desert showed that there are ENE chasms and cracks trending along the top of ridges north of Puu Ohale, both the ridge and the cracks striking straight towards the Cone Craters and Puu Koae. These constitute a wide rift belt parallel with the southeast wall of Kilauea crater and making an angle with the 1868 cracks.

June 23. Between 9:45 and 10:45 a. m. the pit was quiet except for very small slips at the site of the recent avalanches. These had left a wide scar above the northwest talus. The little slips occurred about once in ten minutes. At the fossil talus, shown in section at the top of the northwest talus, an inclined ledge was revealed with a deep niche above.

Some sulphur stain was reappearing on the east floor and talus. In the evenings at this time vapor would condense over the pit. In sunshine steam about the bottom appeared in small amounts at the NE, N, E, SW and S taluses; also around the front of the gravel lobes of the bottom terrace made by the November landslide; and the densest steam of all was at the west pocket along the base of the northwest talus, that is, at the foot of the avalanching region. In the south talus there was a hot, dry patch bordered by steam but without any deposits. In the upper wall northwest a wet spot was steaming.

At 11:40 a. m. a red avalanche cloud rose from the northwest corner of the pit, and at 5:40 p. m. another dust cloud rose over the west side.

June 24. From 2 to 2:30 p. m. there were occasional small rock falls at the west. New talus heaps with corresponding fresh wall notches above lay in two places at the northeast. One of these notches under a more or less peeled wall east of the rift dyke appeared to be undermining the cliff as though more might be expected to fall soon. The new debris was gray and had been stripping the columnar part of the north sill. The day was windy and dry with some whirlwinds on the edge of the pit. A small avalanche NW occurred at 2:34 p. m.

There could now be detected four caverns near the top of the wall in the area stripped by the avalanche of June 20.

June 25. From 10:30 to 11:30 a. m. the pit was quiet and a little sliding was heard toward the northwest. The northeast talus had been slightly rearranged.

There was now a definite U-shaped unconformity exhibited in the wall over the northwest talus. The red ledge two-thirds of the way down the SSW wall appeared to be an old wall-crack veneer.

June 27. From 10 to 11 a. m. there was a little sliding from the north side of the west boss. With a field glass these red bosses at the west and northeast appeared to be jumbles of oxidized rock shot with intrusions and showing some bowlder-like protuberances. The ledge under the old talus section in the wall northwest appeared to be a fossil wall-crack veneer. By wall-crack veneer is meant a concentric dyke of lava formed in the wall-crack of a pit, that is, between the talus or lava fill and the wall, and usually striated while in a pasty condition when the lava fill sinks.

There is one veneer vertically striated above the east part of the north sill, and a similar shoulder is exhibited on both sides of the southwest-rift tunnel and at the high WNW niche. In the zone of the southwest rift on the southwest side of the pit there are five dykes mostly west of the tunnels.

The freshest sulphur was in the high ENE talus. Places wet with steam were the south side of the northwest talus, the frontal region of the gravel terraces on the floor, the steaming walls high up northwest and the top of the northern taluses. In contrast to these were the dry patches bordered with steam east, south and southwest in the talus slopes.

On this day, by courtesy of the army, R. H. Finch and J. B. Stone from the Observatory were taken in airplanes over the northeast rift zone east of Makaopuhi. No new lava was observed along the rift at localities other than those already known. Dead trees along one crack indicated an increase of steaming similar to that observed at Aloi crater.

Figure 13. Pictures illustrating the ball lava of 1823 in Kapapala, southwest of Kilauea. The balls were talus blocks in a chasm churned into spheres by mixture with rising lava. The mixture of spheres and new lava overflowed the chasm. Four spheres shown on the right. Photo J. A. Thomson.

Figure 14. The ball lava west side of chasm below the Kapapala-Puna trail. Shows flat upper crust of the ball-lava mixture and contact below of the ball-lava mixture on an older pahoehoe surface. There are thin layers of 1790 ash between the two. Photo Jaggar.

Figure 15. Coarse ball-lava near the Kapapala-Puna trail at the side of the 1823 chasm. Here the balls are lumpy and one or two feet in diameter. Generally they are of smaller size. Photo J. A. Thomson.

Figure 16. Casts of coarse ball-lava beside the chasm at the trail, showing flat upper crust of the ball mixture. The mixture here overlies aa. The kernel fragments in the balls are pieces of both aa and pahoehoe. The matrix lava of the mixture is pahoehoe. Photo J. A. Thomson.

June 29. At 10 a. m. of a dry, sunny day, with strong northeast wind making dust whirls on the southwest edge of Halemaumau and in the Kau Desert, there was a little slipping of rocks in the pit. Two sulphur patches had become more conspicuous than before, one near the base of the southwest talus and the other on the lava floor in the center of the pit. No steam was detectable at either place. The one in the center was whitish like yellow stained alum, and the southwestern one was bright yellow. The eastern sulphur patches were dim with dust.

June 30. At 9 a. m. after a rainy night, a vapor cloud hung over the pit, the walls were wet and brick red in color, tails of dense steam rose around the bottom and the two sulphurous patches were now steaming and partly obscured from view. Rain was drizzling and small slides were heard falling at the northeast and north sides of the pit.

In contrast to the day before the transformation of the bottom by rain vapor was remarkable. The west pocket was giving up hundreds of tails of rapid rising white vapor. There was much of it in the center and at the northeast and south taluses. There was less at the north, east and southwest taluses. The south talus appeared hottest showing blue gas about the base of the steam jets. During a quiet spell not the slightest whisper of blowing noise could be detected from any of these jets. The driest rock surfaces were the north sill and the west boss intrusive, places which were red hot until August of 1924.

SEISMOMETRIC RECORD

During the month ended midnight June 30, 1925, 51 local earthquakes and four teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h., 30 m. slower than Greenwich.

Abbreviations have meanings as follows: vf=very feeble; f=feeble; s=slight; m=moderate; d=instruments dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

June
1—a 9:43 a. m. vf.
3—a 6:58 a. m. vf.
4—a 2:14 a. m. vf.
5— 8:17 a. m. vf.
6— 2:54 a. m. vf.
10:58 p. m. f.
8— 3:34 p. m. vf.
9— 2:18 p. m. vf.
10— 2:10 a. m. vf.
5:53 a. m. vf.
9:18 p. m. vf.
10:08 p. m. vf.
10:09 p. m. vf, △20.
11— 5:17 a. m. vf.
6:13 a. m. vf.
11:17 a. m. vf.
11:44 a. m. vf.

June
13— 4:13 a. m. vf.
17— 12:11 a. m. vf.
8:38 p. m. vf.
18— 12:21 a. m. vf.
2:34 a. m. vf.
2:43 a. m. vf.
6:41 a. m. vf.
19— 12:23 a. m. vf.
a 2:23 a. m. vf.
a 4:46 a. m. vf.
20—a 12:44 a. m. vf.
9:33 a. m. vf.
10:15 a. m. vf.
a 11:48 a. m. f, large avalanche at pit.
4:23 p. m. vf.
4:46 p. m. vf.
21— 7:53 a. m. vf.

June
23—a 11:44 a. m. vf.
24— 5:32 a. m. vf.
a 10:08 a. m. vf.
5:35 p. m. vf.
25— 5:56 a. m. s, fl, △14.
11:01 a. m. vf.
26— 12:24 a. m. vf.
10:42 p. m. s, △1, fl.
27— 12:53 a. m. vf.
29—a 4:52 a. m. vf.
a 8:47 a. m. vf.
9:01 a. m. vf.
a 9:17 a. m. vf.
9:23 a. m. vf.
a 9:31 a. m. vf.
30— 7:40 a. m. vf.
3:58 p. m. vf.

Teleseisms

June 4.....1:47 a. m., slight.
9.....3:21 a. m., slight, △ 4750 miles.
27.....3:09 p. m., slight, in Montana.
29.....4:20 a. m., moderate, in Santa Barbara.

Harmonic Tremor

This type of tremor was absent in June.

Microseismic Motion

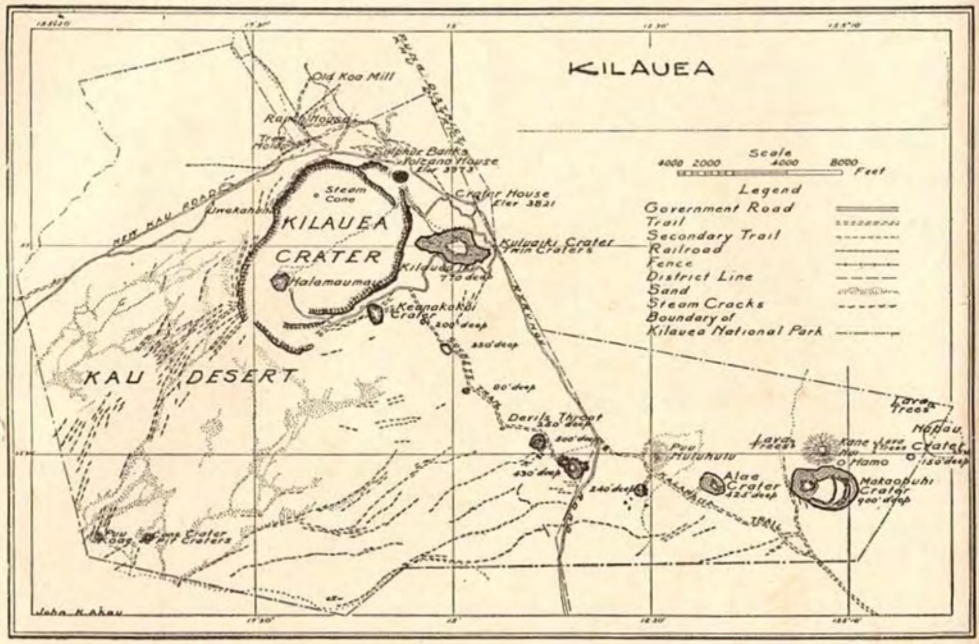
The amplitude of microseisms was slight throughout the month.

Tilting of the Ground

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

May 31-June 6	0.5 second	N.
7-13	1.5 seconds	SSW.
14-20	1.2 seconds	NNW.
21-27	1.3 seconds	NW.

T. A. JAGGAR,
Volcanologist.



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MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

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CONTENTS

AN INTERESTING LAVA-MOULD OF A CARBONISED TREE-TRUNK FROM HOKIANGA, NORTH AUCKLAND, NEW ZEALAND

By J. A. Bartrum, Auckland University College

Through the kindness of Mr. K. H. Cumber, headmaster of the Taheke school in the Hokianga district of North Auckland, the interesting specimen illustrated by Figures 17, 18 and 19, was recently presented to the Auckland Museum, where the writer of this note has been enabled to examine it through the courtesy of the Curator, Mr. G. E. Archey.

The specimen is believed to be the lava-mould of a tree embedded in lava and there converted to charcoal. The liquid rock covered the fallen hollow trunk and entered its central hollow. As a result of shrinkage consequent upon carbonisation, a set of radial cracks developed along many of the medullary rays, and another set transverse to these and to the length of the log. Simultaneously the liquid lava filled the cracks, and produced a perfect mould

of the wedge-shaped blocks of charcoal by means of lamellae of finely vesicular basalt which are often no thicker than a sheet of paper. There is now no remnant of the original wood or charcoal.

There have been successive outpourings of basalt in an extensive area south from the shores of Hokianga Harbor during a period ranging from Pliocene to sub-Recent times, but the exact date of the flow from which this mould was derived is not known.

The writer cannot recall having seen any closely similar examples of such igneous injection described or illustrated in the literature at his disposal, and therefore forwards the following description and photographs in the hope that they may prove interesting to others.

The lava "log" seen lengthwise in Fig. 17 has a length of 2 feet and a maximum diameter of a little under 1 foot. The diameter of the hollow of the trunk which is now represented by a solid core of basalt, has been approximately 7 inches. The infilling basalt is fairly finely vesicular, and has a distinctly scoriaceous surface (the lower one in Fig. 18), which is believed to represent the base of the lava flow that covered the original tree-trunk, though no detailed information likely to throw light upon this point is at present available. It is by no means impossible to regard this scoriaceous surface as the upper one of the flow, though there are several arguments adverse to this view. It appears probable, moreover, that the lower part of the log had rotted away, adjacent to the ground in which it rested, before it was buried in the liquid rock, for this supposition would allow ready explanation of the asymmetry of the periphery of the "log."

The radially disposed injected sheets prominent parallel to the length of the "log" in Figs. 19 and 17 seldom exceed ⅛ inch in thickness, and have a relatively coarsely vesicular central zone. They are discontinuous both longitudinally and transversely in the radial planes in a manner comparable with the mode of development of medullary rays in plant stems, though on a larger scale than is usual. Presuming that this detail of structure is genetically related to original medullary rays, its scale would indicate that the original tree was probably a dicotyledon. The transverse lamellae are less closely spaced than the longitudinal radial ones; their thickness ranges from that of writing paper up to ¼ inch, or occasionally more. Individual sheets are more uniform in thickness and more continuous in extent than the radial ones; like these latter, their central portions are vesicular.

A feature of especial interest concerns the radially injected lamellae, and is illustrated in the upper half of Fig. 17, and the left-hand upper portion of Fig. 18. Over an arc-length of about 5 inches the lamellae have been bent over in a gentle curve. These recumbent lamellae can further be seen in Fig. 18, to abut on their lower side against others which rise very steeply from below, and meet the upper set at an angle of approximately 60°.

The curvature of the upper lamellae can be explained as a result of a downward settling of the series under the influence of gravity before solidification occurred. It is difficult, however, to explain the deviation of the lower set of lamellae from true radial position. Apparently it is a result of local collapse of the injected mass during the process of injection. It is, in fact, conceivable that the flexure of the upper series was inaugurated by such collapse.

—x—

VOLCANIC CONDITIONS IN JULY

Activity of Halemaumau

During the month of July numbers of local earthquakes per week waxed to a minor maximum and waned, the tilting of the ground turned from the average southwesterly trend of the springtime to the beginning of northeasterly such as is characteristic of the autumn, and the underground lava remained invisible. The summit crater of Mauna Loa was visited July 24 and found to be fuming in two places as usual. No remarkable change there was observed.

During the first week of July changes in Halemaumau were small. There were little rock slides at the southwest July 3, very small ones west and northwest July 4, hardly any July 5 during the period of observation; some north and northwest July 7, along with fresh debris exhibited on the northeast talus, and on July 8 there had been a strong avalanche, leaving a scar in the northeast wall and debris and dust below, probably occasioned by an earthquake at 5:45 that morning, which was generally felt on the island of Hawaii. There were white stains on the pit wall, a vapor column condensed above the rim at night and during humid weather, and there was always hot steam on the bottom.

The week ending July 8 registered twelve local earth movements, of which three were perceptible earthquakes. A distant earthquake was recorded at 3:51 a. m., July 7. Tilt for the week was very slight to the southwest.

The second week produced increased numbers of local earthquakes along with somewhat unusual avalanches on the west wall of the greater crater Kilauea. Some earthquakes were felt that gave evidence of centering in Mauna Loa and there was a little avalanching in Halemaumau pit. There was a change to northerly tilt at the same time and the whole volcanic system appeared to have augmented seismic motion.

On July 10 avalanches at the pit made numerous dust clouds, and on July 15 there was a considerable avalanche on the northeast wall which stripped part of the intrusive sill and left fresh debris and red dust on the bottom. Three avalanches from the Uwekahuna wall of Kilauea occurred July 14 and 15, but no seismic movements were noticed simultaneously with them. Twenty-seven local earthquakes were registered for the week ending July 15, of which three were of the avalanche type. Two earthquakes of the evening of July 9 and another at 3:23 a. m., July 14, were felt at Pahala, the last indicating an origin twenty-seven miles away, and strongly suggesting movement under Mauna Loa. At 4:25 p. m., July 12, an earthquake felt at the Observatory suggested vertical motion and was accompanied by a rumble.

The third week exhibited little of interest at Halemaumau. Small dusty slides were seen by anyone remaining there a half hour or more. A northeastern avalanche July 16 was heard at the Observatory and made a dust cloud. One was seen on the 17th falling from the southeast wall, which is unusual. A remarkable fumy cloud was seen over Mauna Loa on the evening of the 10th.

The increase in numbers of local earthquakes instrumentally registered appeared to be systematic the first three weeks of July, the frequency per week respectively being twelve, twenty-seven and thirty-four. At least ten of the jarrings of this third week were of the type characteristic of the avalanches of Halemaumau and the dust of numerous avalanches was seen. Some of these slides were big, especially two near midnight July 18-19 when the northeast rim of the pit was carried away along with a new trig station. These falls of wall rock left the bottom covered with much red dust. A remarkable slide on the afternoon of July 17 started at a brick red patch in the wall and made a rose colored cauliflower cloud and a purplish red streak. Three perceptible earthquakes occurred respectively on July 16, 18 and 19, the second accompanied by rumbling noise. Tilting of the ground was very slight to the west.

The last week of the month accentuated what had been much observed during the summer, namely, the production of heavy dust clouds in the Kau Desert through the action of the northeast trade wind. It is evident that the ash and sand of 1924 are being greatly rearranged by wind, and it is easy to see how the sand dunes of the southern part of the desert were built out of the ash of 1790.

During the night preceding July 29 after heavy rain there was a fall of rock from the northeast wall, leaving a straight sided upright scar of fresh dry rock in the wall, and a new dump of debris at the base. There were numerous avalanches July 25 and others on the 27th.

The earthquake frequency diminished to twenty-seven shocks for the week ending July 29, and fourteen of these were without phases, probably avalanche jarrings. There were perceptible earthquakes July 23 and 27, the latter indicating an origin distance of nineteen miles. Harmonic tremors on the seismograms of the forenoon of July 25 and the morning of July 29 resembled the type of motion ordinarily characteristic of fountaining lava in Halemaumau. No lava, however, appeared. Net tilt for the week was slight SSW, varying from moderate NE to moderate SW.

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July 1. There had been drizzle in the night and the morning was sunny. At 9:15 a. m. the vapor jets had diminished in volume. The lower stain on the southwest talus was whitish now instead of yellow as on the 29th. The central stained patch was still steaming. During ten minutes the pit was rather quiet. It was observed that the vertical groove made by slides at the west end of the north sill, a conspicuous feature three months before, had so caved away as to be no longer in evidence.

July 3. At 5 p. m. small rock slides were heard from the vicinity of the southwest rift cavern. There were white deposits on the northeast and northwest walls.

July 4. At 11 a. m. the pit was dry as was the day. Bottom salts were a little more yellow. There was remarkably little vapor on the south talus and somewhat more at the west pocket. Rocks slid occasionally on the west and northwest walls. The northern taluses and the high northwest wall were wet. On the south and northeast wall there were white stains. No vapor whatever hung over the pit, but some of it rose at cracks back of the rim east, northeast and southwest.

July 5. At 11 a. m. in cloudy, dry weather, the bottom vapor was denser west, center, south and southwest. There was very little rock motion. The south talus had a dry streak up the middle between wet areas on both sides.

July 7. At noon in drizzling weather the principal bottom steam was at the west pocket and south talus. Whitish salts were now reappearing at the wall base southeast. A similar bank of steaming solfataric wall had appeared high up the cliff between the west boss intrusive and the southwest talus. There was a little fresh debris on the northeast talus and stones were heard falling N and NW.

July 8. At 2:20 p. m. one small avalanche fell at the northeast wall. A fresh scar and talus at the columnar part of the north sill indicated a recent avalanche probably occasioned by the earthquake registered at the Observatory about 5:45 a. m. The day was cloudy, steam was dense at the eastern rim cracks, and moderately so in the pit.

July 10. Several dust clouds rose from the pit during the day, notably about 8 and 11 a. m. and 2:15 p. m. At 2:30 p. m. an avalanche occurred at the west corner of the pit. A small yellow patch was observed on the northeast wall east of the rift dyke.

July 13. At 4 p. m. the pit was visited with a Congressional party and it was discovered that the cavern near the Little Beggar known as Pele's Bathroom, which is generally hot, had become rather cool. It was also noticeable in crossing the 1919 lava that rather hot steam emerges from it as though the 1919 heat was still retained.

The pit bottom was unchanged, there was not much steaming, and an avalanche fell at the northeast side of the pit from the upper wall to the columnar part of the north sill.

July 14. At noon the pit walls were working a little NW and NE. It was a dry windy day with dust whirls, and about 8 a. m. a small avalanche had been seen from beneath the high part of Uwekahuna Bluff. In the afternoon there were others along other parts of that cliff.

July 15. At 7:20 a. m. an avalanche fell from the south part of Uwekahuna cliff, and another occurred at the same place about 9 a. m.

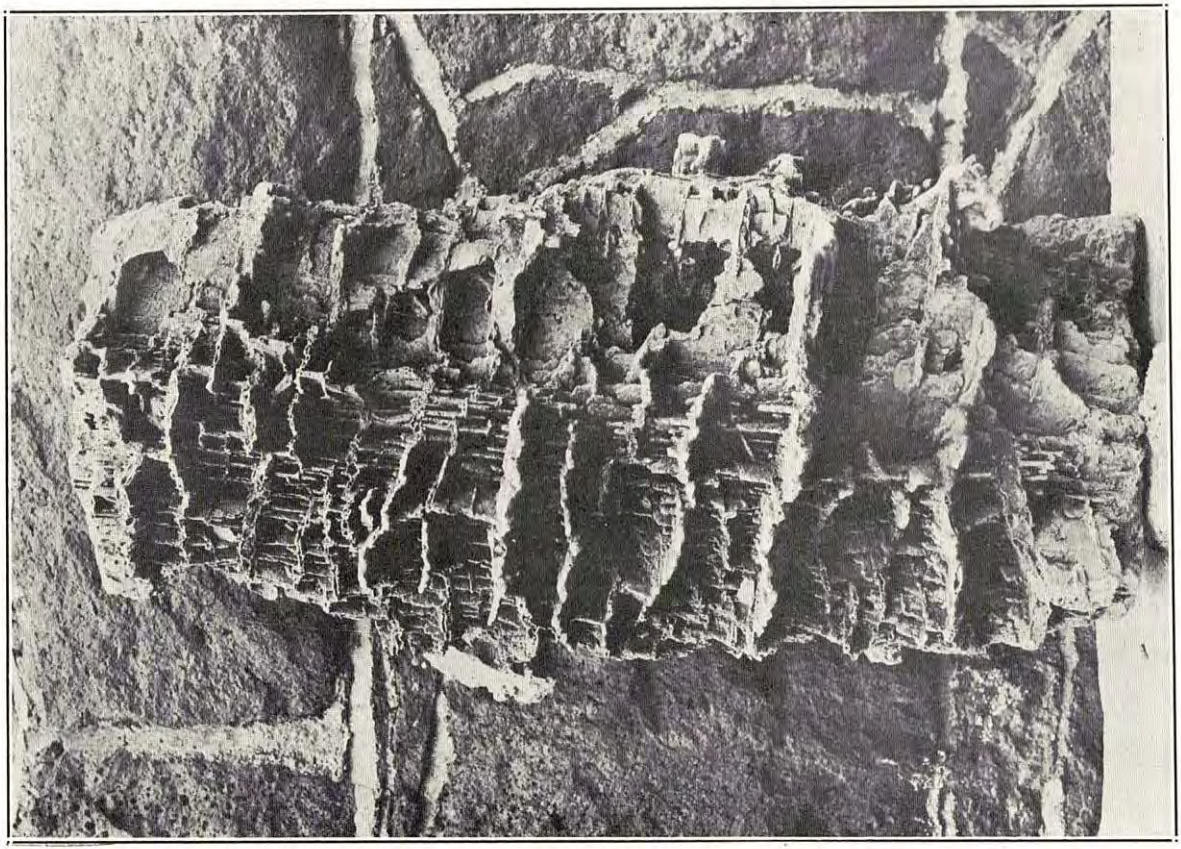


Figure 17. Lava mould of carbonized tree-trunk. Longitudinal view. The length is two feet. Photo Bartrum.

Figure 18. Lava mould of carbonized tree-trunk, end view. Diameter about 1 foot. Photo Bartrum.

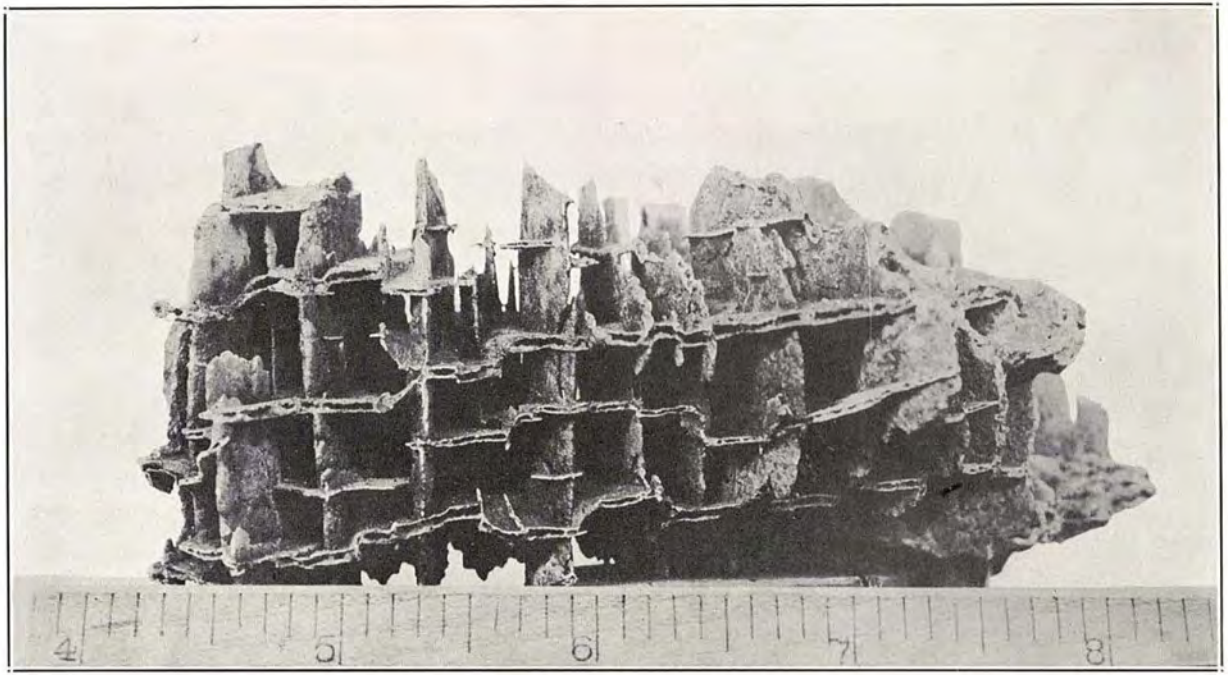


Figure. 19. Separated fragment of "log" illustrated in Figure 17. The vertical lamellae follow earlier medullary rays, and are somewhat curved. Photo Bartrum.

At 8:05 a. m. avalanche dust rose from the northeast side of Halemaumau. At 2:30 p. m. the pit was visited in calm weather with light southerly puffs of wind. There was new avalanche debris and red dust on the northeast talus from caving of the wall above the east end of the north sill. At the north rocks were heard falling. Blue fume was noticed mixed with the vapor at the east sulphur patch on the floor of the pit and at the eastern edge of the vapor vent in the center of the pit. The whole north talus and some of the north floor was red with fresh dust. At the southeast rim the odor of spicy sulphur was perceptible.

July 16. The rim of the pit was examined on all sides between 10 a. m. and 12 noon. Much of it had fallen away at the northwest. Sulphur stain was observed in a steam patch on the west side of the south talus and the sulphur patches on the floor were brighter yellow than before. Hot steam was rising from chasms near the edge of the pit NW, NE, SW and E. Looking toward the south end of Uwekahuna cliff the wall was seen to be stained with streaks of the new ash that had slid or washed down from above and small dusty slides remained at the place of the recent avalanches in that cliff. It is noticeable in walking around the pit what a large number of red fragments exist in the 1924 debris. At 6:15 p. m. an avalanche at the pit made a roar and sent up dust.

July 17. At 3 p. m. new trig stations were put up about the pit consisting of upright pipes with diamond-shaped plates of galvanized iron rivetted to them. At 4:15 p. m. an avalanche fell from a brick red patch in the northeast wall at the lower end of the fossil talus section that overlies the western half of the big sill. The avalanche exhibited extraordinary color making a rosy cauliflower cloud and leaving a rose colored streak on the wall.

There were occasional small slides including one from the southeast wall. From the western rim of the pit a massive intrusive body was detected showing under the edge of the south talus. Much rock in the last few months had peeled away from the region of the southwest caverns so as to change the form of the entrances. Some blue fume showed in the steam of the south talus.

July 18. Between 9:30 and 11 a. m. the SE, E, NE and N trig stations were set up. Small slides were seen at the north and northeast. Sulphur stain had increased on the east side of the floor and at the SSW talus.

In the late afternoon between 5:30 and 6 p. m. a remarkable cloud stood over Mauna Loa with fringes like a rain shower but with milky fume above. It appeared to be a convectional rain cloud mixed with fume. At sundown it cleared away showing only the usual slight fume veil over Mokuaweoweo.

July 20. In the forenoon the remainder of the trig stations were set and location of them was started. A curious thing had happened. It appeared that on the night of 18-19 July avalanche seisms had been recorded strongly on the seismographs and that afternoon a number of trig stations had been set up. Now the northeast flag was found to have been carried away along with the rim and that particular wall was stripped freshly all the way up to the top. A. Lancaster reported observing a big avalanche at that corner about 8 a. m. July 19.

Today an avalanche was seen above the northwest talus at 11:30 a. m. and a few trivial slides occurred at the north and northeast. The bottom was dusty from the recent avalanches.

July 21. At 4 p. m. there was a little rock movement northeast and northwest. There was but little vapor. The avalanches of the 19th had dusted the east and north taluses and the bottom area red and obscured the new sulphur and sulphate stains with dust.

July 22. From 11:30 a. m. to noon there was slight sliding NW and NE. Blue fume appeared on the eastern lava floor and there was much dust on the bottom.

July 24. At 5 p. m. a hairline of fresh cracking was observed across the road and for a short distance on each side near the auto parking place. Vapor from the rim cracks was abundant.

July 27. At 10 a. m. an avalanche occurred at the pinnacles east of the south station and at 10:15 a. m. another on the northeast side of the pit. There was some rock motion at other times but generally the pit was very quiet. New flags were set up northeast and northwest.

July 28. At 11 a. m. during surveys on the west rim of Kilauea crater a cloudburst of rain fell there making a roar on the lower Uwekahuna terraces and sending cascades of mud over the cliff. A vapor cloud hung over the pit.

July 29. At 8:45 a. m. the walls of the pit were red from the heavy wetting with rain water, the north sill and west boss remaining drier than the rest. Heavy fresh avalanche material lay dry on the northeast talus under the middle of the north sill west of the big dyke. Above this was a stripped area of wall in a vertical band extending half way up to the rim. At 9:15 a. m. an avalanche here fell athwart the bright red deposit making red dust. Small falls were heard NW and SW, the latter as though inside the rift tunnel. On the previous night the seismograms had exhibited a quarter hour of harmonic tremor as though possibly the southwest rift were in motion. A yellow patch was seen to be developing in the upper part of the north wall where formerly there was fume.

July 30. At 4 p. m. there was fresh white stain on the east side of the floor, some small slides occurred, and new fragments had fallen on the northeast talus.

SEISMOMETRIC RECORD

During the month ended midnight July 31, 1925, 109 local earthquakes and one teleseism were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h., 30 m. slower than Greenwich.

Abbreviations have meanings as follows: vf=very feeble; f=feeble; s=slight; m=moderate; d=instruments dismantled; fl=felt locally; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

July

1— 4:10 a. m. vf.
7:06 a. m. vf.

2— 9:31 a. m. vf.
10:57 p. m. vf.
11:10 p. m. vf.

3— 3:33 p. m. vf.

4— 1:30 a. m. vf.
7:55 p. m. s, △22.

5— 7:37 a. m. vf.

6— 1:47 p. m. m, d, △11.
3:30 p. m. f, △11.

7— 9:25 p. m. vf.
11:35 p. m. vf.

8— 5:45 a. m. s, felt all over Hawaii.
11:06 a. m. vf.
6:25 p. m. vf.

July

9— 4:35 p. m. vf.
6:57 p. m. vf.
8:49 p. m. vf, felt in Pahala.
11:35 p. m. vf.

10— 1:09 a. m. vf.
1:07 p. m. vf.

11— 3:16 a. m. vf.
8:24 a. m. vf.
12:22 p. m. vf.
1:10 p. m. vf.
a 2:17 p. m. vf

12— 4:58 a. m. vf.
5:02 a. m. vf.
4:25 p. m. s, fl, accompanied by rumble and appreciable vertical motion.

July

13—a 4:37 a. m. vf.
11:08 a. m. vf.
11:53 a. m. vf.

14— 3:23 a. m. s, △27.
7:18 a. m. vf.
9:12 a. m. vf.
9:24 a. m. vf.
9:25 a. m. vf.
9:54 a. m. vf.
1:59 p. m. vf.

15— 1:53 a. m. vf.
a 9:29 a. m. vf.
11:42 a. m. vf.
12:49 p. m. vf.
a 1:45 p. m. vf.
10:31 p. m. vf.

16— 6:23 a. m. vf.
8:16 a. m. vf.

a 8:38 a. m. vf.
a 9:11 a. m. vf.
11:36 a. m. vf.
a 12:31 p. m. vf.
11:57 p. m. s, fl.
17— 1:27 a. m. vf.
6:30 a. m. f, fl.
10:09 a. m. vf.
a 12:29 p. m. vf.
a 1:51 p. m. vf.
7:44 p. m. vf.
18— 8:25 a. m. vf.
8:52 a. m. s, fl.
19— 12:49 a. m. vf.
a 1:28 a. m. vf.
a 1:44 a. m. vf.
a 1:50 a. m. vf.
2:00 a. m. s.
2:01 a. m. vf.
2:02 a. m. s.
8:46 p. m. s, fl, △2.
9:02 p. m. vf.
20— 5:56 a. m. vf.
1:25 p. m. vf.
6:25 p. m. vf, f, △2.
21— 1:05 p. m. vf.
22— 4:58 a. m. vf, △2.
6:18 p. m. vf.
8:01 p. m. vf.
8:02 p. m. vf.
23—a 8:06 a. m. vf.
a 9:10 a. m. vf.
a 10:13 a. m. vf.
8:57 p. m. s, fl, △2.
24—a 8:00 a. m. vf.
a 8:49 a. m. vf.
a 11:46 a. m. vf.
8:56 p. m. vf.
25— 1:16 a. m. f.
2:09 a. m. vf.
a 8:06 a. m. vf.
8:14 a. m. vf, △2.
a 9:02 a. m. vf.
a 9:55 a. m. vf.
a 10:45 a. m. vf.
26— 2:28 p. m. vf.
a 6:05 p. m. vf.
27— 2:42 a. m. s, fl, △19.
a 8:48 a. m. vf.
a 11:57 a. m. vf.
a 2:02 p. m. vf.
28—a 8:41 a. m. vf.
9:24 a. m. vf.
9:41 a. m. vf.
30— 3:49 a. m. vf.
8:11 a. m. f, △13.
9:51 a. m. vf.
31— 4:38 a. m .vf.
8:24 a. m. vf.
8:31 a. m. vf.
4:40 p. m. vf.

Teleseism

July 7.....3:51 a. m., moderate.

Harmonic Tremor

This type of tremor was absent during July.

Microseismic Motion

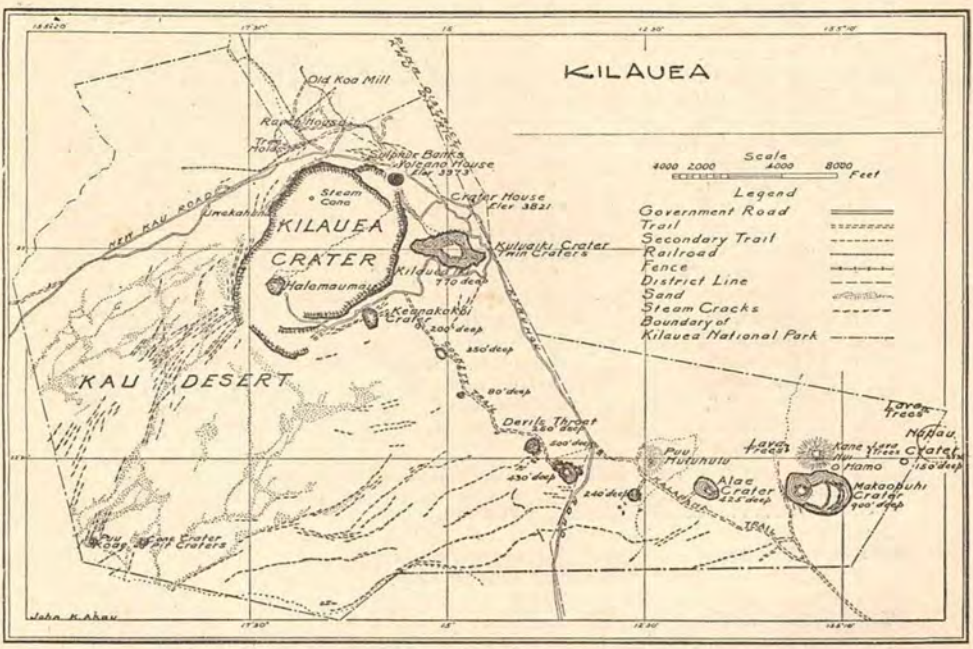
The amplitude of microseisms was slight throughout the month.

Tilting of the Ground

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

June 28-July 4.....0.6 second W.
5-11.....0.2 second NNW.
12-18.....1.0 second WSW.
19-25.....2.1 seconds NE.
26-Aug. 1.....0.2 second 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, Volcano House, 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, Hilo and Hilea.

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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo, Hilea and Kona stations operate horizontal pendulums. Their seismograms are sent to the Observatory.

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CONTENTS

VOLCANIC CONDITIONS IN AUGUST

Activity of Halemaumau

The beginning of August found the Halemaumau pit at Kilauea a large quiet cauldron where no glow of magma has been seen for a year. The last glow observed was a little incandescence in large gabbroid intrusions which are still seen in the lower walls of the pit. In August of 1924 they showed slight red glow in cracks and on surfaces peeled off by avalanches, this being incandescence remnant from what was revealed in the great engulfment and breaking away of the walls that occurred during the explosive eruption of May, 1924. These bodies are still hot as shown by their dryness after rain. The last actual flowing lava in the pit ended its activity just a year ago, leaving a rusty lava floor which still persists, overlapped by avalanche debris.

For a week ending August 5 motion in the pit was slight. Even avalanching was reduced to a minimum. There was some new red debris on the northeast talus. There were very high winds, dry days and wet days, but none of these produced slides.

In the seismograph cellar microseismic movement became large August 1 and 2, and there were destructive sea waves on the coast due to northeast gales. For the week there were twenty-four local earthquakes and tremors, none felt. An earthquake felt on Oahu, 9:18 p. m. July 30, was not recorded

here. Most of the local disturbances appeared to originate farther away from the Observatory than Halemaumau, and a shock at 8:11 a. m. July 30 indicated origin distance thirteen miles. Tilt was moderate to the NNW.

In the second week there were eleven local seismic movements of which five appeared to be of the avalanche type. Most of the others were very small, and from origins apparently more distant than the pit. The pit showed sulphur increasing about the eastern and southern edges of the bottom. During an inspection of two hours the forenoon of August 9 small avalanches averaged every fifteen minutes in interval from different parts of the wall. That morning a big slide had made a dust cloud visible at a distance. This had fallen from the middle of the big northeastern intrusive sill so as to create a new notch in the wall and a new cone of talus below. Tilting for the week ending August 12 at the Observatory was moderate SSE.

The week ending August 19 was remarkably quiet both seismically and volcanically, only ten earthquakes being recorded, all small and unfelt. Also there was no tilt apart from the diurnal movement. For five days from the 10th to the 14th there were no seismic movements at all. A distant earthquake was registered on August 19 with indicated distance about 3000 miles. The only phenomena observed at the pit were light slides, fresh white sulphates in places and a little fresh stripping of the wall. The southwest-rift tunnel was observed to be more filled with debris than formerly. A sulphur smell at the southeast edge of the pit was noticed August 18. There had been very little of this odor lately, and the hydrogen sulphide odor, which a year ago was strong even miles away to leeward, was now no longer noticed.

During the next week the pit when visited was almost perfectly still. Fifteen earthquakes were registered, two of which on August 19 indicated an origin forty-one miles away, one of them felt in Hilo and Kohala. Four of the tremors were of the avalanche type. Tilting was very slight to the north. At 4:05 a. m. August 21 a bright meteor was observed at Kilauea, Kohala and Kona.

At the end of the month steam was heavy on the taluses after much rain and blue fume was mingled with it along the east edge of the floor. Fresh debris fell on the northern slopes, and an upward directed cavernous hole was seen to be developing in the wall above the northwest talus.

There was a very notable development of spasmodic tremors increasing about September 1. For the week ending September 2 the seismograms showed twenty-seven local earthquakes and thirty-six of these tremors. None of the seisms was felt here. A shock at 9:03 p. m., August 28, had indicated distance to source forty-three miles and was plainly felt in Kona. One on August 29 had distance indicated at twenty-five miles. Tilting was slight to the northeast, this being the season for development of northerly tilts.

JOURNAL, AUGUST, 1925

August 1. From 10 to 12 a. m. there was strong northeast wind blowing dust all over Kilauea crater and Kau Desert. No big slides occurred in the pit. An inspection of the southern terrace of Uwekahuna Bluff discovered there many large fragments and impact pits thrown out from Halemaumau in 1924.

August 2. At 10 a. m. during a short visit only one slight movement of rock was heard.

August 3. From 9 to 12 a. m. there was high wind but only one slide was heard in the pit. A whitish patch was observed at the top of the steaming area on the south talus. It was noticeable that the yellow color of sulphur in the bottom deposits is limited to the southeastern half of the pit.

August 4. During a long day spent in surveying at the pit rim only trivial small slides were heard and vapor jets were small. The weather was dry and sunny.

August 5. At 2 p. m. there was no change and no slides occurred.

August 6. The sulphur on the east floor and east talus appeared a little more abundant. A visit to the 1920 chasm in the desert showed that the surface ash of 1924 was being washed and blown away leaving much thinner layers than at first.

August 7. At 7:30 a. m. a cloud of avalanche dust rose from the pit.

August 9. A big avalanche cloud at the pit was reported in the morning. From 9:30 to 11:30 a. m. eight slides of small size were observed, of which the two largest fell from the red or upper portion of the west boss; four fell from the middle and west parts of the north sill; and two from the south corner of the pit. It was a calm morning and light airs started noisy whirlwinds at hot cracks on the southwest rim of the pit. These made a blowing noise such as might easily be mistaken for a steam jet in the pit. A sulphur spot and whitened area was definitely getting brighter colored at the base of the east talus. The caving away of the wall under the northeast station had developed on the face of the cliff a vertical half-shaft or groove stained with sulphur, of arc curvature in plan like the remnant of a vertical tube.

West of this place on the northeast rim there was a notch created by the caving in and subsidence of a large block of the rim rock where an upright cavern pitching down at a high angle was discovered some months ago. Farther down the wall at the lowest sag of the north sill could be seen the largest fresh break in the present pit wall. This was a place that had scaled off shaped like the hollow of a clam shell and extending 300 feet up the wall from the top of the sill. Below was a cone of fresh purplish talus in large blocks reaching vertically half way across the thickness of the sill. The talus all around was reddened with the dust of avalanches at this place, the redness being occasioned by a bed of very bright red oxidized material at the foot of the ancient fossil talus the cross-section of which overlies the sill.

August 10. At 3:30 p. m. to an observer standing on the northeast rim a slight boom was heard underground without any perceptible earthquake and a few rocks fell in the pit.

August 11. At 3:30 p. m. no slides occurred, but the north talus appeared to have been added to.

August 12. The pit was very clear and no changes appeared.

August 13. At 3 p. m. there was a little sliding at the west boss. The niche over the northwest talus had lost its former overhang that had made it a kind of cavern and there was fresh debris below.

August 16. At 3:30 p. m. the weather was rainy, there was the usual increase in vapor, and the pit was quiet.

August 17. In the forenoon the pit was very quiet and dry. Hardly any vapor condensed above the south talus. Seen from the northeast rim of the pit the upper tunnel of the southwest rift in the wall of the pit appeared more filled up in its bottom part than formerly.

August 18. At 5 p. m. there was a smell of sulphur at the southeast rim. At a steaming patch in the center of the bottom area white sulphates appeared to be fresh. There were no signs of new debris on the talus slopes.

August 19. At 2:30 p. m. some light sliding during a quarter hour was heard twice from the northwest wall. There had been fresh stripping of the west wall over the north end of the west boss. At the south side of the boss and also on the northeast wall there were fresh white stains. There was little bottom steam except at the west pocket.

August 21. At 10 a. m. the pit was dry and still and gave one the impression of being more motionless than at any time since the explosive eruption. There were no changes and no slides.

August 22. In the forenoon the yellow spot at the base of the east talus appeared to be brighter than before.

August 25. At 10 a. m., after rain, steam in the pit was abundant and rising above the rim and the inner walls were remarkably red.

August 27. At 2:45 p. m. the pit was rainy and steamy and steam rose at the northeast talus as well as at the usual places south, west and center. Blue

sulphur smoke was mixed with the steam at those places where sulphur habitually deposits along the east edge of the floor, and also at the south talus. Single rocks were heard falling towards the west.

August 29. At 2:45 p. m. some rocks fell at the northwest. The niche above the northwest talus was seen to be extending itself northward into a cavern directed upward. Fresh debris lay on the talus slopes NW, N and NE. The first two were red, and the latter gray from the columnar rock of the north sill. Higher up at the northeast above the bend of the sill there appeared a heavily oxidized brick red area.

August 30. At 2:30 p. m. the pit was quiet except for isolated small slides. The southwest and northeast talus cones appeared to be growing in height.

August 31. At 2:30 p. m. rocks were in motion a little at the northern wall. A spot growing yellow appeared to be hot at a rock ledge above the top of the south talus. Individual new fallen stones appeared on the northeast and northwest talus heaps. Steam rose from the upper part of the face of the northwest wall.

SEISMOMETRIC RECORD

During the month ended midnight August 31, 1925, 94 local earthquakes and one teleseism were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 m. slower than Greenwich.

Abbreviations have meanings as follows: vf=very feeble; f=feeble; s=slight; △=indicated distance to origin in miles; and a=a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

August

1— 1:08 p. m. vf.
6:01 p. m. vf.
11:59 p. m. vf.

2— 1:20 p. m. vf.
1:42 a. m. vf.
3:33 a. m. vf.
12:48 p. m. vf.
1:13 p. m. vf.

4— 12:01 a. m. vf.
12:28 a. m. vf.
1:03 a. m. vf.
4:37 a. m. vf.
8:55 a. m. vf.
12:56 p. m. vf.
1:15 p. m. vf.
2:50 p. m. vf.
7:02 p. m. vf, △2.

6— 12:18 p. m. vf.
2:41 p. m. vf.
9:25 p. m. vf.

7— 7:22 a. m. vf.

8—a 7:15 a. m. vf.
a 8:24 a. m. vf.
a 9:49 a. m. vf.
a 11:09 a. m. vf.

August

9—a 12:41 a. m. vf.
2:59 p. m. vf.
8:13 p. m. vf.

15— 6:21 a. m. vf.
9:00 p. m. f, △3.

16— 4:31 p. m. vf.

17— 3:15 a. m. vf.
11:21 a. m. vf.
11:55 a. m. vf.

18— 6:33 a. m. vf.
5:01 p. m. vf.

19—a 1:20 a. m. vf.
5:07 a. m. vf.
11:32 a. m. s, △41, felt in Hilo.
3:48 p. m. s, △40.
4:20 p. m. vf.

20— 5:29 a. m. vf.
a 11:25 p. m. vf.

21— 5:02 a. m. vf.
6:04 a. m. vf.
11:41 p. m. vf.

22— 7:49 a. m. vf.

23— 9:40 a. m. vf.

24— 7:26 p. m. vf.

August

25—a 7:41 p. m. vf.
a 7:49 p. m. vf.
a 7:52 p. m. vf.
7:56 p. m. vf.

26—a 9 tremors between 10:30 and 11:15 a. m.

28— 1:06 p. m. vf.
6:40 p. m. vf.
6:54 p. m. vf.
7:03 p. m. vf.
7:49 p. m. vf.
8:51 p. m. vf.
9:03 p. m. f, △43, felt Kona and Honokaa.

29— 2:42 p. m. f, △25.

30— 11:17 p. m. vf.
11:31 p. m. vf.

31— 12:03 a. m. vf.
1:10 a. m. vf.
3:15 a. m. vf.
8:49 a. m. vf.
10:00 a. m. vf.
1:13 p. m. vf.
1:29 p. m. vf.
a 14 tremors from 1 p. m. to 2:45 p. m.
3:13 p. m. vf.

Figure 20. Panorama taken in August, 1925, of the summit cone of Mauna Kea (second from the left) and the splendid sweep of glacial moraines and mutton-back ledges left by the Daly glacier. (See October, 1925, BULLETIN). 12-inch Turner-Reich Lens, G-filter, Wratten panchromatic film, F32 stop, ½ second exposure. Photo Emerson.

Figure 21. Mauna Loa from the summit cone of Mauna Kea, showing the floods of lava from the northeast rift, the Humuula Valley, and the slight notches of the summit crater Mokuaweoweo, August, 1925. Photo Emerson.

Teleseism

August 19.....1:46 a. m., slight, △3000 miles.

Harmonic Tremor

This type of tremor was not recorded in August.

Microseismic Motion

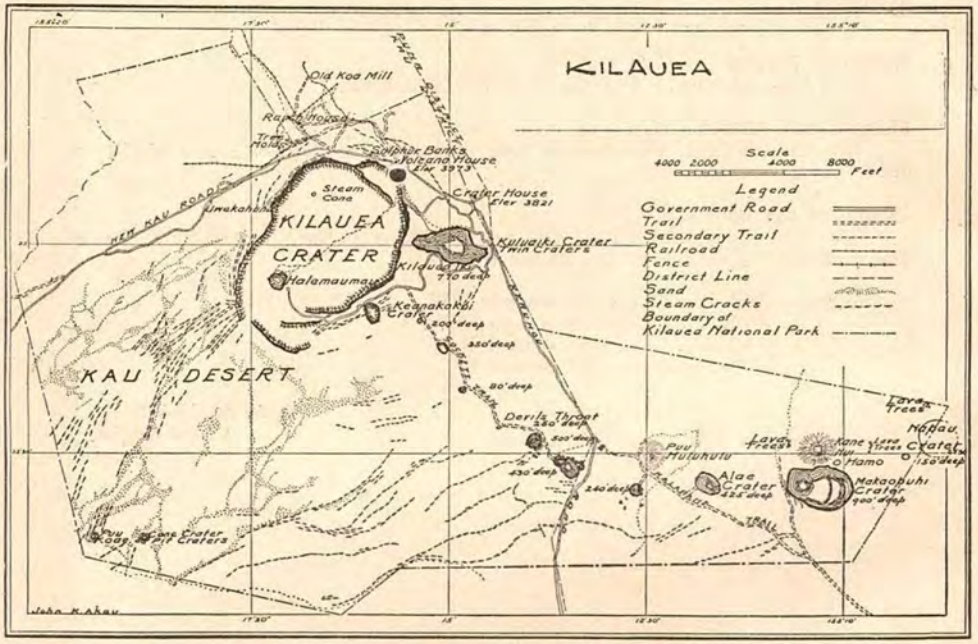
The amplitude of microseisms was moderate on August 1 and slight on other days.

Tilting of the Ground

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

August	2- 8	1.2 seconds NW.
	9-15	0.8 second SSW.
	16-22	0.1 second N.
	23-29	0.7 second S.

T. A. JAGGAR,
Volcanologist.



Black spot shows location of Observatory.

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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, Hilo and Hilea.

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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo, Hilea 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

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(U. S. GEOLOGICAL SURVEY)

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VOL. XIII HONOLULU, HAWAII, SEPTEMBER, 1925 No. 9

CONTENTS

VOLCANIC CONDITIONS IN SEPTEMBER

Activity of Halemaumau

During September the number of small local earthquakes increased considerably at the beginning of the month, but decreased thereafter. Slides from the pit walls were somewhat more numerous than in August, and some of these were big enough to be heard at the Observatory, two miles away. There was no volcanic activity of any sort. Most of the tilting was westerly, unusual for this season.

For the week ending September 9 slight falls of rock from the walls of the pit were heard every time Halemaumau was visited, and on one occasion there appeared to be more sulphur gas of bluish color mixed with the steam at the south talus than usual. A little fresh debris was discernible on the southern taluses.

For this week forty-four earthquakes and tremors of local origin were registered. Of these two were plainly felt in Pahala at 8:24 p. m. and 10:40 p. m., September 2. One, felt at the Observatory at 3:34 p. m., September 5, had its

origin distance indicated as thirty-nine miles. A distant earthquake made a slight record on September 5. Tilting for the week was slight to the west.

For the second week nothing new happened until September 11 when, about 11 p. m., the roar of an avalanche was heard in the still night air and somewhat later another one. The next forenoon two slides occurred in a half hour at the northeast wall and at 1:45 p. m. came a larger slide that sent up a considerable dust cloud from the same place. The weather at this time and for most of the week was hot and sultry, the maximum temperature reaching 82 degrees F. September 14. On that day and the next there were some slides. The many avalanches of the year have produced vertical striations on the wall.

Sixteen seismic movements were registered for the week ending September 16, of which eight were of the avalanche type, many of these occurring September 12. There were no perceptible earthquakes. Tilting was moderate SSW.

For the third week no equinox effect appeared. There was some stripping of the north wall by avalanches, making red debris on the talus from the rocks west of the north sill, and later the same talus was covered with white stones that had come from the sill itself. About 1 a. m., September 22, the roar of an avalanche was heard. As illustrating how unstable the walls are, stones thrown by men over the northwest rim on September 22 started a slide sufficiently great to make a small dust cloud above the pit. In cracks of the wall itself at its base SSW bluish vapor was noticed. The pit most of the time was quiet.

For the week ending September 23 nine local earthquakes were registered, one of them felt in Hilo September 17 and one of them appearing to be an avalanche tremor. Tilt was moderate ESE.

The end of September produced several avalanches big enough to send up dust clouds and loud enough to be heard at the Observatory. Ten earthquakes were registered for the week ending September 30, three of the avalanche type, and none perceptible. Tilting was slight to the west.

JOURNAL, SEPTEMBER, 1925

September 2. At 2:15 p. m. Halemaumau pit was dry and quiet. A little rock slipped from the walls above the west talus. Somewhat fresh debris lay on the talus beneath the southwest-rift tunnel. There was no change on the northern taluses and the largest amount of bottom steam was at the west pocket.

On the night preceding twelve spasmodic tremors were registered, but they do not appear to have been caused by avalanches.

September 3. From 10 to 11 a. m. a few rocks fell from the walls and there was vapor along the south side of the hot dry patch that extends up and down the middle of the south talus cones.

September 6. In sunlight the fume on the south talus appeared blue and sulphurous in marked contrast to the luster of the white vapor rising at the west pocket.

September 9. At 9:30 a. m. there were some very small slides. The weather was dry and the south talus fume was hardly visible. The region under the northeast station exhibited a stripped wall and a little fresh debris lay on the northern taluses.

September 11. At about 11 p. m. and again later avalanche noises were heard from the pit.

September 12. From 10:30 to 11:30 a. m. the northeast wall was working and avalanching. A large slab at the top near the northeast station appeared ready to fall with notches working on both sides. Two slides in a half hour from 10:30 to 11 occurred, and later at 1:45 p. m. a larger slide sent up a dust cloud (the seismogram this day showed three distinct avalanche tremors). The weather was very hot and sultry, 80° F., with thunder in the afternoon.

September 14. At 3 p. m. no slides occurred during a stay of fifteen minutes at the pit, but just before dust had been seen rising in the region of the northeast wall. At the northeastern loose slabs some rock had peeled off. The pit was very clear, still and dry.

September 15. At 9:15 a. m. there was a little sliding of fragments at a rounded shelf west of the lower southwest rift tunnel. Conditions were very dry, there was almost no steam visible beside the large dry streak in the south talus, and the main vaporing place was at the west pocket. There were white salts on the bank at the base of the southeast wall. Vertical striations are detectable up and down two-thirds of the south-southwest wall. At 12:50 p. m. avalanche dust rose from the pit.

September 16. In the forenoon the pit was tranquil. During two hours' work running levels along the east edge of the pit the observers heard no slides and there was no change in the bottom. The forenoon light showed vertical grooving up and down the north wall like that observed on the previous day SSW. This grooving is probably a striation due to past slides; the slides tend to fall for weeks in the same places and so mill the lower walls vertically. Oblique light brings out these millings. There are, however, vertical columnar jointings in the lava sheets which are easily mistaken for the striations, but the latter cross two or more sheets in common.

September 19. At 4 p. m. a new avalanche notch was seen in the wall next adjacent to and west of the west horn of the north sill; fresh red debris lay below. After drizzling rains steam had returned to the south talus.

September 22. At 9 a. m. bluish vapor was observed at rock cracks at the base of the south-southwest wall alongside of the west slope of the southwest talus. Two slides on the north and northwest walls of the pit were generated by men who were walking around the pit and throwing bowlders over the rim; one of these slides was big enough to make a dust cloud that rose above the rim, thus showing how delicately adjusted to sliding are the walls of the pit. An avalanche was heard about 1 a. m. of this day at the Observatory, the night being calm.

September 23. At 9 a. m. there was new dry debris on the west side of the north talus. These fragments appeared to have come from the west horn of the north sill for the rock of the horn was broken inward and freshly shaped. About 9 p. m. avalanche roar occurred.

September 24. At 7:50 a. m. a dust cloud rose from a considerable northern avalanche and at 8:50 a. m. one was observed at the pit over the west end of the north sill. The wall had been freshly stripped all the way up to the rim at the gulch west of the north station. New red dust lay on the northwest wall and the talus slopes below. The rock next to the west horn of the sill is very red and was the source of this dust. The northern wall continued to work during the forenoon. At 9:20 a. m. there was a fall of rock from the very top of the wall west of the north station making a red cauliflower dust cloud.

September 26. At 9:20 a. m. and thereafter slides occurred above the west horn of the north sill and one strong avalanche exhibited vertical columns of cauliflower dust like some of the photographs of the outer part of the Halemaumau explosion cloud near its base, taken by Maehara from Uwekahuna May 18, 1924. The wall is so steep and overhanging below the top of the sill that all the rocks fall clear and the vertical dust columns were made by a train of powder as individual streams of bowlders cascaded out into the air and entrained the dust after them. This explains the Maehara photograph; streams of falling bowlders in individual jets. In the present instance a cauliflower would boil out on the talus as all the cascades of stones hit the ground. No other changes were observed; there were spells lasting fifteen or twenty minutes when the wall was quiet. At 10:10 a. m. dust rose from the northeast corner of the pit; at 10:45 a. m. there was a big avalanche at the north; at 1:25 p. m. another dust cloud arose.

September 27. From 9:30 to 10 a. m. there was one small slide at the north. Red dust lay on the talus northwest and north. A yellow spot high up the north wall had been revealed by slides and appeared solfataric, but no fume could be seen.

September 30. The day was rainy and humid with abundant steam in the pit and the walls bright red in spots only, showing that the light rains bring out the redness at only favorable localities.

SEISMOMETRIC RECORD

During the month ended midnight September 30, 1925, 102 local earthquakes and one teleseism were recorded at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 min. slower than Greenwich.

Local Earthquakes

Abbreviations have meanings as follows: vf = very feeble; f = feeble; s = slight; fl = felt locally; △ = indicated distance to origin in miles; and a = a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

September

1—a eight tremors 11:35 a. m.—1:10 p. m.
a 8:33 p. m. vf.
8:36 p. m. vf.
8:45 p. m. vf.
a 8:54 p. m. vf.
9.04 p. m. vf.
9:19 p. m. vf.
a 9:29 p. m. vf.
a10:01 p. m. vf.
2— 4.22 a. m. vf.
4:23 a. m. vf.
a 4:27 a. m. vf.
4:30 a. m. vf.
5:22 a. m. vf.
7:01 a. m. vf.
2:25 p. m. vf.
4:29 p. m. vf.
8:24 p. m. vf.
10:40 p. m. vf.
10:58 p. m. vf.
3— 5:18 a. m. vf.
5:19 a. m. vf.
5:20 a. m. vf.
5:25 a. m. vf.
11:59 a. m. vf.
3:16 p. m. vf.
3:17 p. m. vf.
10:38 p. m. vf.
10:41 p. m. vf.
11:04 p. m. vf.
4— 8:45 a. m. vf.

September

4— 6:49 p. m. vf.
6:52 p. m. vf.
5— 1:40 a. m. vf.
2:20 a. m. vf.
2:21 a. m. vf.
5:56 a. m. vf.
3:34 p. m. s, fl △ 39
5:25 p. m. f.
6:32 p. m. vf.
6— 1:48 a. m. vf.
1:49 a. m. vf.
1:26 p. m. vf.
3:42 p. m. vf.
3:43 p. m. vf.
3:45 p. m. vf.
6:28 p. m. vf.
11:42 p. m. vf.
11:44 p. m. vf.
7— 7:46 a. m. vf.
9:46 a. m. vf.
12:49 p. m. vf.
5:02 p. m. vf.
8— 8:24 a. m. vf.
10:40 a. m. vf.
10:41 p. m. vf.
9— 2:12 a. m. vf.
5:42 p. m. vf., △ 2
5:47 p. m. vf.
10— 8:55 a. m. vf.
a10:18 p. m. vf.
11— 12:18 p. m. vf.
a11:43 p. m. vf.
12—a 2:43 a. m. vf.

September

12—a 9:16 a. m. vf.
9:54 a. m. vf.
a 1:53 p. m. vf.
5:48 p. m. vf.
a11:30 p. m. vf.
14—a 3:25 p. m. vf.
a 5:25 p. m. vf.
16— 5:07 a. m. vf.
5:37 a. m. vf.
17— 9:53 a. m., s △ 12; felt in Hilo.
2:40 p. m. vf.
11:04 p. m. vf.
18— 4:01 p. m. vf.
19—a11:43 a. m. vf.
11:09 p. m. vf.
20— 1:34 p. m. vf.
21— 1:43 a. m. vf.
22— 4:53 a. m. vf.
23— 1:19 p. m. vf.
9:47 p. m. vf.
24—a 7:49 a. m. vf.
a 8:52 a. m. vf.
25— 6:57 a. m. vf.
26— 7:39 a. m. vf.
27— 5:50 a. m. vf.
29— 8:23 a. m. vf.
8:48 a. m. vf.
10:53 p. m. vf.
30— 1:40 p. m. vf.
3:38 p. m. vf.
4:24 p. m. vf.

Teleseism

Sept. 5—6:21 a. m. Slight.

Harmonic Tremor

This type of tremor was absent throughout the month.

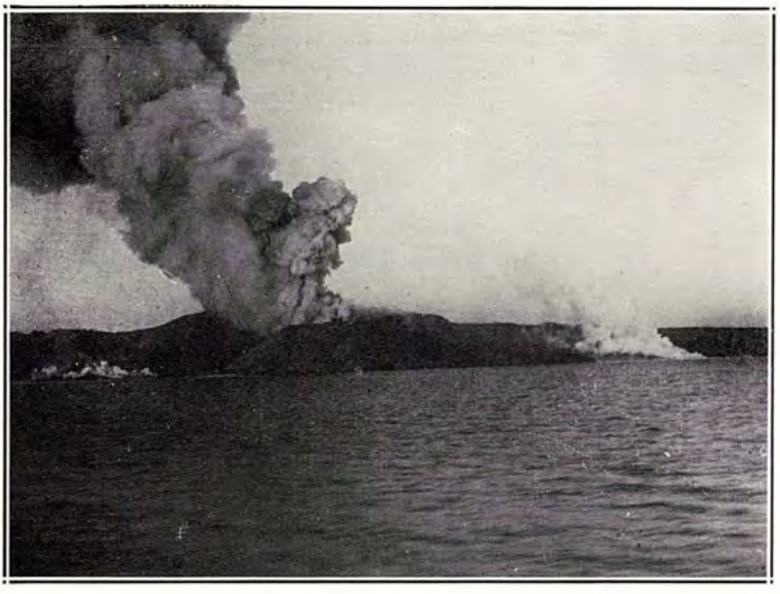


Fig. 22. New eruption of Santorin in the Grecian Archipelago. (Jour. Wash. Acad. Jan. 4, 1926.) Looking west from Thera towards the central island. Steam explosions behind the 1570 cone. Andesite lava formed a new hill called Fouqué Kaimeni. Photograph taken about September 3, 1925, from H. S. Washington.

Fig. 23. Mikra Kaimeni, formed in 1570. Looking toward Thera. The 1925 eruption began about August 1, and filled the strait in the foreground; it still continues. See Volcano Letter, Nos. 43 and 58. From H. S. Washington.

Fig. 24. Mauna Kea, Hawaii, from the northeast slope of Mauna Loa, looking north. Taken February 3, 1924. Shows the glacial plateau and moraines to the right of the summit cone, the deep gulch leading therefrom, and the wash plains extending off to the left. Mauna Loa lava flows fill the rest of the valley. Foreground is the great fissure-eruption rift of Mauna Loa. Photo Emerson.

Fig. 25. Snow-covered Mauna Kea from Kilauea observatory, taken January 31, 1916. The glacial gulch is to the left, and the morainic region is the rough country at the foot of the smooth summit cinder cones. Photo Wood.

Microseismic Motion

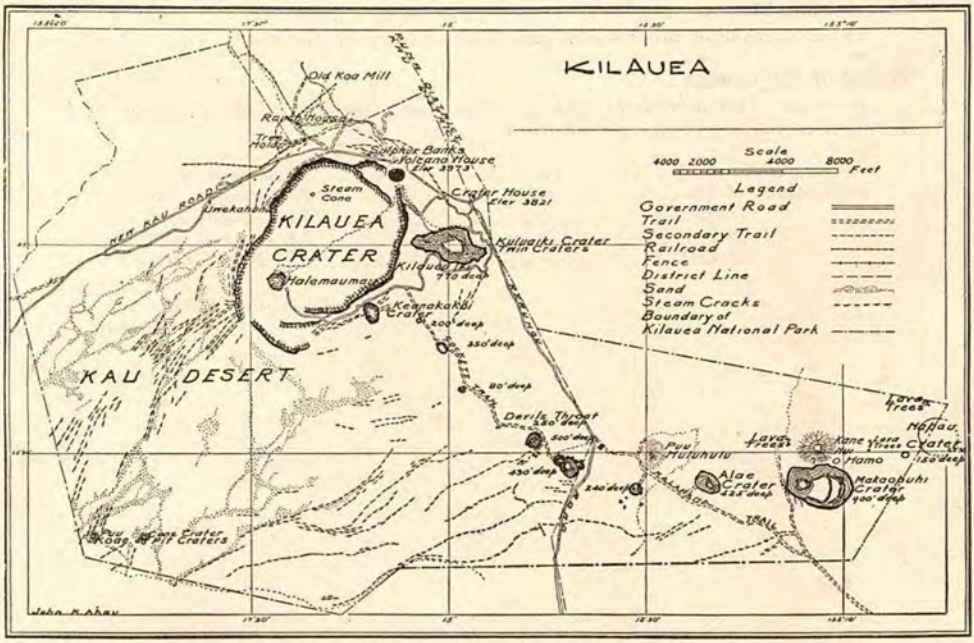
The amplitude of microseisms was slight during September.

Tilting of the Ground

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

August 30–Sept. 5	.....	1.0 second N.
September 6–12	.....	2.3 seconds SSW.
13–19	.....	2.3 seconds E.
20–26	.....	1.6 seconds W.
27–Oct. 3	.....	0.2 second ESE.

T. A. JAGGAR,
Volcanologist.



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MONTHLY BULLETIN

OF THE

Hawaiian Volcano Observatory

(U. S. GEOLOGICAL SURVEY)

Published by

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VOL. XIII HONOLULU, HAWAII, OCTOBER, 1925 No. 10

CONTENTS

GEOLOGICAL NOTES ON MAUNA KEA

By T. A. Jaggar

The writer was privileged to visit the south flank and summit of Mauna Kea from October 13 to 19 by kind invitation of the Messrs. Shipman at Puu Oo cattle ranch, some 6500 feet above sea level. The outstanding features of the upper slopes as compared with Kilauea, Mauna Loa and Hualalai are the greater weathering, trenching and signs of age, the large size of the cinder cones, the appearance of greater viscosity of the lava flung out of the cones in twisted almond-shaped bombs, and the large glaciated area on the summit plateau. The lava flows seen were all stiff aa, generally short and emergent from under heaps of cinder at a cone. The lower lava flows are buried up by soil and vegetation in the forests, and there are deep, coarse black cinder beds trenched by streams which resemble those on Tantalus and Roundtop in Honolulu. But everywhere on the mountain the sections reveal lava flows and perhaps intrusive bodies,

hard rock, and ash sections are rare and thin. No continuous tuff or ash sections, made of volcanic dust, of such thickness as those at the south side of Kilauea Crater (30 feet) were anywhere seen by the writer on Mauna Kea. This was a surprise, for there is an impression abroad that Mauna Kea ended its career with explosive eruptions, meaning ash or "mixed" eruption like Vesuvius. All the cones seen were made from lava fling and fiery fountains.

A typical cone visited was Kuikau, between Kalaieha and Puu Oo. This is a steep, conical grassed hill, at least 400 feet high, with some crater-like valleys in its slope, no crater on top, a cup crater surrounded by almond bombs of all sizes on its lower southern slope, and an aa flow from its northwestern base that pours off to the east. Between it and cones to the west there is a section exposed in an arroyo 12 or 15 feet thick of black cinder. There are some beautifully symmetrical cones and cups near it to the south, so that from the summit of Kuikau one looks down into the cup craters. The slopes of the cone are from 35 to 40 degrees, evidently made of plastered lava fling, and steeper than the angle of rest of loose material. The top of the hill is a rather narrow arete. The rock fragments on the slopes other than bombs are of broken pahoehoe lava, not pumiceous, and having the appearance of being the broken ejectamenta of rather violent lava fountains in a pasty melt, not the light frothy material of the Mauna Loa fountains. The bed of black cinder is different, with a flat upper surface, and looks as though it might have been the wind-carried accumulation of violent cinder spatter at a distance.

The Daly Glacier

Evidences of ancient glaciers on the top of Mauna Kea in the form chiefly of stony moraines and ice-scratched ledges and bowlders have been observed since 1909. At that time they were described by R. A. Daly. (Am. Jour. Sci. 1910, 297; Science Conspectus, 1911, 120; Proc. Am. Acad. Arts and Sci. 1915, 158.) The writer explored the scenes of the Daly glacier, and in addition to the other evidences of glacial action, discovered large outwash plains from the glacial drainage on the south-southwest flank of Mauna Kea at elevations about 6600 feet. By the Daly glacier is meant the ice-cap that covered the summit plateau south of the summit cones. The summit flatter area ends with a distinct shoulder that edges the roundish plateau covered with big cones which tops the mountain. The slope below increases to 30 degrees or more. The shoulder is at about the 10,500-foot level. Apparently in ancient days the glacier overhung this shoulder and its drainage swept down 4000 feet to the plain below.

As other moraines are described on the northern parts of the summit area (newspapers of Hawaii about ten years ago, article by W. A. Bryan) the ice-cap must have been seven or eight miles across. The Daly glacier was over three miles long, now represented by mutton-back ledges (roches moutonnees) elongated to the south-southwest, scored heavily in grooves and polishings, the rock a smooth trachydolerite whitened by the weather and more or less covered by erratic bowlders. The bowlders are subangular or rounded, and scratched. The heaps of morainic material make big whitish piles heaped along the mountain shoulder. The ledges are curiously broken up and plucked, as though by the freezing and thawing of the snow ice of modern days. There are drainage gorges amid the moraines. The whitish glaciated area is in marked contrast to the red aa lava spurs and red cinder cones which bound it.

As to the relation in age between these volcanic eruptions and the glacier, the upper part of the glacier appeared to have left debris that was younger than the summit cones of the mountain. Some lower lava cones, however, appeared partially to bury the glacier deposits. This is a matter that requires geologic mapping.

The plain of gravel, rounded bowlders and alluvium below is ten miles long in a west-northwest direction from Kalaieha, the sheep station, and farther in the same direction is another series of flood plains, at a slightly lower level, about four miles long. The width of the upper wash slope—it is, of course, not a perfect plain—is from three to five miles. It appears wonderfully flat, cov-

ered with winding stream channels of only a few feet depression. These reveal in their banks an upper two or three feet of yellow or buff alluvium, over coarse gravel and stones below. The plain is covered with bunchy grass and scattered mamane trees.

Uphill the stream beds appear to converge at a big diagonal gorge that led down from the glacier, and west of this are other gorges trenching the pyramid-like face of the mountain below the moraines. Some of the plain areas are bordered by terraces that suggest lake shores, consisting of old aa flows reshaped and partially buried by flood or lake action. The plains are so flat in places as to remind one of playas. The stones of the flood plain are identical with those of the glacier, and with nothing else.

The big wash plain where it abuts against the steep face of the mountain, makes a sharper angle in profile than the upper shoulder makes with the summit plateau. This upper land is far from flat and is interrupted by immense cones that appear individually 800 to 1000 feet high or more. The summit lake is a shallow pool at about the head of the Daly glacier site. A zone of cones toward the sheep station Kalaieha suggests the presence of an underlying rift line headed towards Kilauea.

The time of this glacier is usually referred to one of the glacial epochs of the northern hemisphere, when the equatorial ocean level was lower, and consequently Hawaii stood higher and its top, Mauna Kea, was colder. In the August Bulletin two panoramic photographs by Mr. Emerson are reproduced showing the glaciated and cone-covered summit region of Mauna Kea and the sweep of flows down the much younger volcanic slope of Mauna Loa as seen from the summit cone of Mauna Kea. The first almost reproduces the track of the glacier showing the scored ledges in its path, the lines of medial moraine, and the nevé region above. It will be seen that the summit cone has a distinct shoulder where the glacier lay against it. In all the region of this photograph the glacier appears to have been younger than the cones.

In the September Bulletin we reproduced two distant views of Mauna Kea. Figures 30 and 31 are photographs of Waipio canyon in the flank of Kohala mountain at the north end of the island of Hawaii. The canyon itself is an extraordinary trench owing its origin, in part at least, to volcanic faulting. It is presented here, however, to illustrate the fact that drowned valleys are not wholly absent from Hawaii. However the valley was formed, it presents now the phenomena which a rise of the sea in post-glacial time, or a sinking of the land, would produce. It is floored with a recent alluvial fill of rice lands, as shown in the pictures, soil from the upland brought down by the torrential rains of the region. This is one of the rainiest places in the world. If the island of Hawaii today were lowered only a few feet, the northeast Kohala valleys would drown, but nowhere else on the island would subsidence be attested by valley re-entrants. Waipio and its alluvial fill, then, gives evidence of a lowering of Hawaii island relative to the sea, just as do the melted and lost glaciers of the top of Mauna Kea.

In the present Bulletin four stereoscopic photographs show the lower wash plain of Humuula and its pebbles, the light colored glacial moraines and ledges seen on the trail to the Mauna Kea summit, the detail of one of the sheep-back rock surfaces, and the summit lake. These may be examined with an ordinary stereoscope.

VOLCANIC CONDITIONS IN OCTOBER

Activity of Halemaumau

After the spell of avalanching in Halemauman during September the pit at the beginning of October became quieter, but small rock falls could generally be heard during a short visit, and in calm weather multiple echoes were produced by such falls making it difficult to locate them. In general it may be said that the extreme quiet reached in August has come to an end. It looks as though

many of the falls, especially at the two ends or horns of the thick northeast sill, were in some way related to thermal working of that sill, known to be hot and of very high viscosity, but still possibly in some sense mobile owing to the release of pressure laterally that has been occasioned by the 1924 opening of the pit at its side.

Several of the steaming vents on the floor of Halemaumau and on the talus slopes appear dry as though visible vapor escaping were live steam. The rapid ascensional rate of some of the steam columns that appeared above the rim of the pit on damp days also indicated high temperature. Other vents appearing wet indicated that the vapor escaping from them was not excessively hot.

During the week ending October 7 nineteen very small local seisms were registered at the Observatory, four of them of avalanche type, and none perceptible. Faint records of two distant earthquakes were written October 3 and 4. Tilting fluctuated considerably with net change slight to the southeast.

During the second week avalanches were rather infrequent. After heavy rain October 13 the walls of the pit were colored a brilliant red, excepting the large intrusive bodies and some thick dense layers which remained gray.

Eleven small seisms were registered for the week ending October 14 and a month had now passed since a perceptible earthquake had occurred at the Observatory. Tilting was slight SSW. Microseismic motion increased markedly on the 12th, 13th and 14th, a time of development of southwest winds, thunder storms and heavy rainfall.

The third week produced at the pit nothing but small slides and the usual vapor changes determined by the weather, and only seven seismic movements were registered, all very small, including four of the avalanche type. Tilting was moderate NNE. Microseisms were moderately strong. This increase in the amplitude of microseisms has been observed here before in the autumn at the time of the cessation of regular trade winds.

The evidence of heat over Halemaumau was striking on the late afternoon of October 26, after a thunder storm with torrential rain, when the vapor of the jets all over the Kilauea floor was drawn inward toward a huge cumulus over the pit which billowed up to an immense height. Steam spouts or whirls became frequent with the cessation of the trade wind. With light south wind the invisible gas from the pit was seen to nucleate and make visible the vapor jets in the Kilauea floor north of it, which otherwise are not usually seen.

During the week ending October 28 slides were small and few and for fifteen minutes the forenoon of October 24 not a single pebble was heard to fall. The north and northeast walls showed the freshest breaks and cavernous recesses. There were notable dry hot streaks in otherwise wet talus at the south and northwest sides of the bottom where steam rises. The seismograph registered ten tremors, of which six were pronouncedly of the avalanche type. Tilting was moderate SSE.

On October 31 rocks fell from the north and west walls and the north corner showed fresh red debris and dust on the slopes.

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A report from topographers of the U. S. Geological Survey now mapping the summit of Mauna Loa indicated that in Mokuaweoweo, the summit crater, there was only the usual amount of fume with the odor of sulphur dioxide quite perceptible at several vents.

October 3. At 10 a. m. no slides were observed but there was evidence of fresh falls at the southwest rift chasm.

October 7. At 9 a. m. small rock falls were heard from the north wall. About half the steaming vents in the bottom of the pit appeared to be dry as though the visible vapor were live steam; the borders of the others tended to moisten the gravel and sand and give it a darker color.

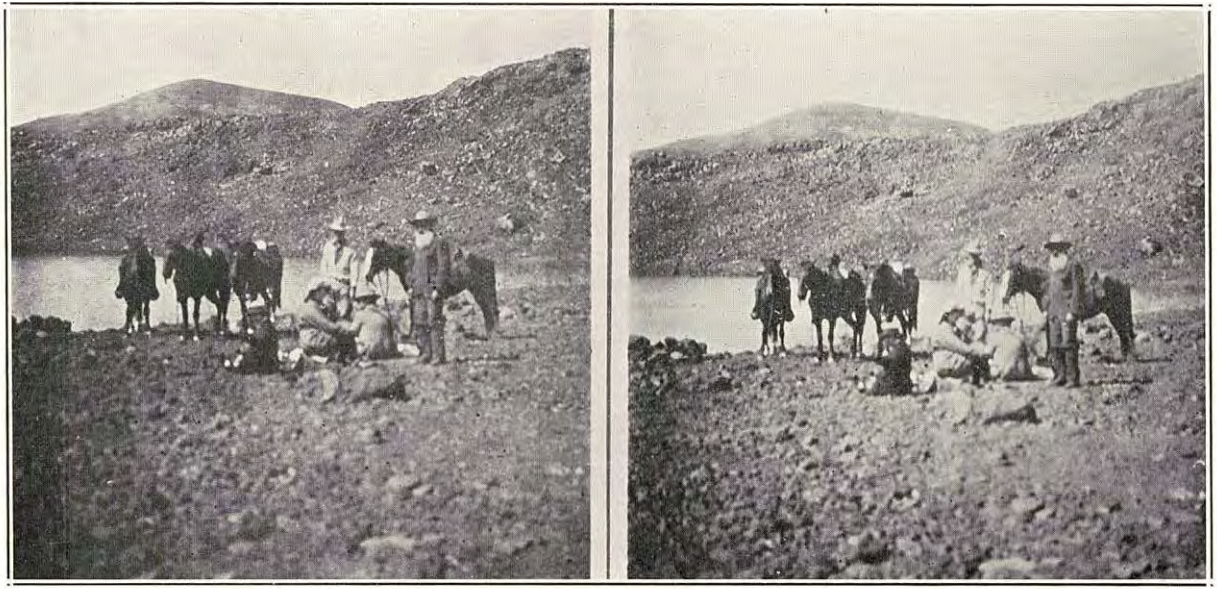


Fig. 26. Stereoscopic view of summit lake and cones on Mauna Kea. This is at the head of the glacial cirque shown in Fig. 20 (August Bulletin). Photo Jaggar.

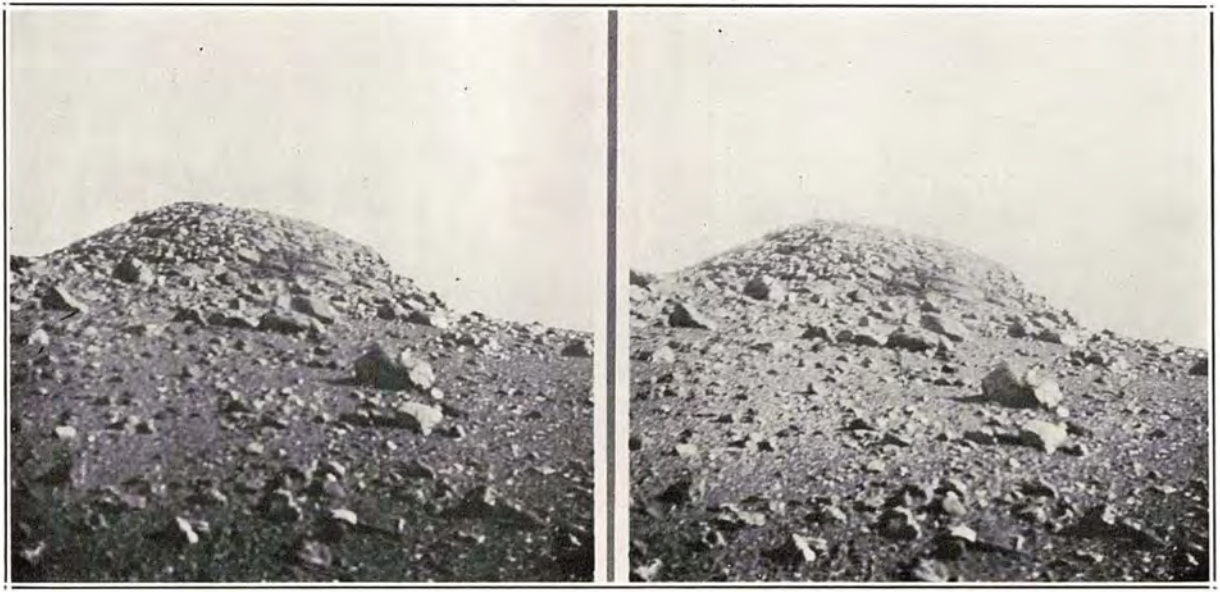


Fig. 27. Detail of scoured and plucked trachy-dolerite ledge, one of the **roches moutonnees** amid the glacial moraines on Mauna Kea. Photo Jaggar.

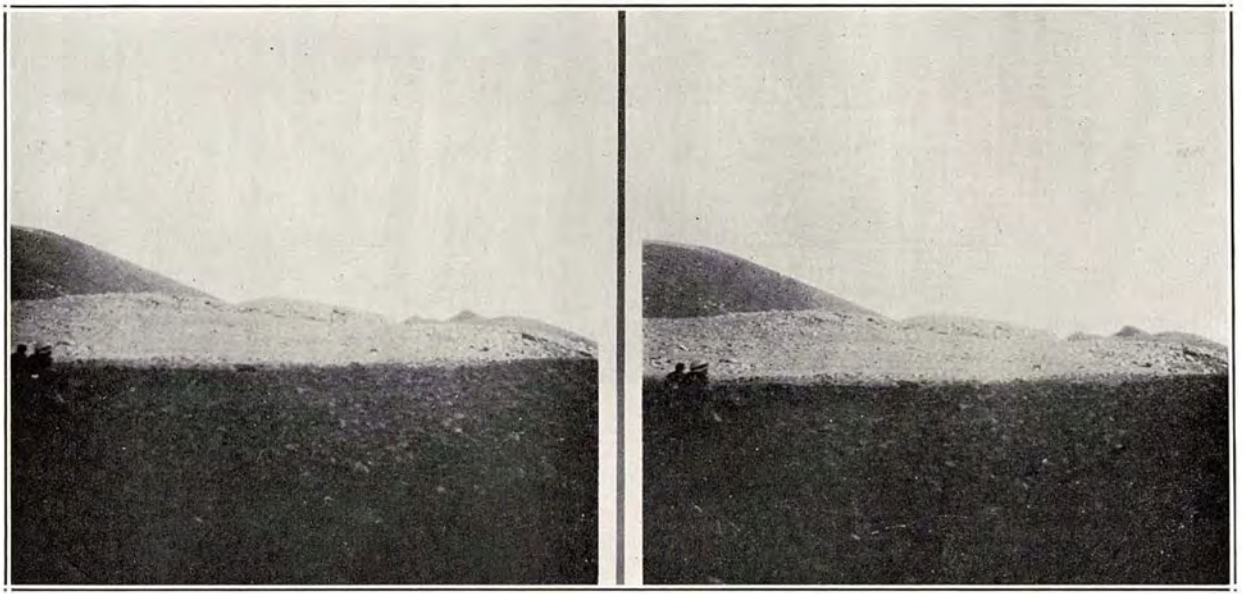


Fig. 28. Light colored trachy-dolerite glacial ledges and moraines, Daly glacier, Mauna Kea, in contrast to the dark basalt cones. Photo Jaggar.

Fig. 29. Glacial washed pebbles and till, ten-mile plain west of Kalaieha sheep station, outwash of Daly glacier, Mauna Kea. Photo Jaggar.

Fig. 30. Waipio valley, north end of Hawaii, showing cascade and hanging valleys produced probably by faulting, and bottom land produced by drowning. Photo Kanemori.

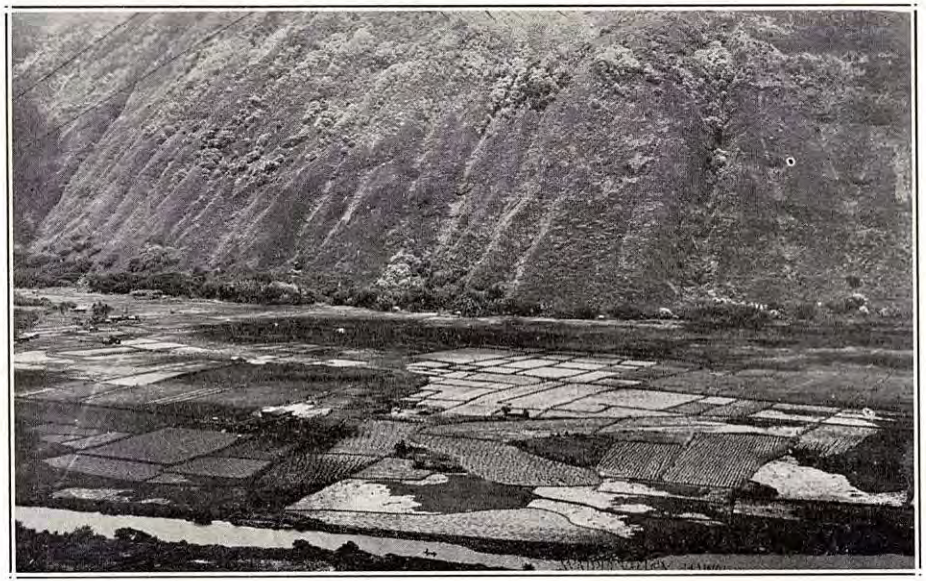


Fig. 31. Drowned valley of Waipio, with ricefields, illustrating subsidence of the island of Hawaii from a former higher level when this valley was eroded. Photo Kanemori.

October 10. At 11 a. m. the pit was perfectly quiet.

October 14. At 8 a. m. occasional rock falls were heard. The walls were very red except for thick massive flows and the intrusive bodies which remained gray. There was a faint bluish haze where the background was dark in the pit, quite apart from the sulphurous steam jets at the east side of the bottom which appear bluish on the edges.

October 15. At 2 p. m. there was southwest wind and the mountain top was in a diffuse bluish haze, especially noticeable in Kilauea Iki. Fog was drifting from the southwest over Halemaumau. The floor vapor in the pit was as usual and evaporated a short distance above the places of issue. Higher up there was condensation of moisture about 400 feet below the rim of the pit, which made dense clouds at the rim level.

October 17. Small rock falls were heard and much of the extreme redness of the walls had disappeared with drying.

October 24. At 9:20 a. m. during an inspection of twenty minutes at the southeast edge of the pit, with light drift of wind from the southeast, no single pebble fell from the walls anywhere for fifteen minutes. Then there were some very light falls at the north gulch. The walls were red and wet after rain. The notably dry places, probably hot, were the northeast sill, the yellow spot high up the north wall, the upper part of a steaming streak in the big west talus, several streaks in the south talus, the lower bench of the south-southeast wall and spots in the decomposed wall matter ENE.

Under the west horn of the northeast sill recent caving had developed a cavern directed tangentially westward. There lay fresh, fine, red debris on the talus in the north corner of the pit. There was also fresh red debris on the high talus cone athwart the middle of the northeast sill; at the top this conoid merged with a notch leading down from the red spot at the base of the fossil talus that overlies the western half of the sill.

Steam was rising at the west pocket, in the center of the pit, at the south talus and at small vents elsewhere. The weather was humid. It was interesting to observe how the exhaust from an automobile would nucleate the vapor from cracks at the road terminus for a long distance to leeward of the car. Much vapor hung over the pit and the Kilauea floor.

October 25. At 9:45 a. m. long dry hot streaks with steam rising were conspicuous above the west pocket of the bottom along the south edge of the northwest talus. This dryness at that place had not been observed much before and may be indicative of increasing heat. The ground on the south side of the west boss also appeared dry from heat. Much white and yellow salt had formed about the pit.

October 27. From 10 to 12 a. m. there were several small slides, chiefly at the north corner of the pit. The vapor jets were as usual and the walls were reddened after rain.

After a thunder storm the preceding afternoon, very high cumulus gathered over the pit and hundreds of tails of vapor from the Kilauea floor converged to the hot convection cloud at Halemaumau. There was now nucleation of vapor jets in large number north of the pit with light southerly drift of wind.

October 28. At 11 a. m. wind was from the northeast and the pit was dry. The maximum of bottom vapor was at the west pocket and the northwest talus. Fresh material lay on the north and northeast taluses. Some rock slipping was heard above the big west talus and at the north. The north and northeast walls showed fresh peeled areas all along the cliff above the big sill.

October 31. At 9:45 a. m. rocks were in motion at the north and west. At 7 a. m. dust had been seen in the pit and now the north corner exhibited a large amount of fresh red debris and dust on the talus. The cavern near the bottom there had fallen away so as to be only a niche. A core of massive

gray rock was observed in the middle of the area of vertical laminations in the eastern part of the northeast sill, itself unlaminated but surrounded by the laminated rock. The niche formed by avalanches which had fed the high talus cone at the middle of the sill had now extended itself eastward so that it was bounded by a vertical straight upright protruding joint at the rift dyke.

SEISMOMETRIC RECORD

During the month ended midnight October 31, 1925, 51 local earthquakes and two teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 min. slower than Greenwich.

Local Earthquakes

Abbreviations have meanings as follows: vf = very feeble; f = feeble; s = slight; △ = indicated distance to origin in miles; and a = a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

October		October		October	
2	a 11:04 a. m. vf.	9	1:26 p. m. vf.	22	a 2:49 p. m. vf.
3	9:44 a. m. vf.		1:36 p. m. vf.	23	a 3:04 a. m. vf.
	9:45 a. m. vf.	10	3:42 a. m. vf.	24	4:29 a. m. vf.
	9:47 a. m. vf.	11	4:58 p. m. vf.		10:30 a. m. vf.
	9:51 a. m. vf.		6:23 p. m. vf.	25	a 6:52 a. m. vf.
	11:36 a. m. vf.		7:10 p. m. vf.	26	12:44 p. m. vf.
4	3:12 a. m. vf.		10:23 p. m. vf.	27	a 1:38 p. m. vf.
	6:48 a. m. vf.	13	1:37 a. m. vf.		a 1:59 p. m. vf.
	7:40 p. m. vf.		2:47 a. m. vf.		a frequent from 11 p. m. to 1 a. m. 28th
	7:56 p. m. vf.		1:35 p. m. vf.		
	a 8:36 p. m. vf.	16	a 12:04 a. m. vf.	28	12:59 p. m. two vf.
5	12:36 p. m. vf.		a 12:26 a. m. vf.		3:15 p. m. vf.
	4:22 p. m. vf.	17	1:00 p. m. vf.		4:52 p. m. s △ 18.
6	5:49 a. m. vf.	18	a 10:47 a. m. vf.	29	a 8:41 p. m. vf.
	a 1:39 p. m. vf.		2:02 p. m. vf.	30	11:21 p. m. vf.
	a 3:11 p. m. vf.	19	2:27 a. m. vf.	31	5:11 a. m. vf.
7	a 4:11 a. m. vf.	20	a 12:02 a. m. vf.		
8	a 12:49 p. m. vf.	21	8:47 p. m. vf.		

Teleseisms

October	3	5:36 p. m. slight.
	4	5:58 p. m. slight.

Harmonic Tremor

This type of tremor was not recorded in October.

Microseismic Motion

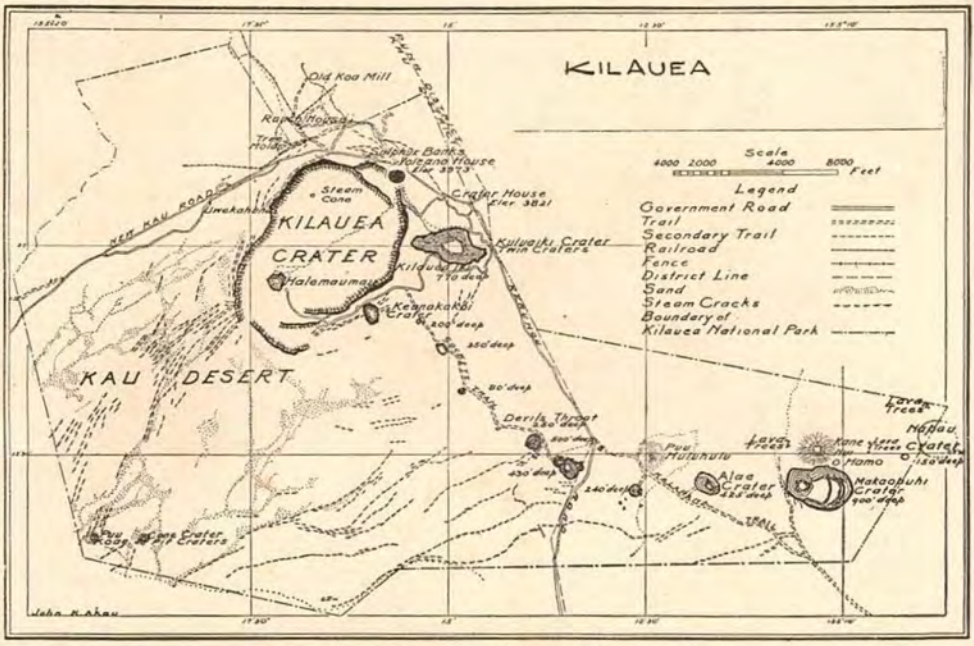
The amplitude of microseisms was moderate from October 13 to 18 inclusive and slight on other days.

Tilting of the Ground

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

October	4–10	1.0 second E.
	11–17	0.5 second NE.
	18–24	2.8 seconds SSE.
	25–31	2.4 seconds NNE.

T. A. JAGGAR,
Volcanologist.



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VOLCANIC CONDITIONS IN NOVEMBER

Activity of Halemaumau

The month of November was a quiet one at Halemaumau pit and the record of local earthquakes and tremors showed a diminution in number of shocks, apart from those occasioned by avalanches, from about ten for each of the first two weeks to about half that number for the last week of the month.

On November 3 there were occasional small slippings of wall rock at the pit southwest, northwest, and northeast. The steam rising at the west pocket of the bottom was livelier than elsewhere.

For the week ending November 4 thirteen seisms were registered, of which four were avalanche tremors and only one, on October 28, was of the perceptible class with indicated origin probably eight miles southeast of the Observatory.

On November 5 dust clouds due to avalanches rose from the north side of the pit at 9:20 and 10:26 a. m., and fresh red and gray debris was left on the northern interior taluses.

For the week ending November 11 twelve local earthquakes were registered, of which two were avalanche tremors. One at 10:44 p. m. November 5 was felt at Volcano House and in Hilo, and the seismogram indicated origin distance thirteen miles probably northwest. The long waves of a strong distant earthquake were registered at 3:35 a. m. November 10. Tilt for the week was slight to southeast.

Two other distant earthquakes were recorded at the Observatory, indicating a flurry of large shocks somewhere in the world. One of these beginning at 1:34 a. m. November 16 had indicated distance of 3200 miles equivalent to that of Kamtchatka or New Mexico. For the week ending November 18 eight local seisms were registered, one of these on the 13th at 5:30 a. m. showing origin distance fifteen miles. Tilting was slight NNE.

There were peelings of the north Halemaumau wall from the west end of the gray sill in red ancient lavas, dumping red and gray debris on the slope below. This action had cut away the shelf that formerly supported a talus above the west horn of the sill. There was odor of hydrogen sulphide at the northeast rim November 17.

The week ending November 25 registered eleven local seisms, six of which were of the avalanche type. All were too small to be perceptible. Tilting was slight SSW. Nothing new developed at Halemaumau. During a period of two hours on the forenoon of the 21st three slight slides from the walls in different places were heard. The next day dust rose occasionally. On the 24th in the forenoon nothing but slight trickle of gravel was noticed on the walls, but in the afternoon a dust cloud rose from a larger slide. On the 25th, after noon, the weather was damp and clouds hung low; there was abundant vapor in and about the pit; one slide and two or three light falls of stones from the northern walls occurred during a quarter hour, and the dense steam at the south talus was hot looking and unusually blue with sulphur gas.

For the week ending December 2 the only event of note at the pit was that a poised slab of the rim was found on November 28 to have fallen. Fourteen earthquake movements were registered, all small, of which three appeared to be due to avalanches. The net tilt was strong NNE. occurring in coincidence with a cool spell beginning November 26.

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November 2. At 3 p. m. no change was observed in Halemaumau, and no slides were seen in motion. Before and after the visit to the pit some dust rose from the interior near the north rim.

November 3. At 3 p. m. and for twenty minutes thereafter there were occasional slippings of rock fragments from the walls SW, NW, and NE. The slips were so small that the rocks falling could not be detected by eye, but the noise was almost continuous for minutes at a time.

The steam at the west pocket of the bottom was more vigorous in its rising, puffing up as separate jets, than the idle steam rising as soft clouds at the south talus. The vigor of the steam on the west talus was intermediate in quality. Sulphur stain at the east talus was no longer bright colored or rapid in its reformation as it was a year ago. There was still a tendency, however, to yellow color there and on the east floor. A sharp edged buttress had formed where the wall had fallen away below the west horn of the north sill, standing out with a crack behind it that is concentric to the pit ring.

November 5. Avalanches produced clouds of red dust from the north side of Halemaumau at 9:20 a. m. and 10:26 a. m. During a visit to the pit in rainy weather at 2 p. m. quiet vapor was rising and nothing could be seen or heard.

November 9. At 2 p. m., in a drizzle of rain, the pit showed fresh red and gray debris on the north talus, and a little fresh gray material from the north

sill lying on the northeast talus. A solfataric spot was noticed on the wall above the middle of the north sill. Breaks in the northeast wall and the debris below were fresher than anywhere else. The abundance of gray fragments meant that the sill itself was always peeling as though its inner material were squeezing out and scaling off under the enormous weight of the rock above. This is in some sense not impossible in view of the fact that this sill was red hot fourteen months before.

November 12. At 2 p. m. fresh talus was observed under the west horn of the north sill consisting of both the gray debris of the sill and red fragments of the adjacent lava flows. In a half hour two spells of sliding occurred at the north wall.

November 14. There was brisk northeast wind making a roaring noise from time to time in the steam cracks at the edge of the pit southeast. The walls were wet and making much steam and conditions appeared the same as on the twelfth (3 p. m.).

November 17. From 2 to 4 p. m. an excursion was made to the gabbroid intrusions at the base of Uwekahuna Bluff, passing the pit going and returning. An odor of hydrogen sulphide was noticed at the northeast edge of the pit. The north wall at the contacts of the west horn of the northeast sill was evidently caving away so as to reduce the shelf that formerly had created a gulch and talus above the horn.

At the larger gabbroid intrusion, known as the Daly laccolith, the gulch in its midst was examined high up the slope and the contact of the intrusion on its west side was found in part to be vertical. The bottom of the intrusion on the eastern or crater side appears to be horizontal. Looking at the face of the wall the intrusion appears like a slag-heap lens of slow cooled basaltic lava contemporaneous with the beds a few feet above it. Higher up the lava flows in the wall are seen to end horizontally with overlap against the curvature of the domed layers. The bottom contact from south to north breaks across the lava strata. This intrusive body is certainly not a laccolith in the sense of a deep intrusion which has arched any considerable thickness of the overlying layers. It may well have been a swollen mass of lava enclosed within its own crusts, in the same sense that every schollendome encloses such a fill of basalt that tends to swell the dome. Its greater thickness and extension may once have been out in the region of the crater.

November 21. During the forenoon from 10 a. m. to 12:30 p. m. three slides were heard in the pit. Otherwise it was very quiet.

November 22. At 10 a. m. no changes were observed and no slides occurred. At other times during the day some dust was seen rising from the pit.

November 24. At 9:30 a. m. the pit showed nothing new. Through the weeks the north wall had been changing detail slightly owing to the continued slides, and the three northern and northeastern taluses were seen to be acquiring conoid form of some considerable height. In the afternoon there was some dust from avalanches in the pit.

November 25. At 2:15 p. m. one small avalanche fell from the middle of the northeast wall and two slides were heard at the north and west walls, all in the course of fifteen minutes. At the south talus blue smoke was very abundant and conspicuous mixed with the steam there. There was new material on the northern taluses. The weather was cloudy and damp.

November 28. At 12 noon the only change noticed in Halemaumau was that a poised slab of the rim east of the northeast station had fallen and a piece of it lay on top of the talus cone below. The rim there no longer appeared so cracked and overhanging as before. The vapor in the pit was in moderate volume and none was visible at the sulphur patches on the east side of the floor. The sulphur stain nowadays, when it reappears after the yellow areas have been obscured by avalanche dust, does so very slowly.

November 30. At 3 p. m. a very slight trickle of stones was heard only once. The north wall had peeled slightly and the north taluses were fresh looking, but there was nothing in the crater in the way of changes coincident with the occurrence of strong northeast tilt that had appeared on the seismograms. This tilt accompanied a sudden change to colder weather.

SEISMOMETRIC RECORD

During the month ended midnight Nov. 30, 1925, 50 local earthquakes and four teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 min. slower than Greenwich.

Abbreviations have meanings as follows: vf = very feeble; f = feeble; s = slight; fl = felt locally; △ = indicated distance in miles; and a = a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

November	November	November
1— 9:56 p. m. vf.	9— 10:33 a. m. vf.	21— 9:15 p. m. vf.
2— 3:57 a. m. vf.	10:17 p. m. vf, △ 2.	22— 12:35 a. m. vf.
3:58 a. m. vf.	10— 1:27 a. m. vf.	23— 2:44 p. m. vf.
4:44 a. m. vf.	2:27 a. m. vf.	24—a 7:55 a. m. vf.
3— 5:08 a. m. vf.	12— 12:39 a. m. vf.	a 8:02 a. m. vf.
a 2:17 p. m. vf.	8:30 a. m. vf.	a 4:36 p. m. vf.
4—a 3:50 a. m. vf.	13— 5:30 a. m. f, △ 16.	27— 2:32 p. m. vf.
a 5:26 a. m. vf.	a 1:58 p. m. vf.	2:34 p. m. vf.
5—a 9:12 a. m. vf.	15— 12:27 a. m. vf.	28— 7:31 a. m. vf.
11:40 a. m. vf.	11:41 p. m. vf.	a 1:13 p. m. vf.
10:44 p. m. s, fl △ 13.	16— 2:26 a. m. vf.	a 1:27 p. m. vf.
6— 9:39 a. m. vf.	17— 6:20 a. m. vf.	29—a11:02 a. m. vf.
7— 2:52 p. m. vf.	18— 7:33 p. m. vf.	11:25 a. m. vf.
8— 5:08 a. m. vf.	19—a10:55 p. m. vf.	a 5:46 p. m. vf.
6:19 a. m. vf.	20—a 7:10 a. m. vf.	30— 4:26 p. m. vf.
6:20 a. m. vf.	11:57 p. m. vf.	10:20 p. m. vf.
9—a10:23 a. m. vf.	21— 5:31 a. m. vf.	

Teleseisms

November 10..... 3:33 a. m., slight.
13..... 2:06 a. m., slight.
16.....1:34 a. m., moderate, △ 3200.
16.....2:28 p. m., slight.

Harmonic Tremor

This type of tremor was absent during November.

Microseismic Motion

The amplitude of microseisms was moderate on Nov. 23 and slight on other days.

Tilting of the Ground

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

November 1– 7..... 1.8 seconds N.
8–14..... 1.3 seconds E.
15–21..... 1.2 seconds SSW.
22–28..... 1.9 seconds ENE.

T. A. JAGGAR,
Volcanologist.

Fig. 32. Illustrations of Mokuaweoweo, the summit crater of Mauna Loa, a sink which has been filling up with lava during the last century. Looking SW from east rim, showing partly buried lunate platform, and gap leading to south pit. Photo August, 1915, by Wood.

Fig. 33. Lava cataract frozen in gap, south pit. This pit bears a relation to Mokuaweoweo similar to that of Kilauea Iki to Kilauea. Its bottom stands at a lower level, and is separated from the big crater by a lunate fault block. Photo Wood, 1915.

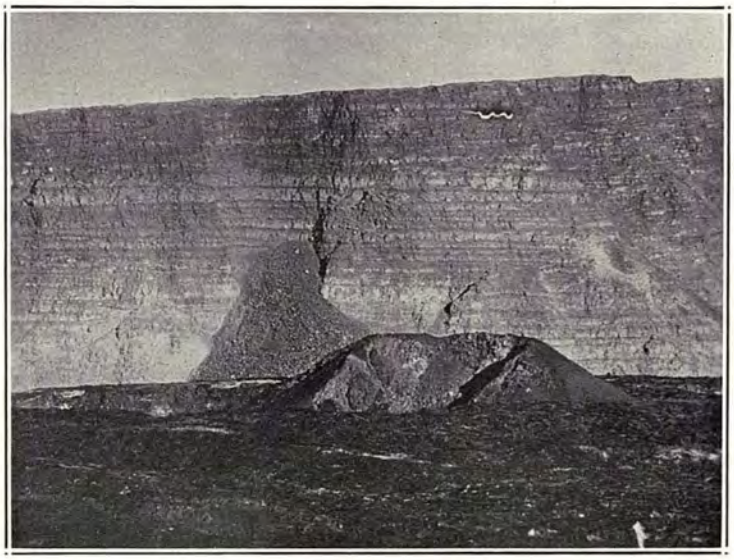


Fig. 34. The 1914 cone on the Mokuaweoweo floor, where the largest lava fountain played in December of that year. Looking west. Telephoto Wood, 1915.

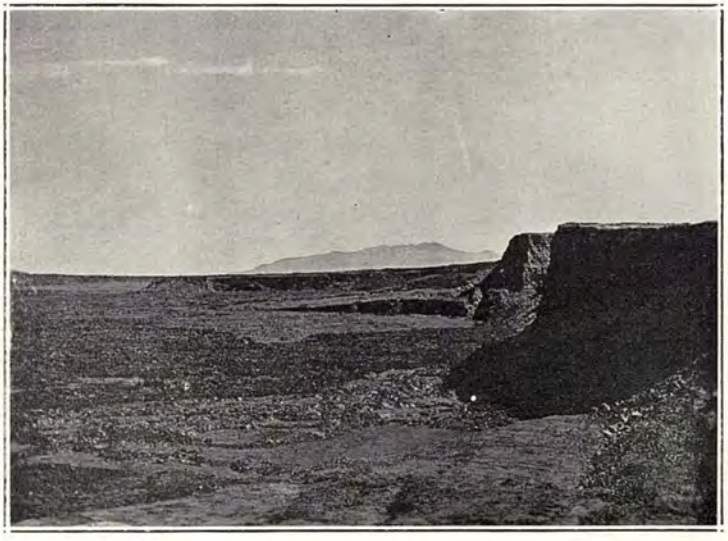
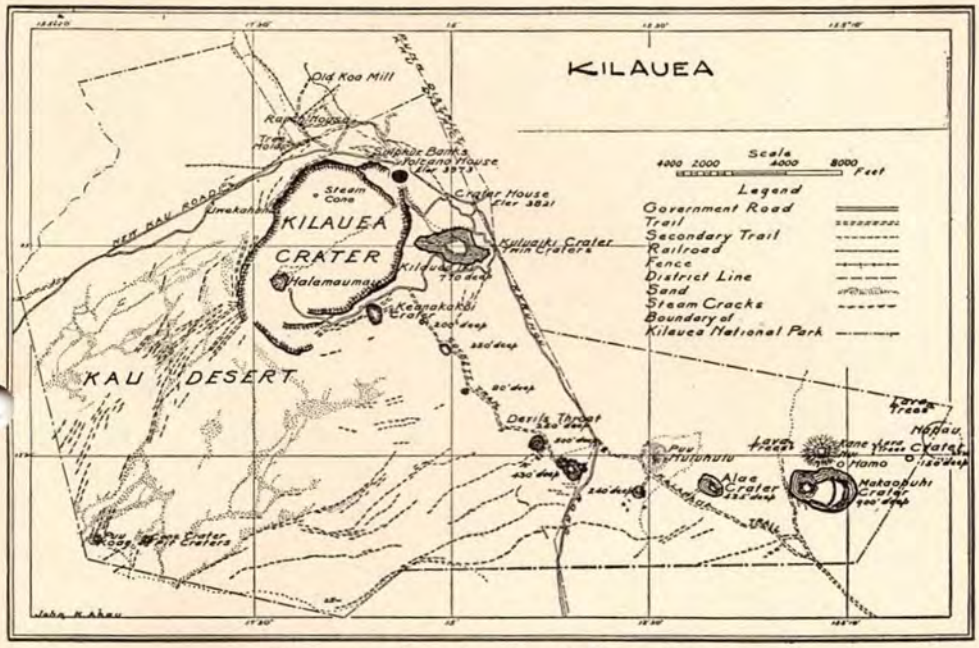


Fig. 35. Looking northeast along east wall of Mokuaweoweo, showing buried north lunate platform and distant Mauna Kea. The burial of these crescent platforms happened during the nineteenth century. Photo Wood, 1915.

Fig. 36. In 1925 Mokuaweoweo was visited in July by Jaggar and August by Emerson. The scene appeared the same as shown in all these pictures. Looking SW from east rim, showing the usual sulphurous fume where it has been for 22 years past. In the middle are the 1903 cones. Photo Wood, 1915.

Fig. 37. Looking NE from south lunate platform. A down-faulted block of the floor under SE rim of Mokuaweoweo. This becomes a deep chasm in the distance. Photo Bryan, August, 1925.



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, Volcano House, 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, Hilo and Hilea.

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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo, Hilea 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.

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CONTENTS

EXPEDITION TO THE SOUTHWEST RIFT OF MAUNA LOA

By R. H. Finch

During December, 1925, exploration of the dry and barren southwest rift of Mauna Loa in the vicinity of the 10,000 contour was made easy by the fact that E. G. Wingate, topographic engineer of the U. S. Geological Survey, with a survey party was camped at about that elevation and had an organization to bring in water and supplies.

With Harry Koa Hookano, Wingate's packer, as guide, the writer left Captain Cook postoffice in Kona at 9 a. m., December 14. The upper Dowsett ranch camp was reached at 2:15 p. m. The ranch camp was left at 9:15 a. m., December 15, and the Wingate camp reached at 1 p. m. From the timber line above the Komakawai water hole a nearly due east course was pursued. It is possible to stay on pahoehoe lava practically all the way and the going is fairly easy for horses or mules.

Wingate's camp was in a lava tube, 9,940 feet above sea level, on an ancient Hawaiian trail that roughly follows the 9,900-foot contour of the southern slope of Mauna Loa. The tube bore evidence of having been used as a camping place by the ancient Hawaiians. It would appear that parties of considerable size at one time used this trail, as built-up shelters were found on pahoehoe outside the tube. The tube is about one-half mile to the west of the line of westernmost cinder cones, though still within the rift zone as there is a crack a few hundred feet to the west. There was no evidence of lava flows or other form of output along the crack at this elevation.

The trail is easily followed across aa flows, but obscure on pahoehoe. It was never rebuilt where it was destroyed by the 1851 and a few other fresh looking flows. It may well be that use of the trail ceased 100 to 150 or more years ago.

In going eastward along the trail an aa flow, remarkable for its even surface, was encountered. Where the flow butted against cinder cones it left a plaster of aa lava 5 or 6 feet higher than the present level of the flow. It looked as though the flow could have made aa tree casts had it occurred in a timbered region. No pahoehoe slabs were observed on the flow.

To the southeast of the above mentioned aa flow there is a large pahoehoe lava dome that cuts across the line of the rift zone at a small angle. Structurally it is very much like the Mauna Iki dome in the Kau Desert.[1] The dome is 50 feet or more above the surrounding terrane and for the most part covered with shelly pahoehoe. Lava had streamed in all directions from the higher parts of the dome, aa forming in only a few small flows. There are several breakdowns in the dome, some apparently over the feeding rift and others in lava tubes leading away from the source rift. Sulphate incrustations as much as two inches thick may be found in the tubes. At the upper end of the dome a built-up shelter was noted.

Numerous cinder cones mark the rift zone. The parts of many of the double or multiple cones are often of very different ages. Fifty feet of a red cone at an elevation of 9,400 feet had been buried by lava flows. The development of cinder cones is probably no new feature of the Mauna Loa rifts and undoubtedly numerous cones of ancient Mauna Loa history lie buried under the accumulation of lava flows.

The hot and steaming locality with sulphur deposits[2] between 11,000 and 12,000 feet can be reached from the Wingate camp without having to traverse more than 400 feet of aa lava. There appears to have been but little or no change in the amount of steaming and in the area of the sulphur deposits since it was observed in 1923. In a few places the steam was very hot and escaping with a purring noise. No odor of SO_2 was detected. Judging from the recent spatter (1916, 1919, and probably at times of other recent flows) at several places along the rift it would appear that cinder cones would have been built up had the activity in this locality continued long enough.

The lava around the sulphur-deposit area seems to be made up of a thin veneer of light, black aa and pumiceous pahoehoe of recent flows over very old aa. Two cones above the sulphur banks are of a recent age, the others are very old. The lava on the southwest flank of Mauna Loa may well be divided into two ages: recent (within the last 100 to 150 years, say) and old. Lava flows of various ages showing a uniform gradation in weathering between the oldest and newest flows are not to be found.

Water was observed in a deep and narrow crack at about 12,000 feet. Mr. Wingate reports water in a similar crack at a dark gray cone just west of the main hot fissure at an elevation of 11,970 feet. A rope 15 to 20 feet long, with some suitable container, is necessary to obtain water from these cracks. Just below the sulphur bank area there are several stone piles, apparently built up for some ancient Hawaiian ceremonies.

Both pahoehoe and aa flow ridges, varying from 10 to 50 feet or more at the base and from 5 to 20 feet or so in height with very narrow tops were

1 This Bulletin, Dec., 1919, to Aug., 1920
2 This Bulletin, Aug., 1923

observed on steep and moderately steep slopes. This type of longitudinal ridge in aa flows or mixed aa and pahoehoe is quite common. They may be found below the road at Kealakekua, Kona.

From a great many points the southwest flank of Mauna Loa may be seen as a series of shoulders and terraces.

VOLCANIC CONDITIONS IN DECEMBER

Activity of Halemaumau

The beginning of December saw nothing new at the Hawaiian craters, but though the Halemaumau pit appears dormant, the heat, fume and seismicity of the region as a whole are not sufficiently different from the times of lava activity to lend color to any belief that the lava has retired to any unusual depth. The proofs of this are that there are vapor and sulphur fume as usual, the pits to the east, such as Aloi, Alealea and Makaopuhi, and the field of 1923 lava west of the latter, give up steam and sulphur, the Mauna Iki fissures of 1920 are hot enough to light wood, fissures at Mokuaweoweo are hot and sulphurous, and tremors local to the crater regions indicate that something below stirs. No great tilt of the ground inward since the lava was in Halemaumau in July, 1924, indicates its subsidence; on the contrary what tilt there is suggests that the underground lava is either stagnant or rising.

The first week of December exhibited considerable avalanching in Halemaumau pit, followed by a marked revival of felt local earthquakes, such as had not been registered here for some months.

In a quarter hour from 9:45 to 10 a. m., December 3, with light south-southeasterly wind, four slides fell from the western and northern walls of the pit. The walls were wet and steaming in several places though there had been no rain. The slides were small, but would start suddenly from high up the walls and make trails of rock and dust, especially about the dyke and caverns of the southwest rift where it outcrops in the pit. The walls were much more in motion than at any time recently. There were trickle cascades of sand on the west wall. Soon after noon the next day big clouds of dust rose from the pit and the seismogram at 2:31 p. m. showed a long earthquake movement coinciding with an extra big avalanche. On the 5th a large scar was discovered in the west wall of the pit, cascades of black sand were continuous four-fifths of the way up the wall, there was fresh red debris below, and clear across the bottom of Halemaumau dust had been deposited so as to obliterate the sulphur stains of the east side.

Two strongly felt shocks occurred about 9:30 a. m. and 12:45 p. m., December 5. Each of these dismantled both components of the Bosch-Omori seismograph. The first visibly touched off a small slide at the pit, but so far as could be seen in the afternoon Halemaumau was very still and sleepy. On the 7th several slides occurred during the day and at 2 p. m. there were again sand cascades on the west wall. An earthquake at 10:16 p. m., December 8, was prolonged but gentle and a lighter shock occurred at 11:48 p. m.; both of these were felt at Hilo. The indicated distance was nine miles southeast of the Observatory.

Eighteen earthquakes were registered during the week ending December 9, of which one was of the avalanche type and four were perceptible. The two of December 6 appeared to have origins close at hand, of the order of two miles distance. A strong NNW tilt accompanied the quakes of that day and the tilting of the week was moderate NW. A dog showed alarm and pheasants squawked during the first earthquake of the evening of December 8.

This seismic spasm died away during the second week. The weather was dry, but in spite of this the walls were much wetted by steam. Steam-crack belts in and outside the pit appeared to accord notably with the southwest rift direction. Generally small stones could be heard falling from the north wall.

Avalanche dust arose December 13 at noon. Some sulphur odor was perceived at the rim of the pit and sulphur spots reappeared on the bottom. At the southwest wall steam appeared to be increasing.

During the week ending December 16 twelve very feeble seisms were registered, lessening in amplitude and frequency. Microseismic motion increased about the 15th, this being coincidental with the beginning of southwesterly wind.

During the week ending December 23 after a southerly storm on the 18th, the walls of Halemaumau became wetted and deep red in color, this coloring extending even to the talus slopes. Steam was abundant in the pit and rock falls were frequent, especially at the northwest. All the seismographs on the island registered marked increase in amplitude of microseisms with the beginning of the Kona wind. Six earthquakes were recorded, one at 3:37 p. m., December 19, being felt at Olaa and at the Observatory, its indicated distance of nine miles being the same as that of the earthquakes of December 8. Tilting was moderate SE.

For the week ending December 30 nine local earthquake movements were registered on the Observatory seismographs, all too feeble to be perceptible. Tilting of the ground was slight towards the west. On December 27 no rock falls were heard during a visit to the pit; on the 29th a few small dust puffs rose from the cauldron, and on the 30th dust in small amounts rose frequently, steam was conspicuous along the south rim and from the southwest half of the interior and sulphurous odors were noticed at the rim. By drying after rain a coating of white sulphates had blossomed out on the northeastern wall.

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December 3. In Halemaumau pit from 9:45 to 10 a. m. with wind from the SSE, the actual wall rock was observed to be wet and steaming above the talus near the top of the northwest slide, at the east end of the northeast sill, at the base of the southwest rift dyke on both sides of the latter, and along the base of the southeast wall. There had been no rain within twenty-four hours and the vapor jets on the bottom of the crater were of ordinary volume.

Within the quarter hour four slides occurred at the north, southwest and west walls. Two of these were from the southwest rift belt. The slides were small, but made trails of rock and dust, and tended to start suddenly from high up the walls. The cliffs appeared to be much more in motion than at any time recently. There was red dust on the floor and new debris on the northern and western taluses. Trickle cascades of sand were in motion on the west wall south of the northwest talus cone.

December 4. At 2:30 p. m. a big cloud of dust rose from the pit and the seismogram at the Observatory showed a long earthquake movement at the same time. About noon and thereafter there must have been big avalanches from the west wall of the pit which had been foreshadowed by the movements of the previous day.

December 5. At 2 p. m. inspection of the pit showed that these avalanches had left a big scar in the west wall between the west boss and the northwest talus. A large surface mass of rock had fallen away. Fragments were in motion there now, and cascades of black sand were continuous downward from a point four-fifths of the way up the wall. Fresh red debris lay below and the bottom was dusted clear across the floor to the east talus where the dust obliterated the yellow sulphur stain.

At the west pocket of the bottom the steam jets were rearranged along the border of the new debris that had fallen. The former west pocket was covered with rocks; it had been a steaming mud flat. The steam extended in a line up the bottom part of the northwest talus, and purplish black sand formed small talus cones on top of the new debris. The sliding was almost continuous at the new scar, and some rocks were falling at the southwest side of the pit.

Fig. 38. June 29, 1916. Looking toward the summit of Mauna Loa from Puu o Keokeo, about 7,000 feet above sea level, along the line of southwest rift cones. Shows the whole south flank of this extraordinary mountain. Looking southeast (right), northeast and northwest. In the foreground on the left is the cone of 1916, and in the extreme distance is the light line of sulphur deposits, following the rift, at about 11,000 feet elevation. Photo Wood.

Fig. 39. Sulphur deposit area at 11,000 feet along southwest rift of Mauna Loa. The side of the cone is steaming and coated with sulphur. Photo Emerson, August, 1923.

Fig. 40. August, 1923. Looking down southwest rift of Mauna Loa from above 11,000 feet. Cones of Puu o Keokeo group on sky-line. Flat intervening ground is striped with flows that have poured east from the rift zone, which is on the right. Photo Emerson.

Fig. 41. August, 1923. Looking toward Puu o Keokeo southwestward down Mauna Loa, from lower end of sulphur deposit area at 11,000 feet. Photo Emerson.

December 6. At 9:30 a. m. a snappy, jerking earthquake shock occurred, of short duration, and plainly felt. Just afterwards an avalanche fell in Halemaumau. A second earthquake of the same general quality occurred about 12:45 p. m. feeling about the same as the first one but a little more prolonged. It was strong enough to cause a collie dog to show alarm. Both these earthquakes dismantled both the Bosch pendulums, set off an experimental annunciator seismometer, and the second one upset the most sensitive prisms of a prism seismometer which had been readjusted to more sensitive balance after the first earthquake.

The pit was visited at 2:20 p. m. and was found to be very dry and showing very little rock motion. The sand cascades at the west wall had nearly stopped. There was light south wind. A vertical wet zone was observed in the southwest wall of the pit east of the rift cavern, and steaming near the top. The earthquake had produced no obvious effects in the pit.

December 7. At 2 p. m. the weather was calm and the pit very still so that if there had been the slightest blowing noise at any of the steam jets it would have been perceptible. There was none. Sand cascades were again in evidence on the west wall and a small slide occurred there. Rocks fell also at the southwest and north walls. There was fresh debris on the northeast talus. Yellow-green stain of sulphurous aspect was conspicuous now only at the base of the southwest rift talus. Twice during the day dust rose from the pit. Several earthquakes were registered lately on the seismograms at Hilea.

December 8. About 10:14 p. m. a prolonged earthquake occurred, pheasants squawked much during and after the main shock, and a dog jumped up and showed alarm.

December 11. At 10 a. m. in bright calm weather after rain the previous night, the walls and talus heaps were steaming, especially about the southwest rift. So were the gullies north and northwest. The west wall was streaked with fine dark brown sand above the smooth pile of it at the foot of the wall. The popping sound due to single rocks striking clear was heard four or five times during fifteen minutes, but the stones were not detected.

December 13. At 11:40 a. m. a little pink dust rose from the north side of the pit.

December 14. At 11 a. m. after thirty-six hours with no rain the steaming places in the pit floor and walls were still notably wet. Sulphur smell was noticed and yellow stain was detectable at the bottom of the east side of the southwest rift talus and also among broken rocks at the southeast edge of the floor. Sounds of falling rock were heard twice in five minutes.

December 16. At 9 a. m. conditions remained as before, individual rocks were falling at the north, and the wind was light from the northeast. There had been light rain. One of the falling rocks sounded like a pistol shot. Blue fume was noticed in the steam of the south talus and at a crevice in the east floor. White salts appeared on all the rock east and west of the southwestern taluses. There was much wetness and flocculent steam at the top of the big talus, at the south side of the west boss where the white stain was fresh and most abundant, and at the wall under the rift chasm. White stain was beginning to appear again on the flat surface of rock along the base of the southeast wall. A sulphur patch appeared in the steam at the foot of the talus next to it on the north. The steam rising from cracks at the edge of the pit southeast was thrown into a whirlwind with blowing noise. There was heavy flocculent steam at the base of the northwest talus and soft steam clouds at the south talus. The steam jets formed a sinuous line across the bottom of the pit from the south talus to the northwest talus.

December 17. At 9:30 a. m. fresh red debris was observed at the north. The yellow stain under the southwest rift tunnel was increasing. The steam

patches and walls were unusually wet. The steam at the south talus was on this day all clustered at the top of the slope so that the long dry streak up the middle of the talus cone was free from steam. Generally it is bordered by steam on each side.

December 23. At 10 a. m. there was abundant steam condensed from the recent rains and there were occasional rock slides from the western wall. The walls were dark red and several of the talus slopes had streaks of the same color.

December 27. At 11 a. m. steam was abundant, especially southwest, and no rock falls were heard.

December 29. A few small dust clouds were observed.

December 30. Steam was abundant along the south rim and from the southwest half of the pit. Sulphurous odor including possibly hydrogen sulphide was noted. A coating of white sulphates had formed on the northeast wall above the east half of the north sill. Dust clouds at the pit were frequent.

December 31. At 11 a. m. one slight echo of falling rock was heard. The pit was dry and still and nothing whatever could be detected that was new.

SEISMOMETRIC RECORD

During the month ended midnight December 31, 1925, 48 local earthquakes and no teleseisms were registered at the Observatory. These and other earth movements are exhibited below. Time is Hawaiian Standard, 10 h. 30 min. slower than Greenwich.

Abbreviations have meanings as follows: vf = very feeble; f = feeble; s = slight; m = moderate; d = instruments dismantled; fl = felt locally; △ = indicated distance to origin in miles; and a = a peculiar type of tremor that builds up gradually without phases, continues longer and with lesser amplitude than ordinary local earthquakes of similar intensity. There is a close correlation between these tremors and the occurrence of avalanches at Halemaumau.

Local Earthquakes

December		December		December	
1—	1:51 a. m. vf.	6—	5:23 p. m. f, △ 11.	13—	11:35 a. m. vf.
	12:52 p. m. vf.	7—	1:59 a. m. vf.	17—	3:02 p. m. vf.
	4:11 p. m. vf.		1:46 p. m. vf.		6:29 p. m. vf.
	4:52 p. m. vf.		8:00 p. m. vf.	19—	1:46 a. m. vf.
2—	6:26 p. m. vf.	8—	10:16 p. m. s, fl, △ 9.		3:37 p. m. s, fl, △ 9+
	6:29 p. m. vf.		10:24 p. m. vf.		
	7:06 p. m. vf.		11:48 p. m. s, △ 8.	20—	4:52 p. m. vf.
3—a	8:37 p. m. vf., lasts for 5 minutes	10—	3:06 a. m. vf.		4:55 p. m. vf.
			7:41 p. m. vf.	23—	5:24 p. m. vf.
	9:13 p. m. vf.	11—	7:48 a. m. vf.	24—	4:23 a. m. vf.
4—	2:31 p. m. f △ 9.		4:49 p. m. vf.		4:37 p. m. vf.
5—	11:16 p. m. vf.	a	5:36 p. m. vf.		6:31 p. m. vf.
6—	9:19 a. m. vf, △ 2.		6:20 p. m. vf.		10:44 p. m. vf.
	9:20 a. m. m, d, △ fl.	a	11:48 p. m. vf.	25—	4:12 p. m. vf.
	11:58 a. m. vf.	12—	12:19 a. m. vf.	27—	2:49 a. m. vf.
	1:45 p. m. m, d, fl, △ 19.	a	2:05 p. m. vf.	29—	5:29 a. m. vf.
		13—	10:36 a. m. vf.		5:34 a. m. vf.

Harmonic Tremor

This type of tremor was absent throughout the month.

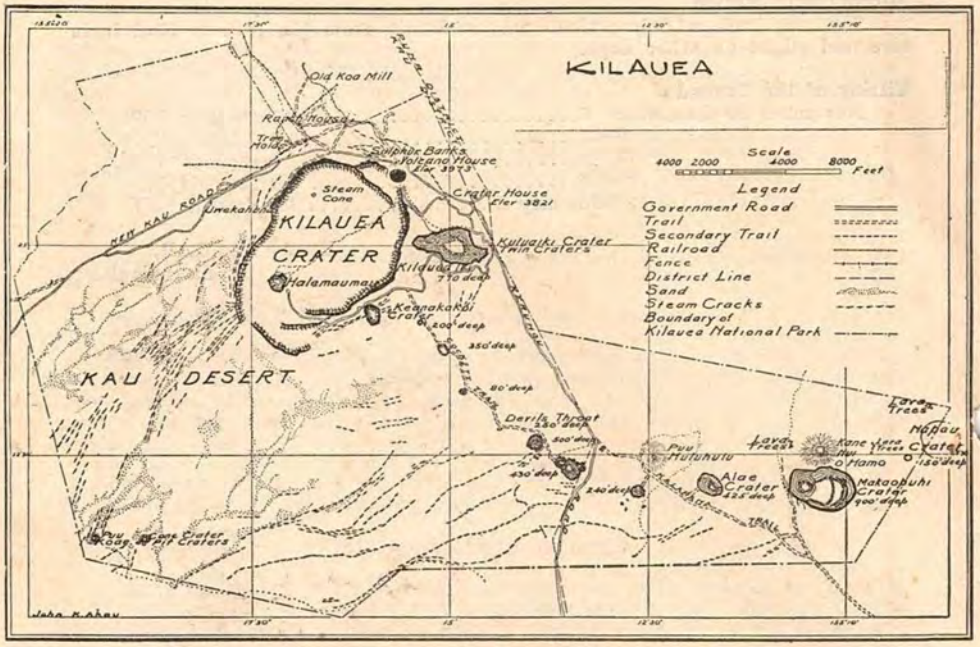
Microseismic Motion

The amplitude of microseisms was moderate from the 19th to 23rd inclusive and slight on other days.

Tilting of the Ground

November 29–December 5	2.1 seconds	SW.
6–12	3.7 seconds	NNE.
13–19	1.4 seconds	ESE.
20–26	1.9 seconds	W.
27–January 2	0.6 second	ENE.

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, Volcano House, 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, Hilo and Hilea.

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′ 54.2″ N.; Long. 155° 15′ 39.2″ W.; Elevation cellar 1214.6 meters (3985 feet). The Hilo, Hilea 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.