WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

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TECHNOLOGY STATION, Jan. 6. 1917.—During the week ending Jan. 5, 1917, the lava of Halemaumau subsided twenty feet for the first two days and developed violent cascading downward into a chasm at the extreme southwest. The lake then recovered its level with spasms of return to the cascading process alternating with strong rising and overflow both from the coves and through driblet cones and pots on the floor. The net effect for the week on the lava column January 4 by measurement was a stationary lake 100 feet down with the overflooding expended in spreading out the floor and tending to surround the crags, filling depressions and building ramparts and conelets. The fumes are very thin, but very sharp to leeward. Descents into the pit by the east gulch are now easily made and experimental work with the liquid lava at the edge of the lake is in progress.

On December 30, 1916, at 2 p. m. the lake seen from the northeast station appeared ten feet below its rim and a flow was in motion on the north floor. At 2:20 from the northwest station a dome-shaped cone could be seen on the south border of the northwest pond depression. This pond was crusted but the cone exhibited glowing lava. The pit was smoky.

At noon on December 31, the lake seen from the east appeared twenty feet below its rim with active fountaining at the north and large stalactites in the grottoes. At 12:25 p. m. a large fragment of the crag mass on its northeast side fell into the lake and induced strong fountaining. At 2:30 p. m. and in the evening a cascade had developed from the southwest arm into a cove extending northward from its west end, the lava of the lake pouring downward with great rapidity into a chasm. This cavity had developed by collapse from the blowing and flaming pot which has for weeks past been observed at the west neck leading to the southwest peninsula.

On Monday, January 1, 1917, at 3 p. m. the lake was seen from the northeast to have recovered and at 3:40 it was overflowing on the northeast and southeast. At 4:30 the overflow had extended to the northwest arm and had spread to the base of the wall of the pit.

On January 2 at 3 p. m. the lake was ten feet below its banks and its surface was quiet. At 3:35 subsidence set in, there was rapid streaming westward around the south island with strong fountaining and the cascade again developed from the lake into the southwest chasm making a loud roaring noise. Only a dark pot without glow could be seen at the site of the northwest pond. At 8 p. m. the lake appeared low with the two arches showing west of the south island. Flames were playing from the northwest cone and the high orifice in the wall on the south side of the crag mass. From the east station the driblet cone on the north floor was seen to be ejecting spasmodic spurts and flings of melt from a large hole. The noise which it made was peculiar, a deep gurgling spasm with a bell-like note due to the ringing of the cone cylinder, made of lava glass. Occasionally enormous fountaining areas would develop in the middle of the lake and migrate southeast. Eight or nine fountains were in action, especially in the grottoes of the north rampart, and flames burst from under

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surface crusts. A glowing cone could be seen near the west wall.

At 11 p. m. the cascading was renewed from the lake into the southwest chasm. From the southwest station this was seen to begin with inrush from the southwest arm to the cove where a cauldron gradually developed by subsidence, thirty feet in diameter and twenty feet deep. The whole end of the southwest arm was sucked down with a roar and there was high incandescence and effervescence of intensely suffocating sulphurous gas. The effect was like a waterfall and inside the cauldron there was tremendous churning and boiling. Simultaneously a sharp crackling noise was heard toward the southeast and the lake was everywhere sinking and showing a stalactitic border.

On January 3 after 11 a. m. the southern region was stagnant and the streaming was northward and from the northwest arm outward. The driblet cone west was high with radial flows, the northwest pit was small and deep, a large sulphur-stained flat cone was crackling southwest of it and from it lumpy short flows had poured westward and a long festooned one south from its east side. There were no fresh flows from the northwest arm.

The north driblet cone was now twenty feet high with an open arch below and a field of hard lumpy pahoehoe around it. Going down by the east gulch the writer, accompanied by Mr. Twigg Smith, explored and photographed this field and the north rampart.

The pahoehoe was making out in incandescent toes covered with a membrane of glassy fibres stiff and flexible. The orange hot melt beneath flowed like very stiff porridge full of bubbles.. Dragged out on a stick it stretched much like candy, but in a few seconds became hard as glass. On ascending the rampart which poured forth much yellowish white fume over a grotto, the lake was seen about ten feet below streaming slowly northward and fountaining violently against the rampart a few feet in that direction. The fountains were singularly noiseless heard from this low level, and the skins tearing appeared to consist of thick ropy fibres. The material of the fountains appeared much stiffer than when seen from above, shredding into leathery rods and hard droplets. The gasses eddying up were not oppressive and quite different from the intolerable blue fume which condenses in the air above the fountains and is so unbreathable on the south rim of the pit. The rampart was covered with splashes and droplets of black glossy glistening lava glass. The surface of the lake showed bellying skins with gas beneath, and upfolded and upturned crusts. As a whole, however, it was quite level. The pounding in grottoes produced no shaking and little noise back of the rampart. Noise, heat and fume are all stronger on the high rim of the pit than they are on the floor.

We next walked through the east valley to the southeast floor and up on the southeast rampart. The lake was pounding hard beneath and all along the rampart farther south. There was no great inconvenience from the fume but it was more disagreeable than on the northeast rampart. Great banks of half-decomposed Pele's hair clung to the base of the south wall of the pit, having the appearance of rotten hay seed.

On January 4, 1917, measurement at 10 a. m. made the depression of the lake 101 feet below the southeast rim of the pit and the height of the crag mass sixty-four feet above the lake.

These measurements indicated a stationary condition for the previous week.

There were fresh flows in motion on the north, south and west floors from 7 to 8 a. m. The western floods had nearly joined the southern ones back of the southwest bench. The driblet cone appeared submerged. During the morning the fresh flows, after developing crusts three to five inches thick, collapsed in their middle parts leaving upstanding shells with stalactites around the borders.

At noon the writer, with Alex. Lancaster, Joe Moniz and F. J. Stotts, stood on the northeast rampart after crossing the fresh lava flow and collected an iron pot full of lava by thrusting it beneath the surface of the lake on the end of a long iron pipe. The pot was dipped three times and the specimen resulting will be sent to the Geophysical Laboratory of the Carnegie Institution for analysis of the gases enclosed.

At 12:30 p. m. the inrush cascade at the southwest cove began as before the subsidence. At 1:45 p. m. this stopped during a rising spell. Cascading was resumed at 2:15. This stopped and rising ensued at 2:50 p. m. Thereafter there was a lull in the cascading but at 8:30 p. m. the southwest arm was again tumbling into the void.

On January 5 at 2 p. m. the lake was high with slight fluctuations and new flows southwest, southeast and northeast. Five or six fountains were in action and there was strong blowing at the north rampart. At 4:20 p. m. a powerful true fountain of the "artesian" variety started a flow southward from the northwest cone and overflows flooded the benches northwest, east and southeast. At 5:30 p. m. the lake and the northwest pot subsided so that a sharp glow outline appeared around the former about three feet deep with stalactites and the northwest pot became a glowing oven. The flow crusted and violent large fountains started in the lake north, southeast and southwest. There was tremendous hissing emission of gas from under the lake skins along the north and southeast ramparts throwing high spray and puffs of blue fume. There were falls from the spatter benches southwest and elsewhere. During the overflow much of the boundary between lake and floors was obscured by the lava flood. When the west arm settled back there was drip of glowing lava into the lake from the bank under overhanging skins.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with January 5 two local earthquakes, of small and moderately small seismographic amplitude have been registered. These were not of perceptible magnitude. Microseismic motion has been as usual. The seismographic amplitudes of the waves of volcanic vibration have been larger than normal and the conspicuous groups of such waves have been more frequent and of longer duration than usual. In the early part of the week-interval there was a sharp increase in the apparent tilt to the east and north and this has been maintained with little change.

TECHNOLOGY STATION, Jan. 13, 1917.—During the week ending Jan. 12, 1917, the lava lake of Halemaumau has continued to rise at the rate of about two feet per day, with overflows from time to time and lava welling up through cones on the floor, especially at the north and northwest. The crags have also risen, in general keeping pace with the rising of the lake. Experiments have been made during the week by the workers at the Observatory in measuring temperature, collecting gases and photographing the pit from the inner crags.

On Saturday, Jan. 6, the lava had subsided slightly after the strong overflowing of the previous day. On Jan. 7 the writer accompanied by Smith, Lancaster and Moniz adjusted the rope ladders to the west niche of Halemaumau and descended to the northwest floor. Here it was possible to cross the floor to the crag mass and climb to its summit. Photographs were made of the pit walls from the summit and others of the lava lake. Three flaming cones were examined in the vicinity of the northwest pond, the largest of them a glowing orifice three feet in diameter

at the southern margin of the pond depression. Flames were playing about the pot and lava could be heard pounding within. The northwest pond itself was a shallow oval depression in broken lava crusts. Two smaller cones about the north margin of the west wall pond were hissing from small holes and lava could be heard splashing inside. There was an extensive fresh flow over the northern and southern benches which had been in motion in the early morning and lava toes were moving red hot in the valley between the southwest crags and the wall. The fumes from the northwest cones were disagreeable to leeward of them, but the air on the upper part of the crag mass was not bad except for occasional whiffs from the large fountains in the north cove. The lake was low and occasional cascading took place into the southwest chasm.

On Jan. 8 a second expedition was made to the northwest cones by Messrs. Wood, Lancaster and Moniz in order to try for gas collection with vacuum tubes. One of the small west cones was broken open in order to enlarge the flaming orifice for insertion of the tubes, but the orifice immediately sealed with lava spatter.

At 10 a. m. the writer inspected the north cone which was putting out lava toes and was now a group of small hummocks a few feet high. From one of these a flame was playing from a narrow vertical slit about eight inches long and there were white sublimates deposited around the glowing orifice which made a whistling noise. The lava in the lake rose and fell through a small range and was in general about ten feet below the rampart. In the evening from 5 to 7 o'clock the lake was still low with numerous fountains and many flames from the grottoes, the wall chimney on the south side of the crag mass and the large northwest cone. The west wall pond was again revealed as a small pool covered with dark blistered skin and showing a quiet glowing grotto at its north end. The north cone was still ejecting sluggish pahoehoe.

On Jan. 9 the lava was high and flows were in motion. On Jan. 10 the lava retained its high levels and there was glow in the northwest cone and in flows around the north cone.

On Jan. 11 at 9 a. m. the lake seen from the east station was brimming level with the rampart, four or five fountains were in action, the recent flows appeared small except for a considerable field of pahoehoe around the north cone.

Assisted by Messrs. Thurston, Smith, H. Johnson and Moniz, the writer made a temperature test with Seeger cones. A battery of six cones of fusible clays, such as are used in the porcelain industry, was enclosed in an iron cylinder, screwed on the end of a galvanized iron pipe and thrust three feet below the surface of the lake. The cones selected ranged in fusibility from 990° C. to 1150° C. The apparatus was immersed in lava for six minutes. Flames from burning gas played around the orifice where the pipe punctured the skin of the lake and these flames were a brilliant greenish yellow color from the zinc of the pipe's galvanized surface. Droplets of metallic zinc and a yellow deposit of zinc oxide were left on the pipe, and this deposit turned white on cooling. The pipe bent sharply at the point where it entered the lava, softened by the heat. On removing and cooling the cylinder, none of the cones showed fusion, indicating that the temperature here, three feet below the surface of the lake, was less than 990° C. Further experiments will be made with cones of lower fusing point.

Overflows began northeast and southeast just as the experiments started, three of them along the northeast rampart, threatening to make the work on the rampart impossible. Fortunately two of these progressed but a short distance and the northernmost only about one hundred feet. The overflowing stopped at 9:30 a. m. and the lake subsided six feet and then recovered three feet. A very large half-dome grotto had been built up southeast and there was occasional heavy fountaining north, and swift streaming westward from the bench at the south island.

Mr. L. A. Thurston experimented by throwing logs of ohia cord wood into the lake. The first, thrown while the

lake was overflowing, plunged beneath the skin and remained burning submerged, the flames puffing through the lava and producing some ballooning of the surface, but almost no fountaining. The flames were yellow. The second experiment was after subsidence and during temporary rising. This time the log was hurled down end-on so as to puncture the surface layers of lava over the gas beneath. The result was again flames and puffs of smoke followed by a fountain which spattered thick pasty lava over the bank for several minutes. On neither occasion did the wood show any tendency to float up but burned beneath the surface. Several normal gas flames from the lake were seen which burst from under the crusts and appeared reddish in daylight.

A remarkable fact was noted on this day and previously; namely, that there is practically no odor of sulphurous acid gas to leeward of the moving pahoehoe flows on the north bench. On this day the writer was immediately to leeward of where the golden torrent poured over the rampart with hundreds of small bubble fountains bursting through it. There were oppressive heat waves to leeward but there was none of the acrid and intolerable blue sulphurous fume which reaches the upper rim of the pit from the flaming fountains and grottoes. The suggestion is strong that the oxidation producing the sulphurous acid fume results from union with atmospheric air, and this checks with the observation that not all of the fountains produce flames.

Measurement on Friday, Jan. 12, 1917, at 9:30 a. m., determined the depression of the lake to be 87 feet below the south rim of the pit, indicating a rise of 14 feet in eight days. The south island stood 49 feet above the lake, the east crag 52 feet, the southwest crag 45 feet and the crag mass 65 feet. The length of the lake as a whole was about 800 feet and its width at the west arm 700 feet. The lake was six to ten feet down, first subsiding and thereafter rising with some inrush at the southwest cove with churning in the grotto there. There was southward streaming from under the two arches west of the south island. A sluggish pile of pahoehoe was making incandescent toes over the site of the west pond. There was occasional heavy bombardment in the northeast and southeast rampart grottoes and sometimes very heavy blowing fountains in the north cove. There were two heavy falls of spatter bench material southwest. No marked changes were observed on the northwest floor.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week interval ending with Jan. 12 two local earthquakes have been registered—one with moderate seismographic amplitude and one with small seismographic amplitude—and one wave group of doubtful character. The seismographic amplitude of microseismic motion has varied irregularly between normal and moderate values, rising at the end to strong values. The seismographic amplitude of volcanic vibration has fallen at times to normal values but, though irregular, it has usually been moderately large. There has been an irregular shifting of the pens tending on the whole to indicate a decrease in the tilting to the west and south. This shift has been most marked near the end of the interval.

TECHNOLOGY STATION, Jan. 20, 1917.—"During the week ending January 19, the immense lava lake of Halemaumau has continued to rise and at a still faster rate than during the previous week. The upper portions of the large crag mass are now in full view above the rim of the pit as seen from the Volcano House, and only eight feet below it. The mechanism of rising is remarkably constant with overflow of the north and south ramparts and uplift of the east and west crags. The writer has continued to make experiments in taking direct temperature at the edge of the lake, the results to date indicating that the temperatures just below the surface skins vary between nine hundred degrees centigrade and one thousand degrees centigrade. Away from the grottoes and fountaining areas the lava is stiff and viscous and proves very unwieldy for experimentation owing to its tendency im-

mediately to solidify around any object thrust into it.

"On January 13 and 14 rising was especially conspicuous at the south end of the east crag, indicated by crevasses and uplift of fresh flows at the base of the crag, and compensated by subsidence of the floor under the northeast wall, causing fresh avalanches from the wall.

"On the morning of January 15 the lake was rising and falling from two to six feet. The lava had been piling up from the west and northwest floor vents and the north cone was buried under a smoking tumble of crusts. In the evening the lake overflowed strongly southward and there were avalanche slides at the east.

"With the assistance of Messrs. Thurston, Palmer, Smith and Alex. Lancaster, the writer immersed an iron cylinder three feet below the surface of the lake, on the end of a one-inch pipe, for eleven minutes. This contained six Seeger cones of fusibility ranging from 770 degrees centigrade to 990 degrees centigrade. None of the cones was fused. Possibly the congealed lava on the end of the pipe acted as a non-conductor to prevent heating in the allotted time.

"Next an attempt was made with a Bristol electric pyrometer to determine the rate of cooling of a sample of lava as it solidified. The thermo-element, a couple of wires twisted together which generate an electric current on heating, was fastened in an iron pot which was dipped beneath the surface of the lake and drawn forth filled with lava. Wires leading from the couple to a galvanometer recorded the temperature. The maximum temperature of the lava in the pot registered 420 degrees centigrade, and the rate of loss of temperature for each five minutes was about twenty-two degrees centigrade for the first twenty minutes, then double that amount for the next five-minute interval, and three times that figure for the next five minutes.

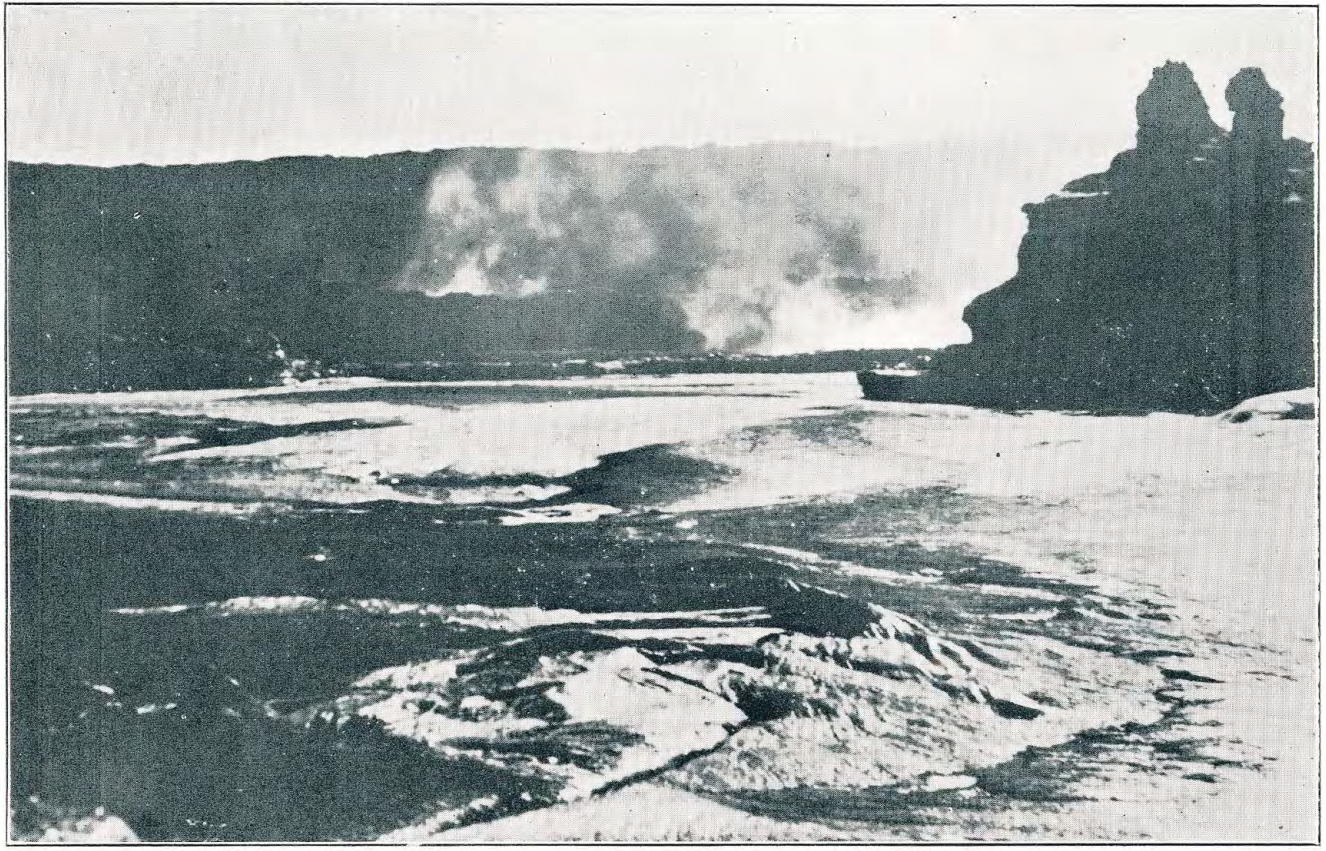
"Assisted by Mr. Thurston, the writer next tested the temperature of liquid lava at the edge of the lake with the uncovered thermo-element. The needle swung immediately and steadily to 910 degrees centigrade in a first test and 850 degrees centigrade in the second test. Adding 100 degrees correction to each of these readings for the overheated 'cold junction' which rested against the rampart where the air was very hot, we get 1010 degrees centigrade and 950 degrees centigrade as the measured temperatures for the two cases, the lower temperature in the second case being occasioned by the encrusting of the terminal, which was drawn under the bank by the current. These measurements of temperature check perfectly with the readings made with thermo-element by Shepherd in 1911 and with Fery pyrometer by Daly in 1909.

On January 16 the lake rose and fell in pulsations until four-fifteen in the afternoon, when heavy overflows rushed over the whole south rampart and cascaded down to fill the wall valley, and at the same time strong overflows poured over the north bench from the northwest arm. The overflowing stopped about four forty-five in the afternoon. During the day small avalanches fell from the 1894 bench northeast. there were about eight fountains in the lake, and a large blowing cone had been built up at the extreme end of the northwest arm, which spurted flames and spray with loud puffing noises. It was possible to approach within a few yards of this cone, and just beside it in the northwest arm the writer watched, only a few feet away, a spectacular grotto hung with glowing stalactites, where gas from under the skin blanket made violent outrush with puffing and spraying.

"During the overflow a glowing filigree cone developed at the north cone locality. Occasionally during the day a deep booming sound was heard from the rising east crag, which had been lifted twelve feet within a few days, carrying with it the boulders under the east gulch and the fresh flows near the southeast cove.

"About noon a balloon of skin was raised over the middle of the north cove and extended itself for thirty feet eastward, finally bursting open at its east end and revealing a most beautiful and brilliant cavernous space all glowing and floored with bubbling incandescence. After releasing the flam-

Looking southeast from summit of great crag-mass—showing south crag and connecting peninsula, and lake streaming round crag. —Photo. Jaggar.



Jan. 5, 1917—Crag mass and lava lake from N.E. rampart, standing on edge of lake. —Photo. Jaggar.

ing gas through this archway the bubble slumped. Its outer surface was silvery gray and resembled the back of a hippopotamus.

"The cylinder experiment with Seeger cones of lower fusibility on this day failed owing to an attempt to leave the apparatus in the lava thirty minutes. Heavy skins piled against the pipe where it entered the lake and solidified there. On listening at the upper end of the pipe one could hear distinctly the bubbling noise of the seething lake twenty feet below. On attempting to twist the pipe, it parted at the lava contact where it was heated to redness and immediately the zinc galvanizing of the lining blazed with a strong yellow flame, which played in pulsations for six minutes, leaving a yellow white coating.

"On January 17 at eleven o'clock in the morning the lake was overflowing northeast, and at four that afternoon the north cone gave vent to a flood over the north floor. The lake was then ten feet below its banks. In the evening there was strong outflow from the cones north and northwest.

"On January 18 the lake was low, nine to eleven feet below the inner bench, and a flow was in motion on the north floor with origin somewhere near the site of the north cone, though no cone was visible. There were fresh overflows northeast and southeast and the north rampart had greatly added to the bordering spatter domes, one of these being fully fifteen feet high. Five or more fountains were in action and the surface currents were rapid. The east crag showed further signs of rising.

"Two temperature tests with Seeger cones were made. A new device for holding the cones was used so that they could be inserted one above the other directly in the end of the pipe. The pipe was heated for thirty minutes just above the surface of the lake and then dipped for only one minute. The results showed a cone of fusibility 870° C fused on the edges and one of 970° C very slightly affected, indicating that the temperature was between these limits. The swift currents caught the end of the pipe and strained and bent it so that it was recovered with great difficulty.

"Measurements on Friday, January 19, 1917, at ten-thirty in the morning determined the depression of the lake to be sixty-eight feet below the southeast rim of the pit indicating a rise of nineteen feet in seven days. The crag mass was sixty feet above the lake, the east crag forty-one feet, the south island forty-eight feet, the southwest crag thirty-seven feet and the pinnacle of the south bench thirty-one feet.

"The lake was rising during the morning and overflows took place about 1 p. m. The crag mass showed increasing tilt to the west. There was fresh tumble in the wall valley between the west and southwest stations consisting of very large blocks from the lower part of the cliff. The south bench pinnacle showed elevation and large crevasses had opened near it. There was a very high pile of fresh pahoehoe in the southwest wall valley.

"The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

" 'During the week interval ending with January 19 three local earthquakes of very small seismographic amplitude, and one doubtful wave group, have been registered. Microseismic motion has been of moderate seismographic amplitude, or less. Volcanic vibration has been of moderate seismographic amplitude, with brief storms of greater energy. Pen shifts in the sense of tilt have indicated an increase in tilt to the south, or more strictly, decrease in tilt to the north, with slight fluctuations in the east-west component without marked net change.' "

TECHNOLOGY STATION, Jan. 27, 1917.—During the week ending Jan. 26, 1917, the lava of Halemaumau has continued to rise and the 1912 level has been passed. The lake is now about 50 feet down. The floor of the west niche is now flooded with fresh lava where the ladders were attached for descent of a 40-foot cliff on Jan. 7. The crags continue to rise and are now in full view from the Observatory. Very heavy and spectacular overflows have taken place during the week from both the north

and south marginal ramparts of the lake and the western floor is heaped high with lava that has welled up through vents in the region of the northwest and west ponds. Experiments have been continued in taking temperatures of the grottoes and flames, and in preliminary soundings to determine the depth and consistency of the under liquid of the lava pool.

On Jan. 20, 1917, at 2 p. m. the border bench around the lake was five feet high with lava that has welled up was in the northwest cove. The flow from the vent on the north floor was extending itself by trickling. The wind was southerly and the northeast floor region accordingly fumy. At 2:30 p. m. sudden subsidence of about eighteen inches was accompanied by violent fountaining in the north cove. These fountains tend to migrate to the northeast rampart where they expend themselves.

On Jan. 21 at 2 p. m. the lake was brimming and fountaining violently so as to flood the northeast rampart in streams which forked and spread eastward and northward. At 5 p. m. the lake was very quiet and about five feet down, the flow on the north floor was trickling, a flame played from the south wall of the crag mass, there were glowing spots on the south floor and the fountaining against the north rampart threw up heavy spatter. Later in the evening the northwest cone was seen spurting.

On the morning of Jan. 22 the trickling thick pahoehoe flow was still spreading over the whole northeast floor. Small avalanches were sliding from the east cliff and the 1894 bench. The continued lift of the east crag was carrying with it the rock tumble at the foot of the trail down the east gulch so that it was now easier to descend over the cliff at the east end of the 1894 bench. The northwest cone was now six feet high above a lava heap at the site of the former northwest pond. The lake level was from three to four feet below its margin, eight or more fountains were in action, the ramparts were building high and the wall valleys apparently sinking. There is a sequence every few days of alternative whereby these wall valleys first deepen, and then fill up by overflow.

In order to measure the temperature of the lava actually fountaining and flaming at the lake border in the northeast dome grotto, a one-inch pipe 40 feet long containing six Seeger cones of fusibilities ranging from 590° C. to 1070° C. was thrust into the grotto and allowed to heat for ten minutes in the invisible flame and then for five minutes in the splashing and down-sucking lava. The end of the pipe was sucked down and violently bent and it required the united efforts of five men to withdraw it. Five feet of the end were plastered with lava. All the cones were completely fused but one, and that one, of fusibility of 1070° C., was partially melted showing that the temperature was over 1100° C. Taken along with the results of previous measurements in the non-fountaining lava of the lake, it appears that the liquid in a distance of say 20 feet may change in temperature on entering a boiling grotto through a range of 300° C., or from about 850° C. to 1150° C.

On Jan. 23 with the aid of nine volunteers, an experiment in sounding was tried. Working on the east point and the northeast rampart a length of 200 feet of half-inch pipe was twice thrust over the bank obliquely out into the liquid lava of the lake 20 feet from the shore, and both times the pipe went down to a vertical depth of only about 50 feet when it encountered, not hard bottom, but an increasing resistance which was gradual, and finally caused the pipe to arch upward and fail to penetrate farther. In the first test the submerged lengths of pipe solidified against the bank on the attempt to withdraw it and the lower lengths were lost. In the second test the pipe was recovered, but only through the most strenuous hauling by nine men in line. Twice it stuck owing to accumulations of lava which caught against the bank. The end of the pipe emerged clean and showed no fusion or especial oxidation.

The notable result of this experiment, giving in two different places apparent evidence of increasing viscosity in depths to an impenetrable pudding at about 50 feet down, is the suggestion

that the lava lake is cooler and more viscous below than it is at the surface. To confirm this, tests must be made for temperature and viscosity in depth, and such tests are now in preparation.

On this day, Jan. 23, the lake was three to four feet down. There was a glowing flow on the south floor. At the base of the northeast wall recent flows were swollen up into ridges with crusts a foot thick and one of these which had collapsed revealed a cavern three feet high of bright orange glow inside. It looked as though the fresh trickling lava of later date had penetrated beneath these crusts and arched them up, welling out through the cracks, reheating the interior, and then partly escaping. Perhaps it is the slow drip of such secondary intrusion which gives rise to the well-known cavern stalactites and driblet spires.

At 1 p. m. there was overflow at the north and at 5 p. m. very heavy overflows across the south rampart sweeping westward and over the head of the west arm sweeping southward. A spray blast played violently at the southwest cove and there was activity at the northwest cone.

On Jan. 24 at 11 a. m. the lake was down ten feet with few fountains. At 2:45 p. m. the southeast rampart overflowed and the north rampart at 3 p. m.

On Jan. 25 at noon the lava was nearly brimming and rapidly rising and there was fresh lava on the northeast floor. At 2:30 p. m. there was overflow across the north rampart for an hour, the flood pouring east and west.

On Friday, Jan. 26, 1917, the weather was rainy with southwesterly wind, but this wind made conditions favorable for an attempt to walk around the entire circle of the pit on the inner floor following the base of the walls. The descent was made with rope ladder at the west niche, the floor of which was now only seven feet above the fresh lava heapings from the northwest pond. Accordingly the lower ladder was taken up and stored, and this was fortunate, for the next day its position was entirely covered with fresh flows.

A second ascent of the crag mass was made and from its high scarps a good view was obtained of the glowing interior of two high curtained dome grottoes across the north cove to the east. The west slope of the crag mass appeared steeper and more rifted than on Jan. 7 and there were yellow sulphate and alum deposits in the cracks.

Accompanied by Alex Lancaster and Messrs. June and Newton, the writer now made the circuit of the inner floor going first over a high dome of pahoehoe where the west wall pond had been. There were lava flows trickling in the southwest wall valley. We crossed a tumble of boulders which had fallen from the southwest wall and passed the mouths of gigantic crevasses which cut through the southwest crag. On arriving under the A-frame at the south the crusted wall pond there proved to be a distinct depression with a hard floor. After passing the south pinnacle the only disagreeable part of the circuit was encountered, namely crossing the hot flows of the southeast floor through the blue fume of that ever-active rampart. The fume proved bad and it was necessary to move rapidly through a short stretch of it. The lake was about four feet below the rampart. We next passed a deep crevasse south of the east crag and reached the east chasm and the foot of the trail and were now on familiar ground. From there the traverse of the north floor was easy. The northeast cavern was no longer glowing. The remnants of the 1912 ledge under the northwest station were now only six feet above the floor and the cavern in the northwest wall was nearly accessible.

The northwest cone was ten feet across and six feet high with the lava of the roofed-over northwest pond pounding within it at a depth of about twelve feet. There were filagree flaming orifices around the cone about two feet below its summit and the largest of these, ten inches in diameter, made a window on its east side through which could be seen plump glowing stalactites and a gorgeous fiery inner cupola shimmering with orange heat and revealing the splashing lava glass below. Fierce blasts of invisible flame which would have been lluish by night light came from the window and occasionally the gas pressure would increase

so that these blasts became rhythmic and noisy like an engine. The extension of the northwest pond north of this cone was arched over with domed lava crusts.

The temperature of the flaming window and the glowing cavity within was measured with a one-inch pipe containing a battery of seven Seeger cones ranging in fusibility from 620° C. to 1130° C. The cupola was blowing hard in pulsations and a whiff of the hot burnt gas from the flame which flew for an instant into the writer's face was a terrific sensation. The pipe was pushed into the window horizontally for three feet and left there nine minutes. First the green-yellow zinc flame appeared until the galvanizing was burnt off. The pipe became incandescent, softened and bent downward.. Then an oxide of iron formed over the surface and glowing drops dripped off the pipe completely liquid. The highest glow played over the pipe just at the entrance to the window where the supply of oxygen from the air was greatest. At this point after nine minutes the pipe was seen to be eaten through and was immediately withdrawn. The whole three feet of iron which had been immersed in the hot gases was a mere black oxidized shell, the end cap was entirely gone but the iron spiral which held the Seeger cones inside the pipe was little affected, showing that the outer reaction was chemical reduction and not fusion. This reaction at such high temperature was probably the union of sulphurous acid with iron to make ferrous oxide and sulphur. The fusible cones indicated a temperature considerably over 1130° C. and probably nearer 1200° C.

The lava lake on this afternoon remained low, from ten to twelve feet below the inner bench, and exhibited six or seven fountains. The north rampart was very high with bulging protuberances and much overhang. There were flaming holes through the rampart which crackled and fumed like a wood fire and showed white deposits.

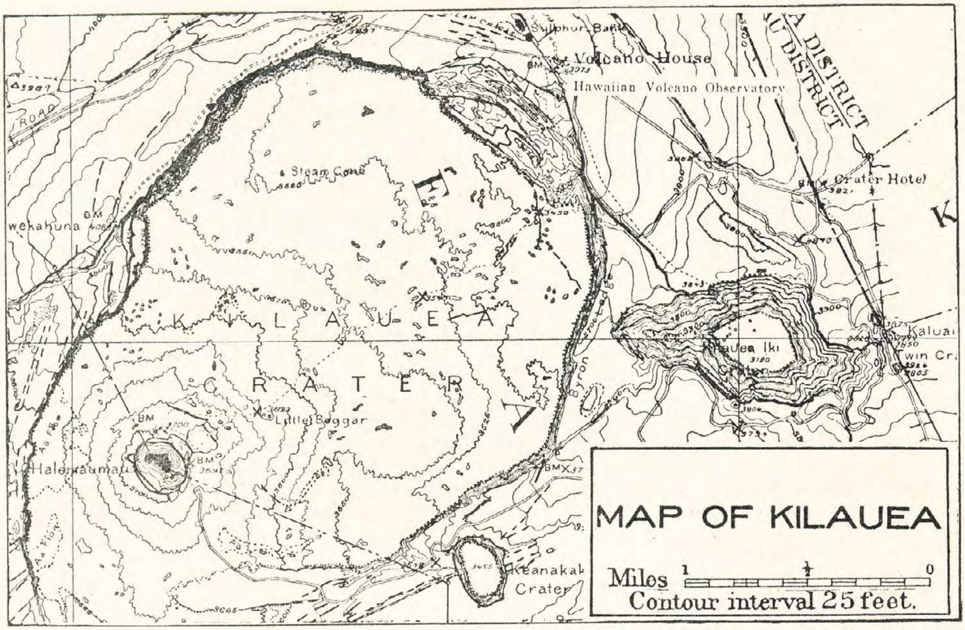
A young boatswain bird was found alive on one of the west crags and was rescued and given his liberty above.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with Jan. 26 two local shocks of small seismographic amplitude, and one doubtful wave group, have been registered. Microseismic motion, and motion of volcanic vibration, have been registered with variable seismographic amplitudes of values comparable with several previous weeks, but larger than the generally normal values. This holds true more particularly for volcanic vibration. This motion has, for the most part, shown increased amplitudes for nearly three months except for short quiet intervals. In the north-south component there has been a progressive shifting of the pen in the sense of tilt to the south, or of decreasing tilt to the north. In the east-west component the shifting has been variable with no well marked tendency, or net change.

Very respectfully,

T. A. JAGGAR, JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1915 there are about 100 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911 now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Assocaition subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, **the milligal.** The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed **in milligals by multiplying each of the numbers by 100.**

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, FEBRUARY, 1917. No. 2

Technology Station, Feb. 3, 1917.

During the week ending February 2, 1917, the lava of Halemaumau continued to overflow vigorously until February 1, when the flowing was confined to the west floor and there began a subsidence which continued for the next few days. The highest level reached by the lake on February 1 was 45 feet below the rim of the pit. The west pond, however, has piled up fresh lava fully 10 feet above that level.

On January 27 there was overflow across the southeast rampart at 12:35 p. m. and from the northwest pond locality in two powerful springs and from the northwest arm and the south bench. A great heap of lava had accumulated over the west wall pond. The flows continued for over four hours. The southwest peninsula showed tumbling spatter borders when the lava began to subside about 4:30 p. m. A high rampart had been built in front of the southwest crag.

On January 28 overflow began at 1 p. m. from the northwest arm and at 2 p. m. from the southeast cove. A cone had developed at the west end of the southwest peninsula which during the afternoon exhibited a standing fountain similar to the Mokuaweoweo fountains, spraying 40 to 50 feet into the air and manufacturing great quantities of Pele's hair.

On January 29 at 2 p. m. there was much fresh lava on the floors and the lake was very quiet and only about three feet below its banks. On January 30 there was overflow northwest at 1:30 p. m. and an hour later this was extended by a break through the northeast rampart.

On January 31 at 11 a. m. the lake was 10 feet down, fountains were numerous and for four hours there was little change. Ten fountains were in action.

On February 1 at 10:45 a. m. overflow began on the northeast and spread extensively on the bench. At 12:30 p. m. the lake was five feet down. The northwest cone was puffing vigorously and great accumulations of lava west and northwest had built up a rolling surface there which was within three feet of the floor of the large northwest wall cavern.

By this time the three greater crags so protruded above the edge of the pit that they were all in view from the automobile terminus. The crag-mess had been tilting westward. There was a flat ring-shaped cone and crater at the west end of the southwest peninsula. The lake had built immense glowing grotto domes in the northeast rampart and at the west end of the southeast rampart, and under the isthmus adjacent to the south island was a quiet glowing cavern. At 2:30 p. m. the lake was eight feet down and an hour later a striking change in the streaming was observed in the north cove, the surface currents pouring southward for the first time in many weeks. About eight fountains were in action, some of the central ones being very large, spraying to great heights and emitting yellow-brown fume which changed to blue above. Some of these fountain masses were from 60 to 100 feet long. There was a deep grotto exhibiting slow inflow southwest which appeared to communicate with an opening below the southwest cone. At 3:40 p. m. there was sudden sinking of the lake several feet so that the arch west of the south island opened above the subsiding melt.

On Friday, February 2, 1917, at 1 p. m. the lake was ten feet below its rim. The lava heapings northwest were now level with the northwest cavern

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L. W. de Vis-Norton.....Secretary

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floor. Flows were trickling in that region. At 7:30 p. m. the lake was nearly brimming but did not overflow. At 9 p. m. the lake had again subsided, there were four great flaming grottoes, and spears of blue flame also rose from the southwest ring cone and the northwest cone. Ten fountains were in action, an especially heavy one occasionally migrating around the south island and expending itself in the southern dome grotto. Here and at a similar grotto southwest the rush of gas threw out lava droplets horizontally which fell upon the crusts of the lake to a distance of from 60 to 100 feet. There were glowing and flaming orifices back of the ramparts northeast and southeast.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with February 2 two earthquakes have been registered. One of these was a local shock of moderate seismographic amplitude but of unfelt magnitude. The other was a great, world-shaking teleseism originating at a distance of a little over 3000 miles from this station. This occurred in late afternoon of January 29. Since no news of it has come to notice it is inferred that the origin was submarine for on land it would have produced certain disaster unless located in the midst of a great wilderness. The seismographic amplitudes of microseismic motion and of volcanic vibration have been variable between moderate and larger values much as in all recent weeks. The pens have continued to shift in a fluctuating way in the sense of increasing tilt to the south and west—or perhaps still, of decreasing tilt to the north and east.

Technology Station, Feb. 10, 1917.

During the week ending February 9, 1917, the Halemaumau lava column has subsided from a maximum height of 45 feet below the rim of the pit to a depth of about double that figure. According to experience this downward movement on the approach of the equinox was to be expected. With the subsidence there has been a sinking of the crags and islands, but not so fast as the going-down of the liquid pool and there have been pronounced falls of rock both from the crags and the old walls of the pit. There has been some overflow on the bench from the western ponds. The present sinking spell is the most pronounced interruption to steady rising which has taken place since June, 1916.

On Saturday, February 3, from 2 to 4 p. m. the lake was 20 feet below its banks and sinking. There were two fresh avalanche falls on the floor south and southwest made of tumble from the high rim of the pit. The places whence these rocks fell were points of emergence of big crevasses. One of these, just beside the south A-frame, had long appeared loose, overhanging and unsteady. There was another fresh tumble at the base of the north wall. The whole southeastern corner of the crag-mass had fallen in including the two pinnacles. Apparently as an effect of the wave or splash of this fall, the long southwestern peninsula was broken through, leaving an open channel where the lava streamed southward from the west arm. The southwest cove had collapsed carrying with it the ring cone so as to extend the end of the southwest arm northward. The west wall pond was again revealed end of the southwest arm northward. as a collapsed pit where the heap of lava had been. This pit was 25 feet across and extended into caverns north and south where the roof would fall in from time to time splashing down into a lava pool twenty feet below. The northwest cone was still in place

with an opening on its east side that led to a splashing oven within. There were several glowing caverns on the northwest floor made by collapsed domes. Under the isthmus west of the south island were two high tunnels showing a tumble of broken rock that made a shoal in the lake beneath them. Streaming through these arches had wholly ceased.

The lake showed five fountains, the grottoes were not very active and the largest one northeast was seen to collapse. The skins on the surface appeared heavy and were occasionally broken by violent central fountains and spurts of rapid streaming around the south island. Two balloons of skin were seen inflated by gas on the surface of the north cove. The streaming was southward from the north cove, there were sluggish heavy crusts at the head of the west arm and stalactites in the grotto at the head of the southwest arm. At the site of the southwest grotto there was a shoal at the lake margin. The crevasse at the base of the east crag had widened.

In the evening the south island was seen to sink bodily and the arch west of it collapsed. The south island had been tilting over so as to overhang on its south side and when it sank back it tipped northward and the surface of the peninsula west of it subsided and also tipped to the north.

Measurements on February 3 determined the highest fresh spatter level of the lake surface to be 45 feet below the south rim, the present depression 60 feet and the elevation of the several crags above the lake surface as follows: South island 60 feet, crag-mass 71 feet, east crag 61 feet, southwest crag 40 feet. The south island was thus level with the rim of the pit and the east crag and crag-mass respectively one and eleven feet above it.

After 4 p. m., February 4, the lake was seen to have changed greatly, the margins remaining fifteen to twenty feet high. The south island had sunk bodily twenty-five feet and was separated on the west by a channel from an island remnant of the southwest peninsula. The entire western part of the peninsula was gone except for a small islet near the former southwest cove. Streaming in the southwest channel was now reversed to the east, meeting the other current in the narrows southeast of south island with violent fountaining. A fragment from the west end of the middle island fell into the lake leaving a red hot scar and the entire southeast rampart had fallen away leaving a raw red hot wall. The dome grotto at the west end of the southeast rampart had collapsed.

The east crag appeared higher but the crag-mass lower than on the previous day. The southwest crags were unchanged except for some falls from the rampart. The west wall pond was an open pit eighty feet long. The northwest pond was an irregular open lake 100 feet long with irregular extensions on the side of the crag-mass and the northwest cone was gone. There was a glowing filagree cone under the west station.

The streaming was outward from the west arm and from the northwest arm and ten or more fountains would occasionally break into activity. In the intervening periods thick crusts would form. There were rock falls from the north rampart. Still cavern grottoes were glowing southwest, southeast and northeast.

The west wall pond would rise and fall through a range of fifteen feet. Flames played from orifices in its east wall and the puffing of the flames was in sympathy with a heaving of the dark flexible crust over the pond. This crust would break up with cracking and foundering at the beginning of each subsidence. The sinking spells were rapid and a red hot sugary looking lava wall was revealed of massive scaly aspect like glowing coke, underlying a definite pahoehoe crust shown in section all around this small pit. An intense yellow glow was maintained in the north cavern extension of the pond. Another higher shallow cavern in a flow shell adjacent to the edge of the pit also maintained a high glow.

Flames were very conspicuous southeast, northeast, the north side of the middle island and in the vicinity of the western ponds. There were occasional falls of spatter borders into the lake and one fall was seen from the wall of the southwest crevasse. The liquidity and intensity of glow appear-

ed high in the spatter grottoes and fountains.

On February 5, at 1:30 p. m., the lake remained about twenty feet below its banks but showed rising, and was flush with the lower parts of the southwest island. Fountains were few. At 2:10 and 3:50 p. m. there were falls from the east side of the crag-mass in the lake, starting ebullition. The two western ponds were active and occasionally overflowing.

Seen from the southeast on February 6 the lake appeared ten feet lower or perhaps seventy-five feet below the rim and fountaining had increased. Rocks fell from the northwest side of the crag-mass.

The lake was still thirty feet below its marginal bench at 2 p. m. February 7, 1917, and the surface was very quiet. At 4:30 p. m. it had resumed active fountaining and very rapid streaming southwest and southeast.

At 2 p. m., February 8, the lake appeared forty feet below the bench and very quiet, with one fountain at the south. Slow subsidence was in progress with submergence and thick blue fumes southwest. Collapse northeast had created a new island 200 feet from the shore.

At 1 p. m., February 9, the lake appeared ten feet lower still, with much fountaining. The crag-mass had subsided with increased tilt to the northwest, and with it the west and northwest floor had sunk about twenty feet. Fumes greatly increased.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with February 9 five weak local earthquakes, two of small and three of very small seismographic amplitude, have been registered. The seismographic amplitudes of microseismic motion have varied between normal and moderately large values. The motion of volcanic vibration has been more pronounced than normal both in regard to the magnitude of the seismographic amplitudes and in regard to the frequency of occurrence of well-marked "storms" of these waves. There has been no significant change in the pen shifts ascribed to tilting.

Technology Station, Feb. 17, 1917.

During the week ending February 16, 1917, the lava column of Halemaumau reached a stationary point about 85 feet below the rim of the pit for the first three days, then subsided some twenty-five feet more. This subsidence was followed by rising at the end of the week. There have been more falls of rock from the high rim of Halemaumau east and south. The island crags which were visible above the rim of the pit, through January, from the Volcano House, gradually sank out of sight from that point last week. They are, however, still conspicuous objects within the pit as seen from its rim.

On Saturday, February 10, 1917, at 1:30 p. m., there was no apparent change in the height of the lake. Occasional fountains broke the surface in the northern region but the remainder of the lake was very quiet. There was some caving in from the northeast inner wall starting ebullition below.

On February 12 at 2 p. m. fumes were thick, the lake was sluggish and without fountains and very slow rising was in evidence. At 3 p. m. fountaining started at the southwest and extended to other parts of the lake.

On February 13 at 11:30 a. m. the lake still appeared about 50 feet below the northeast floor with fountaining on that side. At 11:45 a, m| an avalanche tumbled from the east crag into the lake and started many temporary fountains. Thereafter there was central and border fountaining spouting high in the southwest region, and the main streaming was now in that direction through the central part of the lake and originating in the northwest arm.

From 5 to 6 p. m. the general form of the lake as compared with the high level period of a fortnight previous was greatly changed. The high crag-mass and south island had sunk far below the level of the rim of the pit. The south island and peninsula west of it were now attached by isthmuses of crust to the south bench and bordered on the west by a deep cove of the lake. In this cove and out in the center were new islands. In the high floor bench were five pits all around

the lake, three of them, west, northwest and north, containing liquid lava. The southwest crags and east crag had subsided less than the central islands and the east crag still protruded somewhat above the edge of Halemaumau. The southeast floor of overflow of January was still high, only about fifty feet below the rim, but the northeast floor had subsided lower. A secondary bench about fifteen feet above the lake marked a transient stand of the lava of the previous week. The south bench pinnacle had lowered and opened a pit beside it filled with tumbled rocks, and a similar pit had developed from the crevasses at the base of the east crag. Streaming was sluggish from the northwest arm to the southwest cove, while south and east the lava was stagnant. At 6 p. m. a fall from the edge of the southeast bench sent up brown avalanche clouds, broke up the crusts on the lake below and sent out a wave that started general cracking and foundering. There were about seven fountains in action. At 5 p. m. the lake had been quiet and rising; at 6 p. m. it was active and sinking.

The crevasses at the east margin of Halemaumau had widened greatly and the concrete monument marking the east station had moved outward ready to fall. On the north floor there was a red hot tumble of glowing crusts. The northwest arm had widened and become a deep gorge. The northwest floor overflows were still heaped irregularly about two feet below Perret's cavern and were piled across the floor of the west niche. These flows sloped down to the northwest pond which lay in a valley, crusted over but glowing.

From the west station an islet was seen in the lake where the southwest ring-cone had been and there was incessant fountaining against its west side. There was also a large grotto cavern splashing under the southwest crags. The west wall pond lay in a pit crusted over and showing glow at its margins. There was great increase of smoke from the north margin of the lake and several places west, southwest and south. The south island crag was low and its summit had crumbled. Between its high western extension and the south bench there were crusted shoals with coves east and west and a small pond in the middle.

Measurements on February 14, 1917, at 11 a. m. made the depression of the lake surface 94 feet below the southeast rim of the pit and in the afternoon the lake had sunk ten feet lower. The dimensions of the lake were 850 feet N.W.-S.E. by 790 feet E.-W. The southern island mass was 450 feet long, the new island in the north central part of the lake 220 feet long, the west pond pit was 160 feet long and the new floor pits north, east and south were from 60 to 80 feet in diameter.

It was evident on visiting the lake on this day that it had risen and subsided again. The new central island had lengthened and become low and flat topped. There were almost no fountains in the lake and much crusting. Fumes had decreased in the pit, there were few rock falls, a vertical sided pit had developed in the north floor where the glow heap had been and the south pinnacle hung out farther and appeared ready to fall.

A most wonderful and beautiful performance throughout this day which afforded a rare spectacle was the cascading of the surface lava of the lake into a great pit at the south where a seemingly insignificant pond in the shoals had been on the previous day. A river-like channel 200 feet long led from the southwest cove bank of the south island mass to this pit which was sixty feet in diameter. A rushing torrent poured through this channel from the lake and at the pit cascaded downward fully forty feet, striking the wall obliquely and being deflected as it fell to join a roaring, surging whirlpool beneath. The noise was like a waterfall. This cascade had formed at some time prior to 11 a. m. and it was pouring continuously until 1 a. m. the following morning. Sometime thereafter it ceased and the pit filled up and crusted over before 8 a. m., February 15. The torrent had singularly little effect as an outlet to the lake, which rose slightly from 11 a. m. to 1:30 p. m., and sank thereafter about ten feet. The cascading action seemed to satisfy the requirements of gas pressure which would ordinarily make fountains, for these were very few and the lake sur-

face was very sluggish. Blue fume condensed above the fiery vortex, festoons of Pele's hair clung to the wall over the cauldron and a spatter knob could be seen forming within. The effect was like a river vanishing into a limestone sink hole. The southeast cove appeared to be a shallow saucer separated by only a narrow partition from the cascade, with the liquid melt idly crusting, cracking and foundering, but showing no connection with the cascade pit.

On February 15 at 11 a. m. the lake was about 110 feet below the southeast rim, the crags appeared lower, the south pinnacle had fallen and the east survey station had fallen. Evidently the net effect of the day of cascading had been subsidence. The cascade pot was crusted over and lava welled out from it slowly westward to meet sluggish inflow at the mouth of the channel. The southwest islet was now two islets; the new central island stood eight feet above the lake. There were fresh and very heavy falls of rock to the floor below from the high edge of Halemaumau between the east and southeast stations where the danger signs have been placed. **The edge at the present time is distinctly dangerous and should be avoided.**

There was shore fountaining southeast and only one or two other fountains. At the lower bench southwest, about the site of the former dome grotto, there was a hot spurting pot four feet in diameter probably full of flaming gas. The lake was rising from 11 a. m. to 12 noon but sank lower in the afternoon, and there were more tumbles at the south pinnacle locality.

The next day, however, Friday, February 16, the lake at noon was seen to be rising and nearly level with the surfaces of the new island and the islets. The channel south of the south island was connected through from southeast to southwest with flowing lava. There was a violent shore fountain west with temporary reversed streaming against that bank. Three or four shifting fountains were in action. The northwest and west ponds exhibited occasional fountains at their south ends. The west pit had extended itself northward into a long crevasse which connected in a semi-circle with the northwest arm. This crevasse appeared to be due to a tendency of the crag-mass to change its tilt from westward to eastward, and perhaps likewise from sinking to rising. From 12:30 to 1 p. m. the lake sank about four feet and the two western islets joined in a crescent suggesting the former ring-cone.

Fumes appeared thin this day. The noises during these days have been slight, made by a few puffing fountains and occasional clattering of tumbled lava shells.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with February 16 only one local earthquake of small seismographic amplitude has been registered. Severe Kona winds have produced vibration which have exaggerated, and masked, the motions of volcanic vibration and microseismic motion. However, the seismographic amplitudes of these have been somewhat greater than normal, aside from this.

In the early part of the interval there was a noticeable tendency to pen-shifting in the sense of eastward tilting which was arrested later. Except for the daily fluctuation there was no noticeable change in the north-south component.

Technology Station, Feb. 24, 1917.

During the week ending February 23, 1917, the lava lake has remained stationary but there have been some very extraordinary adjustments among the crags and benches whereby some have risen to compensate rapid subsidence of others. There has also been powerful cascading from the lake into a pot on its northeast shore which has continued for days. The lake is now like a rapid river pouring from northwest to southeast.

On Saturday, February 17, 1917, at 7 a. m., the lake appeared rising and much higher than of late, for the new central island was flush with the lake surface and had evidently been freshly overflowed for it was covered with glow lines. There was fountaining in the northwest pond and in a flaring grotto on the southwest shore. Streaming was outward from an edge of dark

skin that covered the northwest arm and occasionally fountains would form in the north cove and migrate toward the face of the crag-mass, while others would form near the southwest islets and migrate to the southwest grotto. The north pit was glowing. The east crag was the only one of the great summits of January which still surmounted the edge of Halemaumau.

At 11:30 a. m. the next day, February 18, a remarkable transformation had been wrought. This east crag had subsided bodily thirty feet during the night, while opposite it, out in the lake, the low flat central island had risen fully forty feet, so that it was now a high flat-topped mass, its summit an oval table 100 feet long, showing spatter rims of its former level just below the summit for six feet in horizontal bands while for thirty-five feet below was a raw reddish wall sloping outward from the vertical slightly and scored vertically on its south side. Elsewhere this wall was a scaly rough rock which had presumably risen through the crusted margin of the lake as a red hot mass and without giving time for any spatter marks to form. In general appearance it was much like the former south island. The former long northern extension of this central island was now five broken low pinnacle islets extending out to the center of the north cove, the high table rock being eastward between the sunken east crag and the northern peninsula of the south island mass. This latter mass had also risen, the north peninsula of it being heaved up until it was twenty-five feet high with its benches titled westward. The western crag of the mass was rising and cracking, with occasional rock falls, while the east end (former south island- was crumbling and sinking. The great east crag had evidently sunk quietly, for its form was preserved and some iron pipes which we had left on its scarp were undisturbed. The northeast bench had sunk with it and appeared lower than the northwest bench. The east crag was bordered on the south and east by the crevasses along which it had subsided and here were great tumbles of gigantic boulders, partly fallen from the east high cliff.

The shifting of loads whereby the east crag went down and the middle islands came up must have happened after midnight along with a sudden acceleration of the sinking of the east crag and northeast bench due perhaps to the mass suddenly breaking away from its attachment to the east wall of Halemaumau. The balanced action whereby the islands came up as the crag went down lends confirmation to the view that semi-solid matter forms the bottom of the lake and that the liquid lake is very shallow. Probably the recent lengthening of the new island northward was due to the simultaneous subsidence of the northeast bench which pressed out the under substance and squeezed it up under the island.

On this date the lake was rising from 12 to 12:30 p. m. and sinking from 12:30 to 1 p. m. There were fountains in the north, southwest and west coves and in the northwest pond. Crusts bridged the channel between the upraised table island and the east shore. The pit of recent southern cascade was full of lava and overbrimming. The two southwest islets had disappeared. The southwest grotto was in action.

During the next two days, February 19 and 20, the table island became joined to the northeast bench and the pinnacles extending from it became united into a peninsula. The central crags continued to rise and the east crag to sink. The south channel became elevated to a floor above the lake and in it the former cascade pot became transformed into a low rounded sulphurous smoking cone.

On February 21, at 2 p. m., there was rapid streaming of the lake to the southeast cove and violent bombardment at its inner end. The inner bench around the lake was about five feet high, its construction indicating stationary or rising lava. Much of the east and north walls of Halemaumau had been falling to the floor below, indicating subsidence of the inner bench at those places. The inner bench was sagging away from the wall in many places leaving a chasm one to three feet wide. From 10 a. m. to 3 p. m. on this day the lava of the

lake surface was pouring continuously as a cascade into a hole under the northeast bench about where "Old Faithful" fountain used to be in June, 1916.

Measurements on Thursday, February 22, 1917, at 2 p. m., determined the depression of the lake below the south rim of the pit to be 106 feet and the inner bench above it at the base of the crag mass, marking recent levels of the lava, to be nine feet higher.

The lower floor was now a distinct feature five to ten feet above the lake in different places. The east crag was still above the level of the southeast bench. On this bench there were fresh falls of rock east, south and southwest. The former south island was now lower than the west end of the south island mass. Streaming was from the northwest arm to the southeast cove ending in a grotto under the inner cliff between the south and southeast stations where there was violent inrush, intense fountaining and a hot fume column rising. The only other fountains were against the bank southwest and in the south end of the west pit. Smoke appeared to be increasing. The southwest cove and the east side of the north cove were both crusted over but from under the crusts broke the southwest fountaining and the northeast cascade, which last continued to pour down steadily under the bank. The north pit was sending up a column of hot fume. The northwest pond was quiet. The northwest bench now appeared level with the northeast bench. All around the pit were fresh falls of rock from the high walls, and crevasses back from the high rim of Halemaumau had gaped open wider on the east, south, southwest, northwest and north.

On February 23, from 4 to 5 p. m., conditions were much the same and the cascade continued to pour from the lake into the northeast pot. This cascade had now been in action for three days without any marked effect on the level of the lake. Strong streaming poured from southwest and northwest, in a river-like current which appeared to slope downward, to the southeast cove, where the same violent boiling and fuming continued under the cliff. The new island and south islands appeared higher, the floor of south channel appeared only about three feet high but the lower bench on the north extension of the south island mass appeared eleven feet high as though that body were lifting. There was a fountain in the northwest arm but the southwest cove was heavily crusted. There was bubbling at the base of the crag mass but no central fountains. The north pit was quiet and the smoke dense, especially northeast and southeast.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week interval ending with February 23, four local earthquakes of very small seismographic amplitude have been registered. The seismographic amplitude of microseismic waves has varied from normal to somewhat larger values. Volcanic vibrations, though more energetic than normal, have developed seismographic amplitudes of less magnitude than in the two or three weeks preceding. The pen shifts in the sense of tilting have shown no pronounced movements apart from the diurnal movement.

Technology Station, March 3, 1917.

During the week ending March 2, 1917, the lava lake of Halemaumau has subsided fourteen feet in eight days and with this subsidence there has been a tendency to collapse in the January bench near the north pit and under the south station. Cascading into sunken pots at the edge of the lake has continued at the northeast and become evident at the southeast. The general form of the lake and crags has not changed and the fumes from the pit have appeared thin, though within it they are locally very dense; and on the southern margins they have been sharp and unbreatheable.

On Saturday, February 24, 1917, the lake appeared higher, its shore bench being three feet above it. At 11:15 a. m. the surface streaming was wholly reversed, flowing from the southeast cove to the north, where the current met the stream from the northwest arm and both united to pour north and northeast. The north inner cliff was notched back and the current poured

under it into a wide cavernous space beneath the north pit. The walls adjacent were cracked and smoking densely through the north floor with brownish white fumes which were quite respirable. This smoke would collect in a whirlwind occasionally and shoot up in heavy billows quite unusual for Halemaumau. The torrent at the northeast poured over a ledge V-shaped in plan, with the point of the V toward the lake so as to make a double cascade pouring from two sides like the Horseshoe Falls at Niagara. On one side a ledge protruded through the fall which divided on both sides. From the fall the torrent rushed into a cavern at the base of the cliff about 80 feet wide at the entrance and flame and fume rose above with very brilliant glow at night. The clearly proved ledge under the liquid at the fall showed how shallow was the edge of the lake and revealed a margin of the bottom quite in accord with the recent soundings, which showed a shallow lake only fifty feet deep when the lava was somewhat higher. Great bodies of crust would be carried over the edge into this cascade cavern and broken up.

The January floor benches had been sagging away from the old walls during the February subsidence leaving deep crevasses at the base of the upper cliff from one to three feet wide, especially northwest and southeast, and avalanches from the upper wall followed.

On February 25, at 2 p. m., the lower bench appeared about five feet high and the northeast cascade was tumbling noisily. At 3:30 p. m. the lava had risen level with the bench. At 4 p. m. there was a heavy fall of rock from the north bench starting vigorous fountaining in the lake below.

On February 26, at 2:30 p. m., the lake was ten feet below the bench and the northeast cascade was still in action. The inrush at the southeast had stopped but the river-like streaming in that direction continued. It is noteworthy that during these cascading periods central fountaining almost completely ceases, and that in general the net result of such a period is a lowering of the level of the lava lake.

On February 27, at 1:45 p. m., the lava as seen from the east station appeared level with the lower bench and fountaining was nowhere to be seen. The excessive smoking of the north bench observed on February 24 had ceased, though there was much smoke on the face of the north inner cliff. This appears to have been the culmination of a temporary rise. At 2 p. m. from the northwest station the cascade northeast could be seen racing down into the pot but the entrance orifice had diminished in size. The southwest cove was crusted over. At 3:30 p. m. the lake seen from the west station was sinking; the inner bench being three feet high and few fountains playing. At 6 p. m. streaming was rapid and six border fountains were in action. The northeast cataract was working noisily and other noises were those of blowing and fountaining. The central crags appeared high and the inner bench much higher than in the afternoon. Active spatter grottoes were flaming west-southwest and southeast. Streaming was from the northwest arm to the east, southwest and southeast. The southwest cove was active. There was bright glow at the north pit. The south pot had become a filagree glowing cone. In the remnants of the southwest rampart were two high flaming pots. Some movement of rocks was heard in the eastern talus.

On February 28, at 10 a. m., the inner bench appeared eight feet high and the northeast cascade was still pouring sluggishly. The northwest pond remained a partially crusted area with a circular pit on its west side and the west pit contained an active pond in its depths. The streaming of this pond was northward. There was active fountaining and fuming at the southeast grotto, the southwest cove was stagnant, yellow sublimates stained the rock adjacent to the southwest chimneys and very disagreeable fumes rose from this locality, from a grotto west-southwest, and from the southeast inrush. Occasionally hardened spatter rims fell into the lake and produced immediate boiling. This appears to be the action of air, confined in the vesicles of the hardened lava,

on the combustible gases of the liquid melt. At 9 p. m. there was bright glow from the southeast grotto and the cascade pit. Lazy blue flames like burning alcohol played over the southwest chimneys, the larger one being a pot at least six feet in diameter. A spurting blue flame under pressure was seen rising from the bank of the lake in the southeast cove beside a filagree glowing cone adjacent to the southeast grotto. In the northwest arm a small fountain occasionally broke through the crust. There was glow in bench cracks where the floor was deeply crevassed under the south station and at two places northeast. The north pit was glowing and there were brilliant glow, flame and yellowish fume over the northeast cascade pit.

On March 1, 1917, the lake appeared lower and distinctly falling after 11 a. m. There was a heavy tumble of rocks in the region of the south pinnacle under the south station where the January bench promises to fall away completely leaving a gulch. This place is undermined by the former south wall pond, by the inrush grotto southeast and by the south cascade pit (now a cone). The inner bench on this day appeared fifteen feet high and the sinking of the lake revealed cavernous spaces under arches of crust between the central peninsula and the south island mass, under the south channel floor at the inner and the south island mass, under the south channel floor at the inner end of the southeast cove, and under the isthmus connecting the new island with the northeast bench. Four or five fountains were in action including occasional central ones. A new channel appeared between the new island and the pinnacles north of it, with a streaming current from the center of the lake running through it under an arch of crust in the direction of the former cascade, which now appeared to have ceased sucking in the lava of the north cove, unless it were doing it under the crust; no roar, however, was heard. The crag mass showed some subsidence. Halemaumau as seen from a distance was emitting very thin fumes.

Measurements at 10 a. m., Friday, March 2, 1917, made the depression of the lake below the southeast rim of the pit 120 feet in the southeast channel and 114 feet on the extreme west margin of the lake, indicating a downward slope of six feet from the source region at the west to the inrush at the southeast. The shore bench was eleven feet high above the lake, the east crag eighty-one feet, the new island fifty-nine feet and the crag mass eighty-three feet.

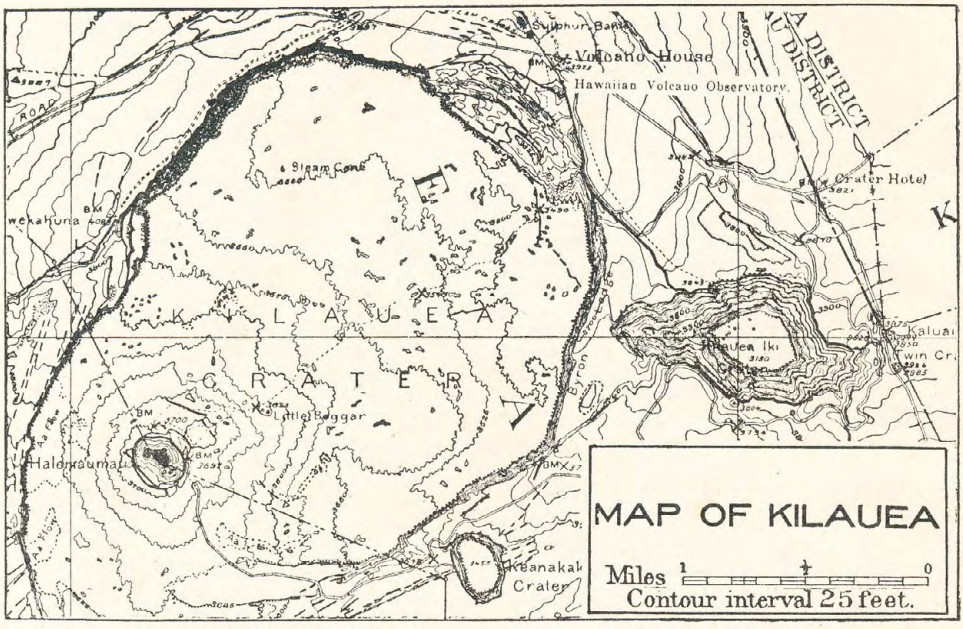
The lake appeared about the same but the southeast grotto was now revealed as a definite cascade from the lake into a hole, and also the northeast cascade had reasserted itself a little farther north than before. There were many recent falls of rock on the January bench northwest, north and northeast.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week interval ending with March 2 two local earthquakes of very small seismographic amplitude have been registered, and two other doubtful groups of waves. Besides vibrations due to strong winds in the latter part of this week interval, the seismographic amplitudes both of microseismic motion and of volcanic vibration have rated larger than normal. Aside from the usual diurnal shifts and others resulting from temperature change and strong winds, there have been no pen shifts in the sense of tilt during the week under consideration.

Very respectfully,

T. A. JAGGAR JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol a, or max. a, is given in the conventional unit, **the milligal.** The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, MARCH, 1917. No. 3

Technology Station, March 10, 1917.

In contrast to the subsidence of the previous week, the week ending March 9, 1917, exhibits pronounced rising of the lava lake of Halemaumau by about fifteen feet. The rising has been accompanied by cessation of the cascading into border sinkholes and by the building of a marked lower bench all around the lake which is occasionally overflowed. The inner crags are essentially stationary so far during this rising, the liquid lake building up its margin around their bases.

On Saturday, March 3, 1917, at 2:15 p. m., from the east station the lake appeared to be about two feet below its inner bench and very quiet and smoky. Lava from the lake was still cascading into the southeast sinkhole. At 3 p. m. seen from the west, the lake was three feet lower and still quiet and fumy. Seen from the east at 5:30 p. m., the lava had risen level with the inner bench and there was increased activity in the southeast cove, with streaming in that direction. At 6 p. m. a reaction set in with several fountains in the north cove and others in the southeast channel and the cascade from the lake into the border cavern northeast developed to a noisy cataract.

On March 4, at 1:15 p. m., the lake was five feet below the inner bench and showed five fountains and rapid cascading northeast.

On March 5, at 1:30 p. m., there was strong overflow in progress upon the lower bench along the shores of the lake to the south. At 2:15 p. m. the lake had subsided about a foot and there was much fountaining and high spurting in the southeast cave. At 2:45 p. m. from the west station, the northeast cascade could be seen still in action and the length of the ledge over which the lava-fall plunged was fully 100 feet. Surface skins were carried over this fall and downward at an angle beyond into a cavern at the base of the cliff which was thus half tunnel and half pit. It appears to have been in fact an inclined tunnel ending in a pit cauldron.

On March 6 at 11 a. m., the lake was five feet below the inner bench and there was increased fountaining in and around the lake with marked gas puffing. The two cascades had ceased action and all signs pointed to rising conditions. At 4:30 p. m. the lake was brimming at the level of the inner ledge and fountains were numerous.

On Wednesday, March 7, at 1:30 p. m., the lake was again at the inner floor level and actively fountaining. At 2 p. m. a large border grotto at the west cove showed intense fountaining and lava spurting with much plashing and puffing noise. At 5 p. m., seen from the east, the lake showed glowing overflows in the east and southeast coves and marked spatter ramparts in process of building on the west, northeast and southeast. The entrance to the southeast channel had narrowed through construction of the border bench. A slight fall of rock at 5:15 p. m. took place, from the southeast inner cliff into the lake.

On March 8, at 4:30 p. m., the lake was still higher and had been building and widening the inner bench. At the moment its surface was two feet below the bench, and there were six fountains which were noisily blowing and rumbling. Grottoes were now in process of construction at the southeast, northeast, north, west and southwest, all of these being places of previously revealed sinkholes or tunnels below. The main outward streaming into the lake was now entirely from the northwest arm. At the northeast

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L. W. de Vis-Norton.....Secretary

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a very large curtained grotto had formed, hung with long stalactites. At the tunnel leading under the inner cliff to the north pit there was continuous fountaining, the lava of the lake being above the top of the arch. Within the north pit there was slow streaming northward to a fountaining grotto within the pit on its north side. Above there was much recent rock-fall on the floor under the old north rest house. The northwest pond no longer showed a pit but in its place was a low smoking cone with stained overflows. The west pit had lengthened by collapsing walls north and south and showed a well three feet across in its bottom containing cherry red incandescent lava which was quiet but occasionally emitted a puff from under its mobile crust. There was an overflow rim around the well. The broken walls of this pit, formed as glistening black glassy overflows only a few months since, were now revealed oxidized through and through to limonite and hematite, yellow and red iron oxides.

Just above the bank of the west cove there had been built a large irregular cone stained sulphur yellow which was crackling, spurting and all glowing through crevices, while a lava fountain pounded in the inner cupola. Just below it at the lake shore was a spatter rampart containing a grotto frequently active. The greatest crackling noise and sharpest blasts from the upper cone happened when this grotto fountain was active. Blue fume rose from both places.

There were other small fountains at various places. The streaming was lively, flames were numerous, the south cone was fuming and the greatest noise came from the north and northeast.

Measurements on Friday, March 9, 1917, made the depression of the lake 102 feet below the southeast margin of the pit. The heights of the crags above the lake were:

East crag, 64 feet.
Crag mass, 63 feet.
Old south island, 23 feet.
New east island, 43 feet.
Central peninsula, 28 feet.
Southwest crag, 72 feet.
Southwest summit of south island mass, 36 feet.

These measurements made the east crag stationary since March 2, the new east island two feet higher than on that date and the crag mass three feet lower.

On the morning of March 9 the lake fluctuated in height between the bench level and about one foot below it. At intervals of about twenty minutes, after quiet accumulation of crust, large fountains would burst in the southeast channel and migrate southward to the bank. The lake would inflate, rise and stagnate during the accumulation, but during the explosion it would sink with rapid acceleration of streaming. During the stagnant spells there would be two or three border fountains active, but during the rapid times there were six or seven fountains. At the southeast cove there was some spattering overflow. Central fountains were more numerous than of late in the three main arms of the lake. The border fountaining over the north tunnel had ceased.

At noon the writer descended to the northeast bench and close inspection of the new island mass revealed the fact that the lower rock which had been pushed up out of the lake was massive and rough and wholly without the horizontal bedding exhibited by the lava flows above. This new island is extraordinarily like the lava plug or dome which was lifted above the summit of Tarumai volcano in north Japan in 1909.

The floor of the northeast bench of January was considerably collapsed

and crevassed. Looking down into the north pit, which is about 50 feet in diameter, a very hot churning lava pool was seen 40 feet below the rim, coated with thin black sinks, and heavy fountains pounded against the north and northeast walls. These walls showed spatter layers and stalactites, but very slight grotto overhang. The north grotto here was more of a cavern a few days ago when the lake was lower. The streaming of the pool was northward, changing to a slow rotary movement counter-clockwise.

In the afternoon the lake subsided ten feet and recovered to a level about five feet below the bench.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with March 9 no earthquakes have been registered. The seismographic amplitudes of microseismic motion and of volcanic vibration have decreased from large or moderately large values in the early part of the interval ot values about normal in the latter part of the interval. This is complicated with disturbances of considerable seismographic magnitude due to very strong winds in the early part of the week. These winds also produced pen shifts in the sense of tilting of considerable amount. Aside from these there have been no noteworthy movements of this kind. At the end of the week the pen-positions are normal for the present time.

Technology Station, March 17, 1917.

During the week ending March 16, 1917, the lava of Halemaumau has subsided about 30 feet with spectacular avalanches of debris from both the upper and inner walls. At the end of the week there has been slight recovery with building of a new inner bench. The sudden subsidence of March 11 to 15, following a temporary rise, is in accordance with previous experience at Kilauea at the time of the equinox in March and September.

On Saturday, March 10, 1917, at 2 p. m., the lake surface was about five feet below the inner bench and five border fountains were in action respectively northwest, northeast, southwest, west and southeast. Streaming was vigorous toward the southeast and southwest. There was activity in the north pit and the grotto of the southeast cove was cracking. A flame played above the west cone and heavy white smoke rose from the northeast wall. Subsidence started on this afternoon, at 4 p. m. the lake was two feet lower and a large fragment fell from the crag mass into the lake, starting much fountaining. At 4:15 p. m. a similar avalanche fell from the north inner wall into the lake, followed ten minutes later by a slide from the north outer wall under the old rest house. The north pit was evidently collapsing.

This was confirmed the next day, March 11, when the most subsidence occurred, accompanied by avalanches and small earthquakes. The lava lake sank about 20 feet, violent fountaining was generated by the avalanches and the arch over the channel leading to the north pit collapsed leaving the pit a tumbled chasm in the bench open on the lake side. At 10:45 a. m. the pinnacled point extending westward from the new island collapsed into the lake and about twenty fountains were generated thereby. At 10:35 a. m. a block dropped into the streaming southeast channel from its north side, again starting much fountaining. At 10:45 there was a slide from the north side of the crag mass. At 11:10 another fell from the north inner wall. At 12:05 p. m. part of the northwest wall collapsed and at 12:20 the north side of the north pit fell in. At 1:10 p. m. an immense tumble of rock defaced the whole eastern aspect of the crag mass, followed by a great avalanche from the northwest bench. The resulting fountaining lasted over an hour. At 1:15 p. m. the arch leading from the lake to the north pit collapsed so that that pit became a cove of the lake. After 1:30 p. m. incessant avalanching enlarged the chasm so formed and it was evident that the whole northern inner bench of 1917 was breaking away from a small remnant left clinging to the wall of Halemaumau. A semicircular crevasse bounded the subsiding blocks on the northeast, north and northwest, this crack being concentric with the pit and extending almost continuously from the northeast floor

around to the west pond. The northwestern block was toppling outward toward the northwest arm leaving a wide gaping fissure north of it.

On March 12 at 11:30 a. m. the lake appeared 20 feet below the inner bench and its surface was very quiet. At 11:45 there was a heavy tumble of rock from the high rim near the south station and on the evening of this day a still heavier fall west of the south station. About 12:30 p. m. avalanches could be heard in many directions including portions of the 1894 bench. At 2:30 p. m. there was a heavy fall into the lake from the northeast followed by fountaining for an hour. By this time the lava of the former north pit was completely smothered by avalanche debris in the chasm there.

On March 13 at 2:30 p. m., the lake appeared 30 feet below the inner bench and again very quiet and crusted, with avalanches still falling. At 3 p. m. there was a fall from the east side of the crag mass. At 5 p. m. the rush of the current from the main lake to the southeast cove through the channel was very swift with tremendous inrush and fountaining southeast; there was no fountaining elsewhere. At 7:30 p. m. a portion of the southeast bench fell noisily.

On Wednesday, March 14, inspection showed that the fumes had increased; the crag mass and inner islands had strongly subsided with the lava column. The only portions of the bench which remained high were around the margins. The inner bench appeared about 25 feet high, caverns had developed under the floors beside the new east and central islands showing that these connecting isthmuses were really only crusts thickened downward. Streaming was now changed, the current pouring from a crust at the west cove southeastward and northward. The southwest cove was crusted over. Eight fountains were in action and the lake was rising with noises of puffing and plashing. The great rock falls from the crag mass had built a new central promontory extending eastward. There was a cove with occasional inflow on the northeast. To the large cavern opening eastward, adjacent to the central island, there was rapid inflow which terminated in interior fountaining and enormous stalactites like clustered organ pipes had accumulated near the entrance.

The southeast bench was cracked near the margin and parting from the wall of the pit in such a way as to appear as though it were actually rising. The gulch below the south station had widened and the south high rim of the pit had greatly fallen away to a tumble of talus below. The southwest crags had subsided and there were new crevasses back of them. The west pit showed new broken extensions but there was still a pot of live lava in its bottom. The east crag had sunk below the level of the southeast bench and the northeast floor was sinking with it. At 1:30 p. m. there was strong fountaining at the east cove. At 2:45 thirteen fountains were in action and most numerous toward the north.

On March 15 from 4 to 6 p. m., the lake appeared low, eight fountains were in action, there was inrush to the central cavern and explosions within it expelled flames and made strong waves which surged outward. There was fountaining against the south base of the new island and occasional shore fountaining in the southeast cove. In the southwest cove a tunnel from under the south floor, where the February cascade torrent was, showed outward streaming from the pit under the south cone. The streaming in the lake was from sources southwest, west and northwest toward fountains at the northeast base of the crag mass, and at the north, northeast and southeast walls. In general the tops of the crags, islands and benches appeared to be approaching a common level.

A circuit of the pit revealed the following: From the east, the northeast floor was seen to have sunken farther, leaving a shelf under the 1894 bench. From the north, the northern chasm was seen to be a smoky tumble of rock. From the northwest, there was seen a narrow bench remnant below against the wall at the January level, but the broad floor beyond had sagged toward the lake and downward. From the west, the slope of new lava from the west niche to the northwest pond was seen to have cracked and subsided so as to open a crevasse at the old cliff under the west niche. The

northwest pond was re-established at its old location as an oval longish pool of quiet glowing lava in a pit and there was blowing and fountaining at its southwest end. Occasionally the surface would crack and founder. Red glowing places were seen among the cracks north, northwest and west, and some of the surface lumps of pahoehoe lava, several months old, were glowing cherry red in places removed from deep cracking, as though reheated through small crevices.

From the southwest, the west pond was seen to contain a rising pool of red hot lava with a flaming blow-hole puffing above its east border. The blowing increased and a small festooned flow emerged from the crusts on the surface of the pool.

Measurement on Friday, March 16, 1917, showed that the lake at the central promontory was depressed 129 feet below the southeast rim, indicating a subsidence of 27 feet in seven days. From 9 to 11 a. m. the lake was rising and falling a few feet, there were four or five fountains in action, including some central fountains. A new narrow bench around most of the lake, especially conspicuous on the north and west, showed that rising was in progress. There were new rampart grottoes at the east cove and against the central promontory of the crag mass. The new island showed tendency to break along two vertical cracks. The central cavern was still flaming and exploding. There were occasional small avalanches and infalling spatter rims, one of the former tumbling from the southwest crags to the shore of the lake. There was much bombardment at the base of the north cliff. Smoke rose densely from the south cone and the north and northwest inner walls.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with March 16 eight local earthquakes have been registered, and two or three doubtful wave-groups. Three of the shocks were of perceptible magnitude. Two were felt in the vicinity of the Volcano House and the Observatory—one quite sharply. The third was strong enough to rattle windows but no vibration was felt. The origins of these were closer at hand than is usual with shocks registered here, yet well beyond the limits of the crater region. Slight but sharply marked subsidence of the lava took place at about the same time, with fracture and partial collapse of considerable parts of the 1917 bench. The seismographic amplitudes of microseismic motion and that of volcanic vibrations have approximated normal values throughout the week. There has been no conspicuous pen shift in the sense of tilt apart from the diurnal fluctuation.

Technology Station, March 24, 1917.

During the week ending March 23, 1917, the lava continued sinking with border cascading southeast, until the evening of March 20 when the depression of the lake below the rim of the pit was at least 135 feet. At that time all signs of subsidence ceased quite suddenly and rising ensued at a rate estimated five feet per day, and continued steadily thereafter. The turning point occurred at the equinox. A remarkable discovery which was made by descending to the eastern lower bench, is that the base of the new island is composed of aa lava. This was the island which rose suddenly out of the bottom of the lake on February 18 and showed a massive lower portion capped by horizontal layers of pahoehoe above. This discovery checks with the belief that the rising lava column of Kilauea, which so rapidly filled the pit after the aa lava flows of Mauna Loa ceased flowing in June of 1916, is identical through subterranean connections in the deep region, with the column that fed Mauna Loa.

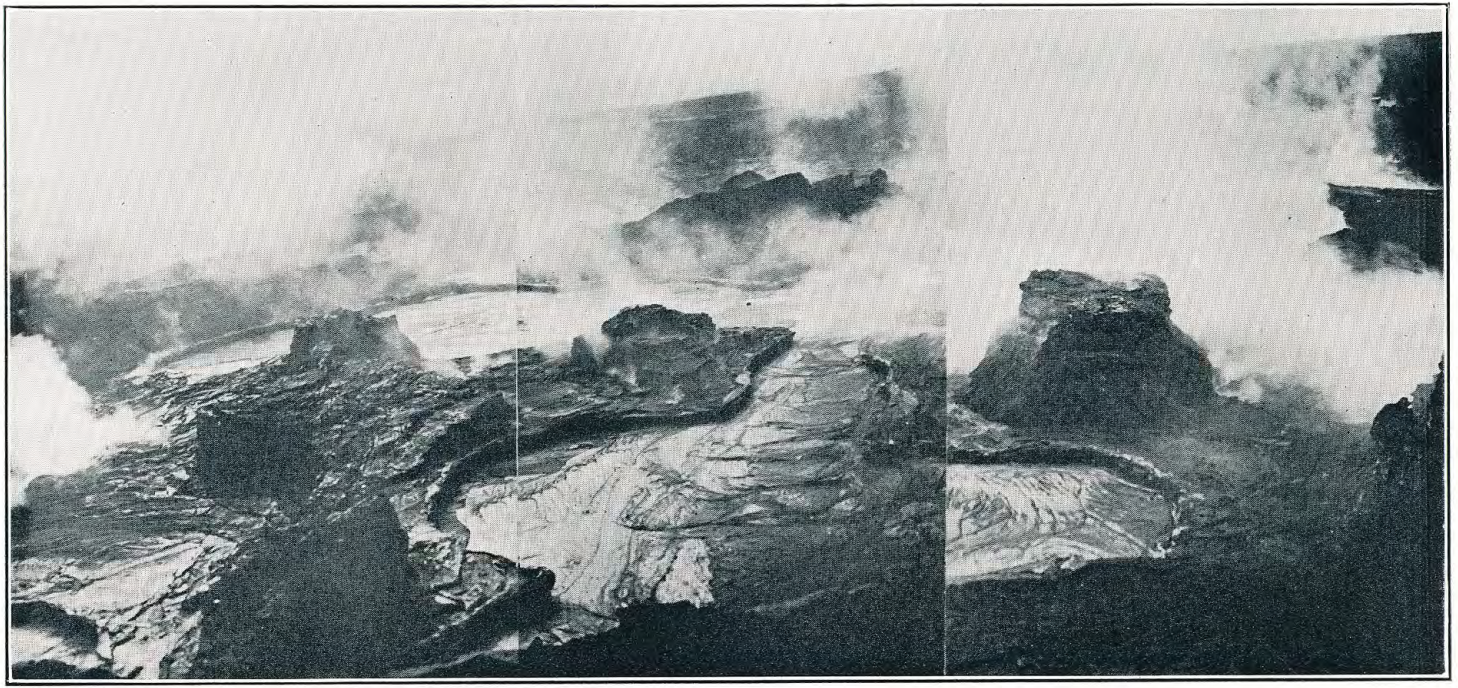
On Saturday, March 17, 1917, at 3 p. m., the central cavern was exploding and there were about five fountains in action including a row of spatter grottoes forming a high rampart along the southwest margin of the southeast cove. The streaming was southeastward originating in the southwest cove which was crusted over. It was evident that there had been a heavy fall of rocks into the southeast cove from the high southeast bench, for the whole southern bottom area or lower floor was plastered with a

splash of fresh lava as far as the south cone and high up the south side of the old south island. Lesser wave markings of this kind appeared on the banks of the wide southeastern stream channel. The northeast bench showed evidence of further subsidence leaving a secondary ledge below the 1894 wall. The east crag had sunk lower and the east end of the southeast bench showed overhang with a loose slab protruding below. At the northeastern base of the crag-mass a very large slab had broken away and stood out above the lake as a pinnacle. The north chasm had subsided still more. A new tumble of rocks had fallen from the south side of the new island and the debris slope lay at such an angle as to indicate that the stream channel into which it fell was shallow. This fall took place on the previous evening.

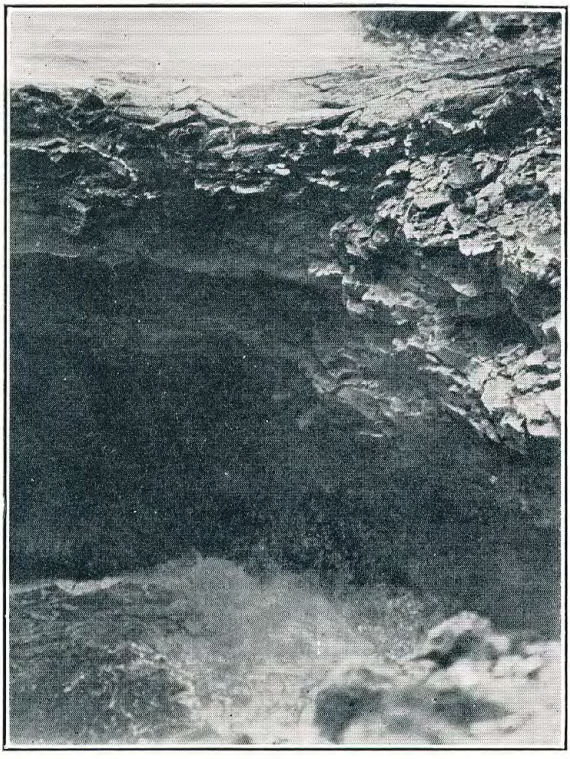
On March 18 at 5:15 p. m. the wind was from the south and the pit very smoky. Streaming from northwest and west terminated at the southeast in a torrent which plunged in a tremendous cascade downward, of vivid orange color, at the sinkhole of the southeast cove. On the brink of the final plunge the lava surged up in a high wave with many bubble fountains and travelled with great speed. The noise was a heavy roar. Gusts of suffocating blue fume rose from the abyss. There were five fountains northwest and a furious one in a grotto under the north bench. The lake was temporarily rising with narrowing of the glow rim and drowning of stalactites at the lake margin. March 19 was very rainy.

On March 20 at 2:40 p. m. the cascade was still tumbling at the southeast cove with great rapidity. At 4:15 p. m. from the northeast a heavy avalanche was seen to fall from the southeast bench into the lake and start extensive fountaining with breaking up of the crusts in the channel and the southeast cove. Such are the avalanches which made the wave marks. At 4:40 p. m. another heavy slide fell from the south bench of 1917. Here a long tumbled slope has gullied the bench back under the south station, and extends down to the southern lower floor, which was the bottom of the lake in January, and the scene of the great cascade sinkhole of February 14, now a cone. At 5:30 p. m. from the east station it became evident that pronounced rising had started and at 6 p. m. there was overflow at the east cove and then the southeast cascade pot filled up and brought the cataract to an end.

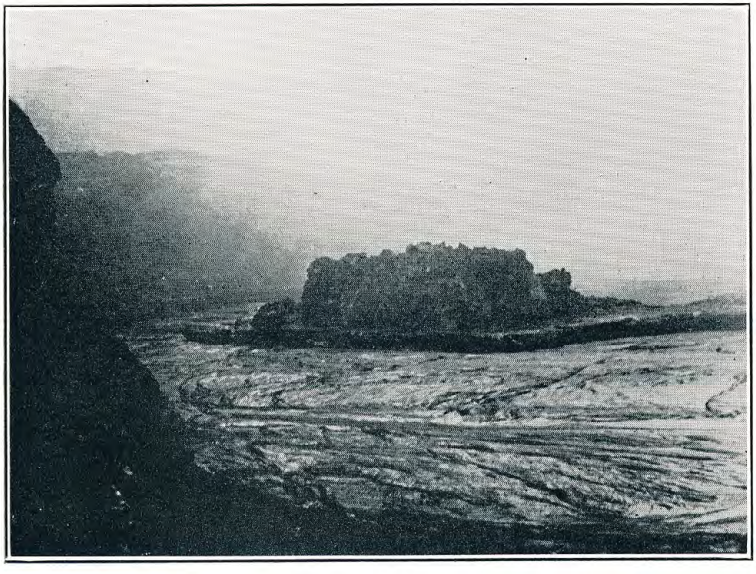
The next day, March 21, at 11:30 a. m. from the southeast, the lake was seen to be rising vigorously and overflowing the south bottom from the southeast cove, the overflows reaching a maximum about noon. The east and west coves were also overflooded. Streaming was to the southeast and northeast. Spatter niches of crescent shape were building east, southeast, southwest, against the north side of the central promontory, northeast and northwest. The south cone was still in place. The flows on the south floor poured westward on both sides of the spatter crescent there and reached the south cone. The central cavern was submerged but there was fountaining above its entrance. The southern islands appeared tipping eastward. Wave splash now plastered the whole of the old south island. Under the south station great slabs of old wall rock were splitting away, and the southwest crags were settling back to a horizontal position. From the southwest the west pond was seen in its ragged pit to be a single continuous fountain of the artesian or uprising variety, with concentric festoons of pahoehoe crust around, which were being pushed away rather than engulfed. The west cone was submerged by the growth of the west cove and out in the lake were the southwest islet, low and flat, and another smaller one nearer shore. The tunnel leading from the southwest cove to the south cone could be seen with crusts at its entrance. The southwest spatter crescent just west of here become active only at intervals. The northwest pond had risen and was crusted over. Up the slope west of it was a bright hot yellow fuming solfataric area and still nearer the west wall could be seen in daylight the pahoehoe lumps which glowed at night (March 15), now slightly whitened by solfataric action. The northwest arm was flooded and showed some streaming from the lake. After 12 noon floods of lava poured from the lake into the depression of the north chasm past a



Halemaumau from the S.E., 4:30 p.m. March 8, 1917. —Photo. Jaggar.



March 9, 1917, 1 p.m. Looking northwest down into fountaining grotto of north pit from its rim, on the January bench. —Photo. Jaggar.



March 9, 1917. Looking south at old South Island, which had surmounted rim of pit in January. —Photo Jaggar.

spatter crescent at its mouth. There were small flows at the lake margin pushing in at the west and northwest coves. The lake was rising, covered with quiet crusts and fountaining was limited to the spatter niches. At 1:30 p. m. the lake was brimming level with the lower bench, with fountaining in the east cove and several fountains in the northern region. In the southeast cove the large grotto niche was at the site of the previous cascade. At 5:30 p. m. there were fifteen fountains, and at 5:45 a fountain started in the east cove.

At 1:30 p. m. on March 22 the lava was level with the bench but about 2:30 p. m. it subsided three feet with much fountaining. The fumes from the pit had greatly diminished. From 5 to 6 p. m. the lake was overflowing so that floods from the east and west joined across the south bottom, those from the west finally dominating the eastern ones as though the tilt eastward of the south island mass determined a slope in that direction. Spatter niches were blowing and spraying southeast, southwest, north, northeast, east and at the central promontory. Glow could be seen over the northwest pond. Streaming was to the southeast and northeast and a very active grotto was throwing high jets under the northeast inner wall. Sinking spells were rare. There were occasional central fountains in the north cove which migrated eastward. Great quantities of Pele's hair were being made.

At 7 p. m. the lava was overflowing from the west cove to the northwest pond. From 10 to 12 p. m. there were spells of rising and sinking, each occupying 20 to 30 minutes, with the rising spells longer than the sinking ones. About 11:30 p. m. a marked subsidence of about two feet developed the form of the true lake and showed the dimmer glow lines of bench flows south and east. In the lake itself all the crusts broke up while twelve or fifteen fountains burst into action. At 10:45 p. m. there was a fall from the southeast January bench into the lake, making a great splash which plastered the old south island and broke up all the crusts of that region. Excessively brilliant fountaining at the east base of the old south island followed the avalanche, while the southeast grotto became quiet. The south cone was now completely submerged. From the northwest pond a stream poured southward, making a glowing festooned current around the end of the crag-mass into the west cove. The southwest cove was crusted and during rising spells dark crusts formed over most of the lake.

At 2 p. m. on Friday, March 23, 1917, from the east the lake was seen to be two feet below the bench and very quiet, with only three fountains in action. At 2:30 p. m. from the south station the west cove was seen to extend all over the northwest pond depression, with one active fountain over the northwest pond vent.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with March 23 one very feeble earthquake probably a near-shock, though the early phases are too indistinctly registered for this to be certain—has been registered. The seismographic amplitude of microseismic motion has been somewhat larger than usual particularly in the early part of the week. The seismographic amplitudes of volcanic vibration have been somewhat larger than normal—especially in prolonged storms in the latter part of the interval. Early in the week-interval, accompanying a strong Kona wind, there was a pronounced shirt of the pens in the sense of tilt to westward; later there was reverse shifting almost completely counteracting this.

Technology Station, March 31, 1917.

During the week ending March 20, 1917, the lava of Halemaumau has oscillated through a range of 20 feet about a depression of approximately 110 feet below the rim of the pit. A pronounced inner bench from the rising activity of the previous week tends to constrict the active lake so that during the present week the inner pit has appeared like a group of three convergent gorges ten to twenty feet deep, the former islands rising as hills within Halemaumau above the inner plateau level. Viewed from this lower flat, the lake has appeared much like the paintings of Tavernier and Fur-

neaux, with extraordinary overhanging bluffs, mushroom islets and marvelous reflected lights and irridescent fumes in the evening.

On Saturday, March 24, after 3:30 p. m., the lake surface was streaming from dark skins on the north and northwest to the west, southwest and southeast. A large half-dome grotto had built at the head of the west cove and the lava flows which had there connected the northwest pond with the lake were now above the lake. The southeast spatter cone had become a high open beehive, flaring and spurting. Heavy falls from the bank took place on opposite sides of the southeast channel. Where the south cone had been there was now only a little smoke through the crust. Looking from the west station the northwest pond region was seen to be covered with crusted flows with a ring-shaped cone spurting on the southwest side. The west pond was also crusted, with a glowing filagree cone and a flaming, hissing orifice east of it. Over the great west dome tremendous splashes of lava were thrown. From the northwest station glow could be seen in the bench northwest and north and the lake on this side was crusted over and no fountaining whatever was going on at the northeast. Apparently the sharp rise had reversed the streaming against the west bank. The north chasm contained a wide area of crusted flows and glow could be seen in cracks of the northeast bench.

A glowing stream poured rapidly along the surface of the lake to the southeast grotto and a small stick of wood thrown in at this point plunged below the thin skin and burned in spasms. The spasmodic lines of flame, bursting through the skin at short intervals as the stick beneath was carried down the current, punctured the surface skin at points progressively farther and farther downstream showing that the undercurrent moved more swiftly than the skin.

On this day, with the aid of men of Company H, 25th U. S. infantry, the writer sounded the channel off the south side of the east island. The half-inch pipe was plunged into the channel and bowed downstream southeastward with the current, but went to the bottom, sticking in stiff material in the lower five or six feet. Forty-six feet of the pipe went below the surface at an angle estimated 40°, making the depth of channel 29 feet. This checks with the supposition that the February subsidence made the lake more shallow for at the end of January the depth was 45 feet.

On March 25 and 26 the lake reacted from its recent rise and subsided. On March 26 there was cascading into the southeast sinkhole. At 4 p. m. on March 27 the lake was depressed 15 feet below its newly constructed inner bench. All around it were vertical and strongly overhanging walls. There was strong overhang beneath the southeast bench and under the old south island, the central cavern was again open and another at the east cove, and the southwest islet was overhanging on all sides like a mushroom. It had evidently increased its surface area as the lake rose. There was general overhang on the west and southwest. Six to eight fountains were in action, streaming was out from the northwest arm, there was a glowing filagree cone on the bench at the east cove and others at the northwest and west ponds. These ponds were crusted but not collapsed. The subsidence appeared to affect chiefly the liquid lake for no avalanches were produced such as occur when the benches subside.

The writer descended the west niche and found his way to the northwest pond and the south end of the cragmass. Here it was possible to walk out on the lower bench and look into the great west half-dome. It was now raised and inactive, exhibited only a slight niche with stalactites on the lake side, and a vertical wall beneath. The southwest islet mushroom was a most extraordinary object out in the lake, 15 feet high and 50 feet long on the summit but not more than half that length at the lake level. The lake showed quiet, swelling, blistered crusts, fountains were playing in curtained grottoes southwest, the streaming was very slow and the heat was strong.

Returning to the upper bench; I followed around the January floor on the north to the east station. An examination of Perret's cave showed that it was 60 feet deep and ended in a

tumble of rocks. Great quantities of yellow-stained alum were forming amid dripping water. Cavern stalactites from the roof were coated with crystals of gypsum and there were driblet cones on the floor which was mossy with Pele's hair.

On the northeast side of the lake there were lower benches of downsunken floor blocks. Fumes had greatly increased over Halemaumau, a dozen places yielding dense white, but breathable, smoke columns. The southeast cone, however, was flaming and producing irrespirable sulphur fume and similar fumes were rising from the glow cones and the southwest grottoes.

On the afternoon of March 28 the lake was lower with inner walls 20 feet high. There was a heavy fall into the southeast channel from the central peninsula. The central cavern was high and deep and a current was rushing into it. The entire bench south of the crag-mass where Alex Lancaster and the writer had stood on the previous day, had fallen into the lake, wrecking the large half-dome and the mushroom islet. The east and southeast cones were less active, there were five or six fountains, streaming was rapid to the southeast and smoke had increased.

At 4:30 p. m. temperature measurements were made with Seger cones at the orifices of the east cone on the lower bench. This cone was about ten feet back from the east cove over the tunnel there. It was about two feet high and ten feet across, consisting of broken stained crusts. The crevices showed a bright cherry red interior by daylight and there was slight blue flame, but no puffing. The glow was distinctly less bright than that of the bright lines on the lake. Seger cones were attached singly by wire to the end of an iron pipe and thrust into the glow about three inches through a crack two inches across. The Seger cone in each test was left heating for five minutes. It would become red hot, of the color of the glow chamber, in about one minute. Four Seger cones were tried as follows:

Seger cone of fusing point 1150° C—no effect.

Seger cone of fusing point 990° C—no effect.

Seger cone of fusing point 920° C—blistered.

Seger cone of fusing point 890° C—end bent down, cone blistered and partially melted within the first two minutes.

Temperature of glow chamber hence over 920° C. This filagree cone was brighter on the day before and almost completely dark on the day following this test.

This careful measurement was of a glowing cavity about the color of the interior of the benches when they break open. As the zigzag lines of the lake crust are brighter, their temperature must be higher than 920° C. As the January measurements made the temperature of the lake three feet below the bright lines much lower than this, we are confronted at once with the query, are not the bright lines heated by oxidizing gases, and is not the thermal gradient of the lava at the actual surface an extraordinarily steep one?

On March 29 at 3 p. m. the lake was rising, with eight to ten fountains and the inner bench fifteen feet high. Streaming was now outward from both the northwest and southwest coves. The central cavern was quiet and appeared to connect through to the southwest cove by a tunnel, for there was fountaining at the other end of the isthmus platform joining the central peninsula with the south island mass. The southwest cove was crusted over and contained two small islets. The west pit showed some subsidence of its crusted pond but its cone and that of the northwest pond were still glowing. There was much bubble fountaining. An interesting feature of the aa surface exhibited in section on the east and west walls of the east island which rose so suddenly February 18, is that this aa shows a curved or humped surface lower on the east and higher on the west, unconformable beneath the bedded pahoehoe layers above. It thus appears at the time of its rising to have swollen up as a mound which sloped towards the sinking east crag; this mound appeared as a shoal in the lake and was plastered by the lake with chilled layers of pahoehoe as a low islet; when the east crag sank suddenly, this hump of aa in the

lake bottom rose and produced the table island.

On Friday, March 30, 1917, at 3 p. m., the lake was 12 feet below the inner bench, eight fountains were in action, and very rapid building of border niches was in progress. Quiet crusts covered the lake, there was increased streaming in the late afternoon, small overflows built a new inner bench southeast, east and southwest, and a large spectacular shore cone was built during the afternoon at the east cove. Streaming was outward from the west and northwest and the southwest islets were nearly submerged. Fumes were thinner. A central fountain broke at intervals north of the junction point of the three arms of the lake. There were spatter grottoes northeast, southwest, east and at three points southeast.

At 4:30 p. m. with the aid of volunteer assistants, a temperature measurement was made of the standing bright line near the northeast margin of the stream pouring southeastward along the surface of the lake through the southeast channel. Five Seger cones of fusibilities 830°, 860°, 950°, 970°, and 1010° C were placed in the plugged end of a one-half inch black iron pipe. The pipe was sixty feet long. The end was dabbled in the bright fluid melt of the zigzag line for five minutes, not more than twelve inches of the end of the pipe being allowed at any time to sink beneath the surface of the lake. When the pipe tended to be swept aside and crusted, it was moved back into the bright part, and no fountains broke against it except the small bubblings characteristic of such bright lines.

The experiment was completely successful, for the cones 830° and 860° were fused to powder, 950° was fumed, 970° bent, and 1010° blistered. The temperature was thus approximately 1020° C, as the next cone in series (1030°) would probably have been unaffected. The bright lines are hence at least 100° hotter than the cherry red glow of the bench magma measured March 28 and at least 250° hotter than the lake magma three feet below the surface, as measured in January.

This astonishing surface gradient accouts for some of the discrepancies of the January experiments, when measurement with thermo-couple just at the lake surface gave 1000°+ and measurement with Seger cones plunged three to four feet below the surface and left there for as long as eleven minutes failed to show any trace of fusion on a cone fusible at 770° C. The conclusion is unavoidable that the bright lines are minutely fountaining and flaming and are heated by union of air with escaping combustible gases.

The rapid growth of the east cove shore cone on this afternoon, March 30, was remarkable. At 2 p. m. it was a slight spatter crescent half circling a niche in the shore line where blowing, flaming, spurting, and extensive spinning of Pele's hair was going on with great vigor. So rapidly did it pile up that by 7 p. m. the circle of construction had closed on the lake side making a cone six feet high and ten feet across the base, with an orifice two feet in diameter in the summit where the violent spattering had given place to a flame that rose in puffs one to two feet above the hole and was of a light greenish violet color. Occasional flings of lava surmounted the rim but the violent spurting had stopped. The next morning the cone was destroyed.

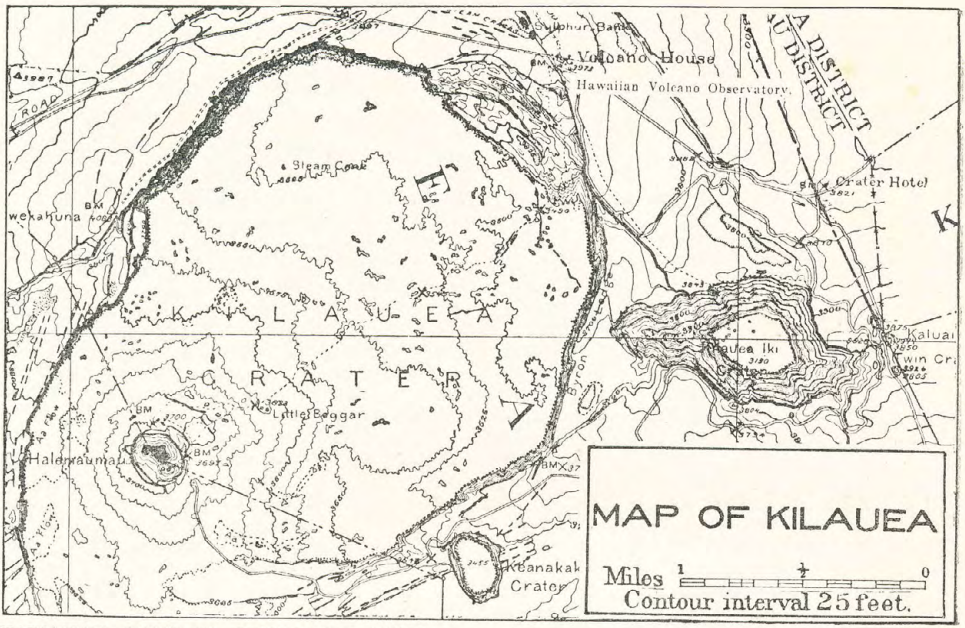
The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with March 30 three local shocks of small seismographic amplitude have been registered. Besides these some twenty-five to thirty earth-jars of a peculiar kind have been noted. These are not earthquakes as ordinarily interpreted—nor groups of conspicuous waves of volcanic vibration as usually manifested. All have been of very brief duration with abrupt beginnings and no division into phases. The periods have been too short for measurement on records as closely written as ours, and their seismographic amplitudes have been very small. No explanation of their meaning is suggested. But they are movements of exceptionally feeble sort and of very local origin.

Registration of microseismic motion and of that of volcanic vibration has been normal and without noteworthy peculiaries. There has been a sharp shift in the sense of tilt to eastward with no corresponding change in the north-south component.

Very respectfully,

T. A. JAGGAR, JR., Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, APRIL, 1917. No. 4

Technology Station, April 7, 1917.

During the week ending April 6, 1917, the lava of Halemaumau has risen slightly with overflows on the south, west and east, but the depression of the lake is still over one hundred feet. The evidence of rising has been erratic as in the autumn of 1916 and the bench crags are again rising. This rising of the crags is now symmetrical about a central point in the pit. This central point is the meeting place of three arms of the lake which lie at angles of 120° to each other. Between these arms are sectors of bench which are sinking around the circumference of the pit and lifting their convergent points near the center. The marginal sinking is started apparently by weight of the overflows and increased by weight of debris from the old benches and from the outer walls. As a result the south island peninsula, the crag-mass and the east island are now all rising, and the east, southwest and northwest floors are sinking. The walls of the inner pit adjacent to the lake, during one of the temporary sinkings, are therefore highest near the center of the pit. As usual the northwest and west ponds are the conduits of uprising liquid lava.

During the week, experiments in measurement of temperature in the depths of the lake have been continued, with the aid of Co. I, 25th Infantry, 4th Co. Coast Artillery, Hilo Boarding School students, and voluntary assistants. The net result of these measurements, made with Seger cones, is that the temperature of the surface of the lake is 1020° C which is 100° C hotter than the lava four feet down; below that point the temperature rises at the rate of 9° C per foot to a depth of 20 feet, the temperature at that depth being approximately 1070° C. Experiments will be continued to determine, if possible, the temperature of the lake bottom and details of the remainder of this remarkable thermal gradient.

On the morning of March 31st, 1917, the lake continued relatively low and sinking during the day, the inner bench walls rising about 15 feet above the liquid lava. At times eight fountains were in action, a large spatter grotto and two islets were seen in the southwest cove; elsewhere a new inner bench about three feet high was being constructed. The cone in the east cove had been destroyed and was covered with slabs from a rise of the previous night. Streaming was mostly slow and there were occasional falls of the spatter bench.

On April 1, at 11 a. m., the lake was slowly rising with few fountains and an inner bench about five feet high. At noon fountaining had increased and the lake had risen to within one foot of overflow. At 4:15 p. m. a collapse northeast developed many fountains and at 6:30 p. m. a similar fall took place on the southwest side of the east island so as to make commotion in the streaming channel there.

On April 2, at 2:30 p. m., the inner walls were five feet high and streaming continued from northwest to southwest and southeast. There was much activity. At 2:50 p. m. portions of the bench on the northeast side of the central peninsula fell into the channel. Fourteen fountains were counted exploding at one time. At 4 p. m. the lake was brimming level with the inner floor on the east.

On April 3 in the morning, the lake was overflowing, and at 2:30 p. m. the inner wall was again five feet high and five fountains were in action, especially at the grottoes east and southeast. At 3 p. m. rapid rising began,

WEEKLY BULLETIN
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Hawaiian Volcano Observatory

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L. W. de Vis-Norton.....Secretary

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at 3:40 p. m. the lake was brimming level with the inner benches, and at 4:20 p. m. it was overflowing at the east cove. At 4:40 p. m. overflows were in progress on all sides, the peninsula crags all appearing surrounded by molten lava and from fifteen to twenty fountains were in action. In the evening the glowing flows lay on the east, south, west and northwest floors but the lake was about three feet down. Eight to ten fountains were in action and the current rushed swiftly from the north bay to the southwest cove. In the southeast channel streaming was more sluggish. Fountains were conspicuous northeast and southeast, in the central region, and on both sides of the southwest cove. A blue flame was flaring above the northwest cone. An overflow had poured from the west corner of the lake into the northwest pond depression.

On April 4 the lake was high but not overflowing. It showed some fresh overspatter at the east cove. There was still much fume. Examination of the western region at 3:30 p. m. showed the west pond to be high, active and level with the floor around it and the northwest cone was spurting and making loud blowing noises.

On April 5 from 10 to 12 a. m. the conditions of activity were much the same and the lake high with five or six fountains in action. At noon and thereafter there was a small trickling overflow in the eastern gulch. In the depression filled with fresh flows on the east side of the east island there was a ridge crossing the flows in a curve from the east cove northward showing that the east island mass was rising while the old northeast bench to the east of it was sinking. There are great smoke holes yellow with sulphur and alum in the northern part of this depression and the edge of the old bench has been crumbling under this faulting movement. The northeast point of the old bench is rising with the island mass.

Looking from the northeast shore of the lake at the central region, a large fountain was seen to burst occasionally in the north central part of the lake. This had some resemblance to the "Old Faithful" of former years. Immense balloons of leathery crust were inflated by gas over the center of the lake, then they would collapse and a great fountain would break through the melt beneath. On the northeast rampart strong grotto fountaining was throwing spatter lumps over the bank and these tended to blow blisters one to three inches across. There was another grotto farther northeast emitting noxious fume.

On Friday, April 6, 1917, the inner little variation. The seismographic amplitude of volcanic vibrations has bench was 10 feet high and sinking increased this to fifteen feet. On this day it became evident that the inner walls were higher (20 feet) near the center of the pit and sloped radially to lower levels with reference to the lake at the ends of the three arms. The summit of the crag-mass was unquestionably rising. Marginal overflow was displacing the bench magma so as to squeeze the pasty substance beneath the crags out towards the region of central lake bottom. There were fountains southwest, northeast, east and southeast. Streaming was from the northwest and was rapid in the southeast channel. There were occasional falls from the raised ramparts.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with April 6, six local earthquakes of small seismographic amplitude have been registered. The motion of microseismic waves has been normal with

been steadily larger than normal but without reaching unusual magnitude, and without conspicuous storms. There has been a sharp and considerable shift of the pens in the sense of tilt to westward followed by a sharp return. The net change is inconsiderable. This action was confined to three days in the middle of the interval.

Technology Station, April 14, 1917.

During the week ending April 13, 1917, the lava lake has continued stagnant at a depression somewhat over 100 feet, but with a general tendency toward slight rising. The three sectors of bench magma tipped respectively by the east island, the south peninsula and the crag-mass have continued to rise in the central region of the pit and sink around the margins so that new islets and isthmuses of raised lake bottom tend to subdivide the lake into three pools north, southwest and southeast. The lake has fluctuated in height through a range of 15 feet.

The experimental work of the week has been directed to continued exploration of the thermal gradient of the lava lake using the Bristol electric thermocouple. Tests in the laboratory showed that this instrument could be used without appreciable error by separating the cold junction from the hot junction with a considerable length of copper wire. Accordingly on April 13 the instrument was thus arranged at the lake margin in the east cove, the wires covered with asbestos being led through half-inch iron pipe. The terminal was thrust through a three-inch crust which on that morning tended to cover the whole southeast pool. Trouble was experienced through burnt-out insulation and the temperature measurement made is only tentative but it indicated a temperature of 700° C at a depth of one foot below the thick crust and over 900° C at a depth of three feet. This suggests that the radiation and cooling effect of large crusted areas is effective immediately beneath the crusts for only a few inches, while below there is a gradual rise of temperature. This checks with the measurements of January which showed a low temperature just under the surface crust. On the other hand the surface of the lake, when crusts are tearing and sinking, becomes very hot not only by oxidation of the escaping gases but also through the rapid rising of the liquid melt from several feet down which replaces the less hot surface liquid. This surface liquid immediately under the crusts is heavier than the melt below and during general disturbance of foundering crusts must go down with the crusts.

That the crusts on sinking become centers of solidification of lava was shown in one of these experiments. Five feet of the end of the pipe was covered with a thin shell of solidified lava. This was thrust back into the lake and left for ten minutes in the melt beneath the crust. On withdrawing it the lava accumulation had tripled in thickness showing how rapidly lava partially cooled will act as a nucleus of solidification.

An interesting phenomenon observed with this apparatus was the immediate rise in temperature, by about 60° C, of such a lump of lava on the end of the pipe when it was withdrawn from the lake and exposed to the air. In spite of rapid solidification the temperature rose. The meaning of this appears to be sudden oxidation in air of the gases and also possibly heat of crystallization.

On Saturday, April 7, 1917, the lake appeared lower than on the previous day with inner bench 20 feet high in the southeast channel, central and southeastern caverns both open and showing inward streaming, and southwest islet standing about eight feet above the lake with slight overhang. There was a heavy fresh tumble of rocks from the southern January bench to the floor below. It was becoming evident that these border tumbles, like the overflow of other occasions, act as loads to weight down the bench magma and force the stiff under-fluid toward the center of the pit—in other words, to force up the lake bottom. These fresh-fallen avalanche heaps appear all around the pit along concentric down-sunken blocks of bench backed by huge crevasses where these blocks have parted from their former attachment to the old walls of Halemaumau. The northeast bench was subsiding below the 1894 shelf The northeast point,

on the other hand, was rising along with the east island. The northwest arm showed a platform of recent overflow above it and the northwest pond was covered with recent overflows from the west cove. The crag-mass, in response to this weighting, showed increased tilt westward.

It has recently been noticed that grapevine stalactites, such as are common in lava tubes, have formed since January in shallow cavernous spaces between lava flows of the northwest broken benches. This indicated that such stalactites are not formed by water drip, but are a peculiar type of feet and formed a secondary conelet under the former cone. The former cone clung to the wall like a bracket, a mere shell of its former structure, but from its under side hung many grapevine stalactites one to two feet long and immediately over the active flaming under-cone. Apparently the great heat from below had produced refusion in the upper cone shell and so developed **in only three days** fully formed stalactites of this type.

The southwest benches had sunk and opened crevasses at the base of the outer Halemaumau wall so as to swallow the heavy talus slopes which had been there. There were new crevasses also at the base of the south wall. The northwest cone was puffing and occasionally lava spurted from adjacent holes in the floor. At 2:30 p. m. the southeast arm sank three feet and there was a heavy fall from the east point of the south island mass.

On April 8 these tumbles into the lake became very numerous and at 2 p. m. it was found that immense falls had taken place from the south side of the east island and the north side of the central peninsula. This last tumble nearly choked the channel leading to the southeast arm showing how shallow the center of the lake was. The promontory making out from the crag-mass had also collapsed and was now represented by two islets five feet high. In the southeast arm the streaming was from the southeast cove, the central cavern and the central channel, the three streams convergent at the east cove. The bench where experiments were made during the previous week, around the south base of the east island, had now entirely fallen away. At 4 p. m. the lake was still sinking, there were more falls from the southeast point and the channel leading to the southeast arm was nearly closed.

On April 9, at 2 p. m., the streaming in the southeast channel was reversed and pouring westward to the central cavern. The elevation of the entrance from the central region to the southeast channel was now complete so that an isthmus connected the east island and the south island mass. The inner benches were 25 feet high in places. At 3 p. m. there was a small avalanche under the east rest house. At 4 p. m. there was slight flow across the isthmus from the north but the main streaming in the southeast pool was eastward from the central cavern. The lake was very quiet. A rhythmic fountain was playing in the north central region and there were shore fountains southwest and southeast. Streaming was outward from a dark skin across the northern part of the lake. A fresh tumble from the bench had left two rocky islets in the southeast cove. Next to the northwest cone a small area of floor over the northwest pond had collapsed leaving a glowing pot.

The spectacular feature of this evening was a revival of the northeast cascade from the lake into an inclined chute under a broad arched cavern at the northeast point. Just south of this point a new pit had opened 20 feet in diameter and this was fuming and flaming vigorously. Looking down into this pit at dusk the lava of the chute could be seen rushing silently eastward like a mill sluice, at a depth of about 20 feet, with glowing gases making a low roar like a furnace and heating the interior of the pit to incandescence. Above the gases condensed to billows of dense white fume which rose rapidly in unusual volume for Kilauea. A few feet to the west of this pit was a sulphur hole also glowing.

On April 10, at 4 p. m., the lake was still low but showed rising tendency, with a new low inner bench which had buried the southeast islets, blocked the entrance to the southeast cove and left a small pool at the inner end of that cove. Four islets lay in a line from the southwest cove to the center of the lake and a rampart grotto was build-

ing between the two northern ones. The cone in the west pond had built up and now showed a flaming triangular gash facing westward and revealing clusters of grapevine stalactites inside. The bench on the north side of the northwest arm had collapsed and the high broken northwest bench of January was further split crosswise. The north part of the lake was stagnant, the northeast pit quiet and the northeast cascade locality was fountaining violently without inrush.

On April 11, at 11 a. m., the lake was still low but showed further evidence of rising in fresh bench construction. A hardened flow from the central region lay across the channel isthmus. A high half-dome had been built against the central island. Heavy crusts over the east cove suddenly broke with a gush of gas and loud hissing noise; this was followed by violent spraying, the crust broke up and foundered, an active fountain developed and this migrated to the bank where it expended itself by building a slight crescent rampart. A sudden sinking of the main lake was not shared by the southeast pool, indicating that the isthmus is upraised lake bottom and not an arch of crust.

On Thursday, April 12, 1917, from 2 to 3 p. m., the lake was seen to be definitely higher. Streaming was outward from the central cavern but there was fountaining inside. The northeast sulphur hole was crackling, fuming, glowing and covered with bright yellow sublimates. A strong "sweet" sulphur odor came from this hole quite distinct from the ordinary sulphur dioxide. The northeast pit was entirely inactive and showed black pahoehoe on its bottom where the sluice way had been. The northeast floor of January showed whitish hot areas with cherry red glow in the cracks one to three feet down. No odor whatever was detectable in the hot air rising from these cracks. The north chasm showed a broad solidified festooned overflow from the lake but no activity or fume. At 4 p. m. the lake was rising and level with its inner bench.

On April 13, from 9 to 11 a. m., the lake was relatively high and rising. After 11 a. m. a torrent poured from the north across the isthmus to the lava drip, probably occasioned by reheating due to oxidizing gases. In proof of this, the cone on the northeast corner of the west pond showed on this day a remarkable collection of these stalactites. Three days before the west pond had been level with the floor around it, but now it had sunk four southeast pool and rising from that time on brought the level to within ten feet of the floor level at the east cove. In the morning the southeast pool was heavily crusted from shore to shore. About 10 a. m. this cover broke with violent gas escape and lifting of crusts, followed by a breaking up with intense evolution of heat and bubble fountaining, as well as grotto fountaining. The deflated pool sank two feet. This spell lasted ten minutes and then crusting set in once more, to be finally broken up by the flood from the north. The northeast sulphur hole had developed into an open flaming pot. There was rampart building at the islets and to the northeast and southwest.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

Only three local earthquakes, all of small seismographic amplitude, have been registered during the week-interval ending with April 13. A small number of indefinite wave-groups of lesser magnitude also were recorded. For the most part the seismographic amplitudes of microseismic waves and waves of volcanic vibration have been normal but in the early part of the week-interval moderately large motion occurred. In the first part of the week there was a marked shifting of the pens in the sense of tilt to the east, and then to the west, followed by a steady run without notable net change.

Technology Station, April 21, 1917.

During the week ending April 21, 1917, the Halemaumau lava lake has continued to rise slowly, and this rising now appears to be growing steady, following the stagnation and irregular fluctuation of the equinox period. The inner bench of overflow was 101 feet down on March 30; this bench had been flooded on March 22 and was not again overflowed until April 2. The definite rise which began on April 1 amounted to 14 feet of actual con-

struction in seventeen days, or a rate of one and a fifth feet per day.

On Saturday, April 14, at 2 p. m., the inner bench was seen to have been overflowed east and southeast, the lake now being five feet below it. The southeast cove was now a niche with a hard floor and no liquid pool. The isthmus separating the southeast pool from the main lake was pronounced. There were now three islets instead of four in the main lake, the two middle ones being united apparently into an island at the entrance to the southwest arm of the lake. There was a small islet at the entrance to the north arm, and the older southwest islet was still in place. High spatter half-domes were building on the central island and on the east shore of the southwest arm. A shore pinnacle stood out from the northeast base of the crag-mass. The central cavern was again open and fountaining within, with outward streaming. Smoke was abundant.

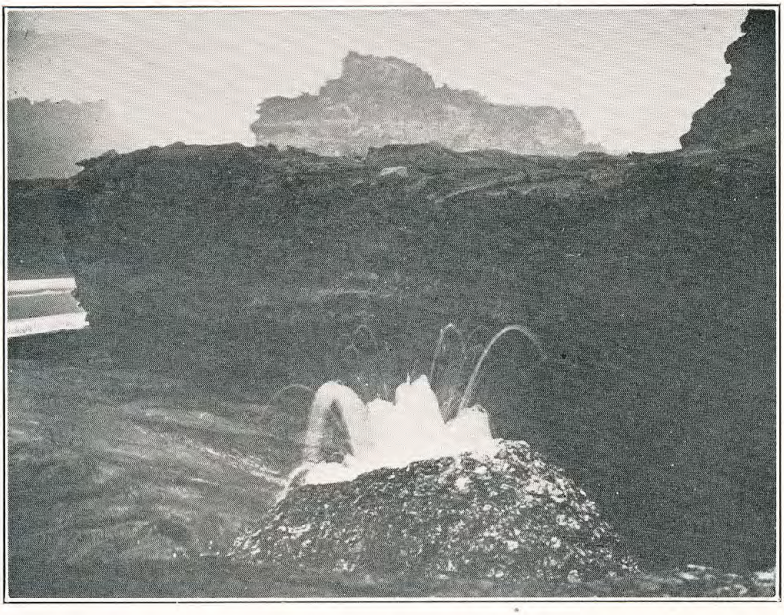
Upright laminations in the jointing of the broken southern face of the east island, at the level where aa lava occurs on the opposite side of this upraised mass, may probably be accounted for by supposing them to be the accumulation of foundered crust of Januar. These crusts sink at the lake border and were doing so continuously at that time on the northeast banks, in the region later uplifted to form the east island. The sinking crusts may be laid against the precipitous submerged lake borders in more or less upright layers, and so build out the banks during a rising period. This would account, at such a period, for the invariable contracting of the lake and the widening of the inner benches. Such benches are always built at the shores towards which the streaming and sinking proceed.

On April 16 there was strong rising which obliterated the southeast niche and flooded the south floor from both the east and west sides. An overflow at the east cove poured through a gap in the lower part of the sunken northeast bench of January making a small leaf-shaped flow on that bench under the east shelter. A new inner bench was constructed around the east island. The northeast sulphur hole lost all glow and became a dead cavity. New benches were built at the northwest and west coves.

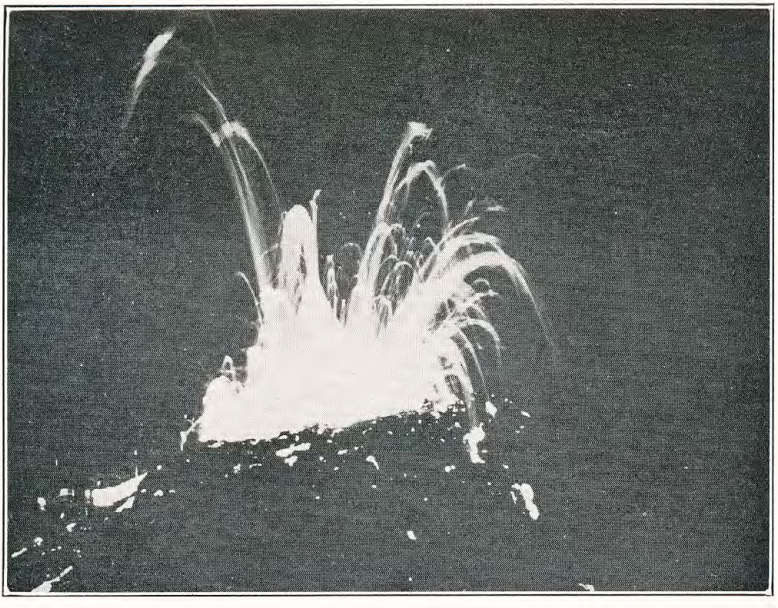
At 2:30 p. m. on Tuesday, April 17, the three islets and the bench around the southeast pool were eight feet high, streaming was from the central cavern in a curve northward, where a fountaining grotto was revealed under the central isthmus. Streaming in the main lake was from the north and the southwest arm was stagnant. The southeast cone was now ring-shaped with a central pot. The southeast side of the crag-mass appeared much fallen away. Splashing grottoes were building on the northeast, west, southwest and east. A portion of the bank at the east cove collapsed and broke up the heavy crust on the southeast pool. Fumes had greatly diminished. The southeast high bench was gaping away from the wall. The depression of the southeast pool was 105 feet. The noises were of grotto splashing and occasional tinkling falls of rock.

On April 18 from 10 a. m. to 1 p. m. the pools rose from a level four feet below the banks to brimming and then strong overflow. Thereafter until 4 p. m. there was subsidence eight feet. The three central promontories have continued to rise and the border regions of the benches to sink. There were now only two islands in the main lake, in the center and southwest arm respectively, and both of these were flat-topped and larger than before. The northern island appeared to have been submerged. At 11 a. m. the southeast pool was flush with the bench and covered with a crust four inches thick, brown and fibrous, which incessantly crackled, throwing up hundreds of tiny fragments either from cooling strains or bursting gas bubbles. This heavy crust extended for 150 feet across the pool, was arched up slightly by the foaming lava beneath, and was kept broken around the edges as it rose along cracks where a sluggish pudding of lava from beneath would well up with hissing gas pressure. Occasionally at long intervals the crust would break up all over and founder with fountaining and tremendous evolution of heat.

The northeast point of the January bench had now become a pinnacle fifteen feet higher than the bench and



March 30, 1917, 7 p. m. Flaming and spurting border cone, East cove, 20 feet away. Exposure 30 seconds.—Photo. Jaggar.



March 30, 1917, 6 p. m. Flaming and spurting border cone, East cove, 30 feet away. Exposure 90 seconds.—Photo. Jaggar.

April 5, 1917. Aa or block-lava pedestal of East Island. (See Feb. 18 and March 24, this Bulletin).—Photo. Jaggar. Note contrast pahoehoe overflows in foreground, and layers of pahoehoe in cliff.

blocks of rock occasionally fell from it into the small pit on its south side. The overflows on this day poured to the northeast crag wall but not through the gap and they filled the depression at the bottom of the east gulch. Flows poured from the east and from the west a short distance over the south floor. The west pond under the high west wall of Halemaumau was covered with new lava crusts at a high level, as was also the northwest pond. The west cone was built high and had in its summit a small glowing and flaming hole blowing noisily, and the northwest cone was also blowing. There was overflow in the north chasm. In the main lake there was much fountaining in the north central region and against its west, southwest and southeast banks. Everywhere there was strong gas pressure with blowing noises added to the plashing of the fountains. At 6:30 p. m. there was a heavy avalanche into the lake from the southeast side of the crag-mass followed by turbulent fountaining. At 6:30 p. m. the bench along the south side of the east island collapsed en masse and carried away much of the isthmus. Immediately an upwelling of lava started in the southeast pool at the isthmus and during the evening the sluggish crusting which had been characteristic of this pool gave place to strong, hot streaming from under the isthmus, implying apparently that a tunnel had opened connecting the two lakes. There was a tendency to whirlpool pattern in the southeast pool.

Measurements, 2 to 3 p. m. on Thursday, April 19, 1917, showed the depression of the southeast pool to be 87 feet below the southeast rim of Halemaumau. The northeast pinnacle rose above the lake 43 feet, the east island 51 feet and the crag-mass 54 feet. These measurements indicated that the east island had risen 28 feet since March 30, and the crag-mass 17 feet. The dimensions of the southeast pool were 380 by 220 feet; of the main lake 800 by 250 feet; the central and southwest islands in the main lake were each 60 feet long.

The habit of the southeast pool had entirely changed, streaming lava was pouring through a tunnel under the isthmus from the main lake into this pool, which was now very hot and covered with black satiny festoons which moved rapidly to a new grotto at the southeast end of the pool. The skins appeared thin and blistered. The lakes were about four feet below their banks, five or six fountains were in action, there were occasional border tumbles, a rampart encircled the southwest arm and there was glow and flame at the southeast cone. Streaming in the main lake was southward with much bubble fountaining near the central island. The narrow steep-sided crag of the central peninsula was broken and tumbled in the middle and smoking strongly. There was much white smoke from the north inner wall. There were no fresh overflows and the lake appeared sinking in the afternoon, but in the evening it rose rapidly and overflowed the entire southern and eastern floods, pouring again through the northeast gap and greatly widening the leaf-shaped flow on the January bench.

On April 20 at 2 p. m., there was new rock tumble at the edge of the lake under the east end of the high southeast bench. Streaming festoons spread in wide folds from isthmus tunnel toward the southeast station. Two high rampart grottoes had been built at the southwest. There was a noise of incessant grinding crust at the east end of the southeast pool. Only two or three fountains were in action, there was much smoke in the central part of the pit and on the northeast, west southwest and northwest. Streaming in the main lake was from north to south and the banks were about three feet high. The south floor was fast widening owing to the burial of the southern tumble.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with April 20 four local earthquakes of very small seismographic amplitude have been registered—together with a number of wave-groups of indeterminate character and exceedingly small amplitude. Microseismic motion has been normal to weak in energy. Volcanic vibration has varied from normal to moderately strong values—with storms of stronger trembling. There has been

little or no net change in pen-shifts in the sense of tilting but in the early part of the interval there were pronounced shifts with strong diurnal movement. In the latter part there has been little shifting of either sort.

Technology Station, April 28, 1917.

During the week ending April 27, 1917, the lava lakes of Halemaumau have maintained their level at about 90 feet of depression without marked net rising. There have been fluctuations from day to day within a range of 15 feet.

On April 22 at 2:30 p. m. the inner wall was 15 feet high, the southeast pool was quiet and the main lake active. The central isthmus had subsided on its northeast side so as to show a slope in that direction and a break on the side of the central peninsula. The tunnel connecting the two lakes appeared to be closed. There was streaming from under the southeast bank and slow rising during the afternoon so that at 6 p. m. the lava of the southeast pool was within seven feet of the inner bench.

On April 13 at 2 p. m. both pools were quiet, with banks about ten feet high and fumes thick. At 4:45 p. m. there were numerous fountains in the northern part of the main lake and among these a large rhythmic dome fountain having the aspect of "Old Faithful." The central and southwestern islets stood ten feet above the lake. The west cone showed one glow spot on its southwest side.

On Tuesday, April 24, at 2 p. m. the central cavern open to the east exhibited continuous boiling up of lava and a current poured out of the cavern and across the southeast pool to the north where it expended itself in a line of tumultuous fountaining and downsucking at the south base of the east island. The main lake was quiet and smoky and somewhat higher than the southeast pool, the latter exhibiting inner walls 15 feet high. At 2:30 p. m. a portion of the bank collapsed at the extreme southeast corner producing short-lived fountaining.

The northwest cone was now a tumbled group of pinnacles and the west cone at 4:30 p. m. was heard puffing, indicating rising gas pressure. There was high crusted lava in the west and northwest ponds, a new high bench enclosed the northwest arm and there were recent flows at a high level in the north chasm. On the northeast margin of the lake a high ring-shaped cone had been built with an open flaming orifice on top.

After 5 p. m. the rising in the main lake gradually reached the isthmus level and then the lava flowed across the isthmus to the southeast pool. The arrangement in this pool was peculiar, two open glowing caverns, one above the other, leading into the north side of the isthmus. From the lower of these there appeared to be an outrush eastward of gas and lava on an up grade and this deflected the current from the central cavern so as to produce a succession of waves and noisy longshore fountaining at the base of the east island. The rising and overflowing from the main lake gradually stopped this process by drowning the lower cavern, but the upper cavern then produced a sluggish cascade outward into the southeast pool. When the torrent had poured completely across, the longshore fountaining diminished and the central cavern became drowned. A slow current southeastward replaced the former activity. The southeast cone continued glowing and flaming.

On April 25, 1917, at 3:30 p. m., the banks of the southeast pool were only five feet high and again it was divided from the main lake by the isthmus. The southeast grotto was active and the streaming towards it. There was steady loud hissing from the west cone. Fountains in the main lake played near the middle island, against the northeast wall and in a curtained grotto northwest. The northeast cone was nearly closed above but showed open gashes below leading to large cherry red incandescent chamber. Seen from the northeast bench, the great western crag-mass by tilting westward had entirely changed in profile. The lakes in general appeared crusted and rising.

On this day the south face of the east island was visited and the upright layers noticed there were verified as consisting of wavy crusts of vesicular and deeply oxidized lake lava plaster-

ed against the upright aa hillock that forms the foundation of the island.

These layers appear to be the sunken crusts of the January activity.

On April 26 at 6 p. m. the lake had subsided, the fumes were thicker and the inner benches 10 to 15 feet high. The southeast pool was crusted, but occasionally a fountain burst in the southeast corner. In the main lake the streaming was from north to south. The great northern rhythmic fountain played at intervals of from 50 to 60 seconds with bubble fountaining between the larger explosions. The central crags were more broken and showed yellow sulphur stain extending to the flat south of them. The central and southwest islets rose about ten feet above the lake with overhanging walls. There was active bombardment at the southwest bank, curtained grottoes to the north, and five or six fountains in all. At 6:30 p. m. the central islet collapsed bodily into the lake producing a wave and a short-lived effervescence. No trace of the islet was left. The west cone was flaming through filagree fused openings. The northwest cone was smoking. The northeast cone was flaming and spurting and the southeast cone flaming. The southeast pool showed streaming out from under the isthmus and occasionally the crust would break up with cracking and foundering.

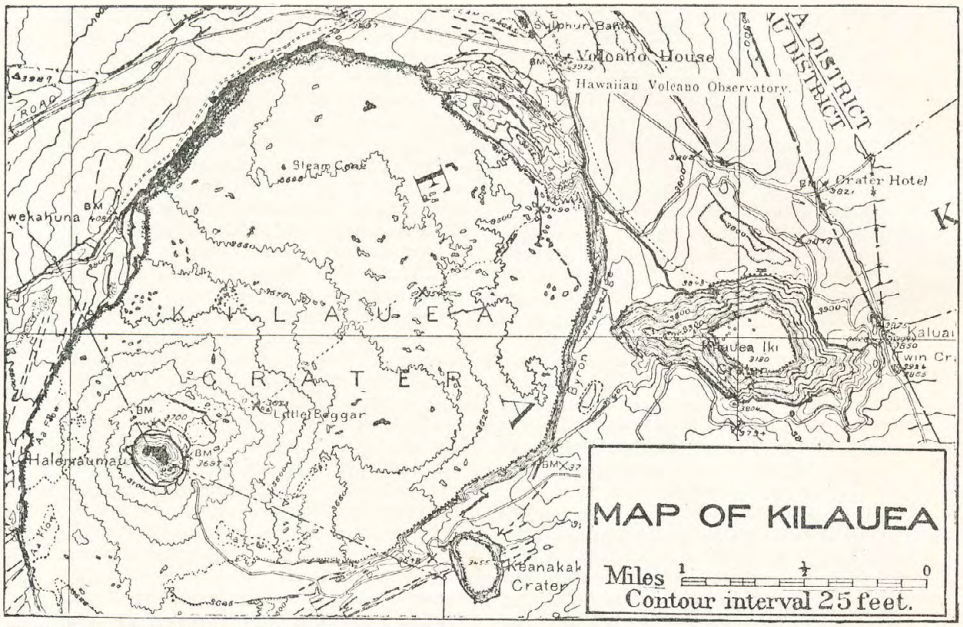
On Friday, April 27, at 11:30 a. m. the lake appeared still lower and more smoky with inner cliffs 15 to 20 feet high, very slight streaming, a few fountains at the Old Faithful region and in the grottoes, and no trace of the central islet. The southeast floor was smoking strongly. There were now disjointed small crags east, southeast, northwest of east island, west, northwest, and north. The progress of central uplift of the crags has developed two marked bench levels, a newer inner one 10 to 15 feet high corresponding to the level of the isthmus between the two lakes. The higher one, in places 20 feet high, corresponds to the level of the floors south and east. Still higher locally are the January benches northeast and southeast, and the extensions of these north and northwest are now becoming uplifted crags. At still higher levels and at higher angles of tilt are the January crags. The general aspect of the pit as one approaches it from the southeast gives the impression that it is extraordinarily choked with crags and benches, but from the southwest the main lake is seen to be still a large body of liquid lava.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with April 27 nine local earthquakes have been registered, all of very small seismographic amplitude. There have been recorded several very small wave-groups of doubtful character besides. Microseismic motion has been normal. The motion of volcanic vibration was stronger than normal in the middle part of the interval but was normal to subnormal at the beginning and end. During the last four days of the week there has been progressive shifting of the pens in the sense of tilt to westward. Earlier the registration was normal. Of late there has been no noteworthy net change in the north-south component.

Very respectfully,

J. A. JAGGAR, JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

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Technology Station, May 5, 1917.

During the week ending May 4, 1917, the lava lake has again risen within its 20-foot range of movement and reached a level slightly higher than on April 19. On April 27, at noon, the depression of the north grotto below the south station was 105 feet. On May 4 the depression of the southeast pool below the east wall of Halemaumau was 83 feet. The fountaining activity varies and Old Faithful, in the north central part of the main lake, appears to be reestablished. In general there is much less tendency to swift streaming than at the beginning of the year and the sluggishness is accompanied by the formation of thick crusts. The construction of driblet cones is again in evidence as part of a general rising tendency.

Experimental work at the lava margin was resumed on Wednesday, May 2, 1917, in spite of the southerly wind and a very fumy pit. The first experiment was to determine the temperature of the bottom of the lake, and simultaneously of the lava at intervals from the bottom upward. For a month past the apparatus has been in preparation. It consists of a steel pipe of 1½-inch internal diameter, 83 feet long, capped with a screw cover at the lower end, and containing a long heavy black annealed steel wire along which were wired nests or cocoons of Seger cones at measured intervals. The cones were enclosed in iron gauze, twenty-nine fragments representing fusibilities from 590° C. to 1290° C. in each cocoon, and twenty of these cocoons were distributed along the wire. There had thus been built a device for exposing twenty thermometers at one time to the heat of the lake at different depths. The cocoons made cigar-shaped swellings in the wire capable of gliding past the joints of the pipe without catching when the wire was withdrawn, the diameter of each cocoon being about one inch. As it takes several minutes for such an apparatus to heat thoroughly and the pipe may be immersed or the wire withdrawn in a few seconds, the error due to immersion and withdrawal of the pyrometer is negligible.

Assisted by Demosthenes Lycurgus, three of his associates and Alex. Lancaster, the writer made the immersion of the pyrometer at the east cove at 2:30 p. m. during a time of crust-breaking, the lava being about four feet below the rampart. The pipe went in at a flat angle owing to its large size and stiffness, but tilted down to 35° in its final position. Seventy-five feet of the pyrometer went into the lake, the lower end finding the resistant bottom lava at a vertical depth estimated at 42 feet. As only a short end of the pipe protruded above the bank, this was held in place by five men holding a taut wire attached to the pipe. The end of the pyrometer wire protruded from the opening of the pipe and was held by the writer. An eight-minute period was allowed for exposure to the heat, three for heating the pipe through and five for fusing the cones, in accordance with previous practice. At the end of the eight minutes the wire was withdrawn without difficulty, no welding or other cementing effect took place in the pipe and the cocoons were all intact with some of the cones fused and others quite unaffected. The pipe was, of course, abandoned.

The results of this measurement indicate a graduated temperature increasing downward as in the measurements of April 5 and 6, at an average rate of 9½° C. for each foot of depth for the whole gradient; for the interval, however, from twelve feet down, where this day's measurement began, to

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twenty-six feet down the increment was 15° C. per foot, whereas below that point the rate of increase was much slower, 3⅛° C. per foot to the bottom.

On basis of the gradient thus established, the bottom temperature on both April 5 and May 2 was very near 1150° C. and apparently this temperature is characteristic of a zone about ten feet above the bottom. Above that point the lava cools gradually, the rapid cooling effect appearing in the middle zone between twenty-six feet down and sixteen feet down, the range in that region on May 2 being from 1120° C. to 920° C. upward, whereas on April 5, during hot and rapid surface streaming, the range here was from 1130° C. to 1040″ C. There are, unquestionably, differences in the thermal gradient on different days, but the general range is from 920° C. four feet below the crust to 1150″ C. on the bottom. This bottom temperature is close to the temperature of the hotter fountains and is very near the fusing point of the sunken crusts.

It is probable that the combination of high temperature and pastiness encountered at the bottom is occasioned by crust material in process of dissolving through heat generated by reaction of lava gases with the air carried down in the pores of the crusts.

Two other experiments carried out on this day were devised in order to learn the effect of mixing air or oxygen with the lava gases. A quart bottle of oxygen gas was thrown into liquid lava and there immediately resulted quick jets of whitish flame and brown smoke puffing up above the melt. The bottle was slowly carried along beneath the surface and the flame explosions reappeared after about one minute down the current and were repeated several times. Evidently combustible gas in the vesicles of the lava was found and oxidized by the oxygen.

An experiment was made with a tank of compressed air to which a long pipe was attached so that the air could be released beneath the surface of the lake. This produced inconclusive results because the pipe was thrust into the southeast pool when the latter was covered with a very heavy crust. The only positive effects were jets of flame through the orifice around the pipe. Thereafter a gradual lifting of the whole crust took place, followed by cracking, foundering and tremendous fountaining. This happened after the air had been inflating the lava for from four to five minutes, when the tank exhausted itself. The pipe was immersed eight feet at first and later fourteen feet. The break-up came about five minutes after the pipe was withdrawn and there is no proof that it resulted from the experiment, though the central fountaining was unusual for this pool and the activity abnormally strong.

On April 28, at 2:30 p. m., the lake appeared over 20 feet below the inner bench and fifteen fountains were in action. The northeast cone was blowing noisily. There were occasional falls of rock into the lake.

On April 30, at 2:30 p. m., the main lake appeared about ten feet below the inner bench and the only fountaining was in the Old Faithful region. The southeast pool was more active but the fumes obscured the view. The northeast cone was still puffing. At 4:15 p. m. the southeast pool was only six feet below the bench and slowly rising.

On May 1, at 2:30 p. m., both lakes were active and rising, about twelve fountains were in action and there were splashing grottoes east and southeast. The isthmus between the two lakes was two feet high and the inner bench elsewhere five feet high. Streaming in the main lake was outward from the southwest and the northwest. The west side of the central peninsula and the highest northeast pinnacle had

fallen. There were great crevasses yawning at the base of the southwest wall of Halemaumau. The southwest island was split along a north-south fissure. The west cone was spouting lava continuously from a hole two feet wide in its west slope so that a lava cascade poured down about three feet to the west pond which was rapidly filling. The pond filled to the level of the hole and overflowed eastward. At 3 p. m. the upward spouting ceased and backflow set in from the pond into the hole with gas explosions at intervals. The northeast cone had collapsed.

On May 2 from 10 a. m. to 1 p. m. the lava rose and overflowed on the north, northwest, southwest and southeast. The southwest point was submerged and flows on the south floor poured from both east and west. The eastern flow was mostly across the site of the former southeast cove to a sinkhole just east of the southeast cone and when the flowing ceased, the cove outline and the sinkhole remained; the latter with lava churning a few feet down. There was border fountaining with strong gas pressure at the east end of the southeast pool, the central and western part being covered with a heavy crust from which streaming proceeded eastward. At noon the two lakes were joined across the isthmus without marked streaming. Once at noon there was very intense blowing off of gas from under the crust at the east cove followed by a break-up and strong fountaining. Streaming in the main lake was southward with the usual fountains.

On May 3, at 6:30 p. m., the banks were three to five feet high, there was sluggish border fountaining, interrupted occasionally by strong gas-pressure fountaining at the Old Faithful locality. Here there would be a noisy tumult of spraying with jets flung up 50 feet and outward in all directions over an area over 80 feet in diameter and this would slowly migrate to the northeast bank. The southeast pool was open and streaming eastward where there was an immense high curtained grotto. There was also a high rampart grotto southeast and flaming cones at the east and west ends of the south floor. The point at the southern end of the southwest cove was reestablished. Streaming was to the northeast and south. The west cone showed bright filagree openings where flaming and blowing took place and there was puffing also from glow spots at the south end of the northwest pond.

Measurements on Friday, May 4, 1917, at 3 p. m., made the depression of the southeast pool 83 feet. There was strong pressure fountaining on the southwest and southeast sides of this pool and in the grottoes of the southwest cove. The lakes were brimming level with the bench, skins appeared thin and blistered and rising was in progress. The southwest island appeared low and high ramparts were building southeast and southwest.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending May 4 four local earthquakes of small seismographic amplitude have been registered; and one teleseism of moderate seismographic amplitude only but with well-marked phase beginnings; hence a world-shaking shock of moderately great power is indicated. The registration of microseismic motion has been as usual. The seismographic amplitudes of volcanic vibration were of normal value until the latter part of the interval when they became larger and very small "storms" became frequent. There have been no noteworthy net changes in the direction of the writing levers (tilt) during the week.

Technology Station, May 12, 1917.

During the week ending May 11, 1917, the Halemaumau lava lakes have risen more continuously than of late at an average rate of about two feet per day. Strong overflow into the low places and uplift of the crags have been resumed and the large tabular block of January bench under the northwest station now promises to become a conspicuous elevation, so rapidly is it rising.

On the evening of Friday, May 4, 1917, at 5 o'clock, the southeast pool subsided five feet in the course of ten minutes and remained stationary until 7 p. m. when rising set in. At 7:30 p. m. there were falls of rock from the crag-mass into the lake and from

the southeast bank, followed by fountaining activity.

On May 5, at 2:30 p. m., it was apparent that the southeast pool had overflowed at the east cove making a short new flow on the northeast floor. The lake margin was five feet high and there was much fountaining toward the north. A large grotto had formed on the lake margin beneath the cragmass. Seen from the southwest station at 3 p. m. the main lake exhibited numerous fountains in the northern region. There was much fuming. Recent overflow from the west margin of the lake had flooded the west pond so as nearly to cover the small cone there and pile up crust slabs against it. The cone was puffing loudly.

At 3 p. m. on May 6 the lakes were only three feet below their banks and very quiet. The whole southern floor was covered with fresh flows showing that a strong overflow had taken place southwest during the interval since the last record. At 4 p. m. the main lake was fountaining in several places, "Old Faithful" was active and both the west and northwest cones were puffing noisily and rhythmically.

On Monday, May 7, at 3 p. m., the lake was still high and not more than three feet below its banks and there were fountaining grottoes in the east and southeast coves. At 4 p. m. the southwest cove was seen from the south to be building rapidly, by border fountaining, an evenly curved rampart giving circular shape to the pool. The whole lake showed much fountaining and the gas pressure at the west and northwest cones had ceased.

On May 8, at 2 p. m., the banks were five feet high and there was much border fountaining southeast. There was fresh overflow across the south floor from the southeast pool. The west cone was puffing and occasionally throwing out spurts of molten lava, and the puffing from the northwest cone had been resumed.

On May 9, at 2 p. m., the lake was lower with banks ten feet high and a small avalanche fell from the north wall into the lake. The isthmus between the two lakes showed signs of subsidence and a tunnel beneath had been submerged. It stood about five feet above the lake. The fumes on this day were thinner, there was vigorous fountaining towards the north and the western cones were puffing.

Thursday, May 10, was a day of very strong rising and overflowing which reached its maximum between 11 a. m. and noon. At 9:30 a. m. the main lake was overflowing across the isthmus into the southeast pool. At 9:45 a. m. that pool was overflowing at its southeast corner so as to flood the south floor. At 10:30 a. m. there were strong overflows southeast, into the east and north chasms, and into the northwest chasm by overflow of the northwest arm. There were short pooled overflows on the west side of the southwest cove. At 11 a. m. these western overflows were in rapid motion so as to pour southward and eastward back of the rampart of the southwest cove and across the south floor to meet the overflow coming from the southeast pool. At the same time the overflow at the northwest arm had developed a T shape, pouring through chasms in the broken January benches eastward and southward. There was now a rapid torrent pouring across the isthmus.

From 11 to 11:30 a. m., the overflow from the southeast pool moved rapidly westward in a broad sheet and at 11:30 it met the great flood from the southwest, so that the two flows pooled for the full width of the southern floor area.

This added weight doubtless heaved up the central crags, for the shore-marking under them stood higher above the lake than at the southeast and southwest. Both the central peninsula and the east island crags now show strong southeastward and eastward tilt in their several escarpments.

The southern flood surrounded the southeast cone and buried much of the southern talus. At the south station there was an odor of carbon gases from this great flow but during the strong rising there was little odor of sulphurous acid to leeward of the pit. The north end of the lake was crusted and the streaming was from that region to the southwest, southeast, east, northeast, north, and northwest. There was no overflow at the east cove but the platform under the southeast bench was greatly built up. Spatter niches were building on the north side of the

northwest arm and in the rampart at the entrance to the north chasm. "Old Faithful" was in action with occasional very strong fountaining. The southwest island was about five feet high. Both the west and northwest cones were hissing steadily, the latter building a spiracle. The crusts on the west and northwest ponds were covered with broad flat flows which had come from recent overflow of the west shore of the lake. There were puffing shore fountains building ramparts at the several places of overflow, and there was strong longshore fountaining at the west cove.

Subsidence began at 11:45 with strong fountaining around the margins of the lake, especially at the southwest cove and then glowing marginal rims of overhang with stalactites began to appear. In the afternoon the lake subsided five feet and at 3:30 p. m. there was a slide from the northeast side of the east island.

It now began to be evident that the northwest tabular block of the January bench, isolated by chasms on all sides, was becoming a conspicuous rising crag counterpoised by the subsidence of the northeast bench and of the fresh flows in the north chasm.

Measurement on Friday, May 11, 1917, at 10 a. m., determined the depression of the southeast pool to be 80 feet below the rim of Halemaumau and about ten feet lower than the maximum height of the previous day. The following are the heights of the several crags above the lake:

East island, 57 feet.

New eastern summit of crag-mass, 60 feet.

Summit of south island mass, 39 feet.

Southeast January bench, 24 feet.

Southwest island, 19 feet.

The lakes appeared about five feet below most of the shore bench, but only two feet below the isthmus. The marks of the previous day appeared seven feet above the lake under the east islands and only about three feet above it at the extreme southeast. The southwest island was rising rapidly, owing probably to recent copious overflow around the southwest cove which is forcing up the lake-bottom there. The large southeast half-dome grotto was curtained across its entrance with a few glowing orifices left and the blowing within it would depress the skin on the pool outside with each puff. There was occasional central fountaining in the southeast pool. Slides took place from the east side of the northeast peak. There was much blowing noise in the pit, the fumes were thinner and the lake was rising. The northwest arm, which had shown no outline during overflow, was now again outlined and the north end of the main lake was crusted. Long crust slabs of the southeast pool would break and founder, occasioning conspicuous lines of bubble fountaining each time the slabs up-ended and went down.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with May 11, three small local earthquakes of sure characteristics have been registered, and two perhaps of doubtful character. A teleseism of small seismographic amplitude has also been registered—its fore-phase very feebly indicated. A shock of no great original energy, yet of the world-shaking class, is indicated.

The seismographic amplitudes of microseismic motion have varied from small to moderate values. Volcanic vibration has been stronger than usual and "stormy" in occurrence. Pen shifts in the sense of tilt have been marked, to westward and then to eastward, without much net change. The end of the week finds a small net shift to westward which is being reduced by the present eastward tendency.

Technology Station, May 12, 1917.

During the week ending May 18, 1917, the lava column continued to rise about two feet per day, the net building-up of the inner floor for the week amounting to 13 feet. Most of the overflowing was at the beginning of the week followed by a reaction of subsidence, with rapid recovery thereafter. The pronounced rising now in progress is in accord with past experience which shows that rising is usual after the equinox. From February 1 to March 20 there was subsidence.

In the early morning of Saturday, May 12, there were extensive overflows of the inner floor which were

fresh and glowing at 10 a. m. At that time the southeast pool had subsided three feet and the main lake somewhat less. After 11 a. m. rising again set in. The earlier fresh flows covered the whole south floor and the northeast floor to a point under the north station. There were fresh flows also in the north chasm and over the sites of the northwest and west ponds going through from the northwest arm to the west cove. The northwest cone was nearly buried. The southeast cone was entirely buried and also the last remnant of the January south island which had been so conspicuous a monolith. Great spatter cones had built on the edge of the lakes north and southeast, each with narrow openings on the lake side. The writer descended to the northeast floor by way of the north end of the 1894 bench and walked through the north chasm to the margin of the lake beside the cone there. This cone was 12 feet high with a fountain pounding against it. The lakes had risen from 11 a. m. to 12:30 p. m., the main lake much faster than the southeast pool so that the heavy crusts at the time of this visit to the shore were flush with the bank. In fact the northwest cove and the southwest shore were overflowing. The west cone was gushing incandescent lava like an artesian well so that the west pond depression overflowed eastward. The main lake overflowed the isthmus so that at noon the two lakes were united. Streaming was south and southeast as usual. The crags had continued to rise and the tabular northwest crag was rising strongly while the north chasm was sinking. This was shown by a cracked down-curving shelf or ridge of fresh flow-lava only two days old along the west side of the north chasm, lifted on the side of the crag and depressed on the side of the chasm, showing a vertical displacement of about six feet from its original position.

The overflowing continued strong, for at 11 a. m., on May 13, the lakes were brimming level with the banks, the fumes were very thin and there were fresh flows everywhere. The northeast floor was now flooded from the main lake on the north as well as from the southeast pool and from the east gulch. The grottoes east, north and southwest were very active and at noon the shores were about three feet above the lakes. There was great activity in the Old Faithful locality with bombardment of the isthmus region. The west cone was hissing and the northwest cone obliterated by flows.

At 5:30 p. m. tremendous overflowing of the benches began and continued for two hours. This flood greatly widened the floors and tended to further constriction of the lakes. On the northeast the flood surmounted the remnants of the January benches and on the northwest the tabular crag was entirely surrounded by new lava. The wall valley southwest received driblet flows from the ends and through the middle crevasse. After 7 p. m. the lakes sank about three feet.

The view from the north and south sides of the pit now showed more than a semicircle floor on the east and south, the only interruption to continuous flooring being the relatively small southeast pool. The greater part of the liquid lava is now wholly west of the middle line of the pit in the main lake, which is elongate in a north-south direction. Even on the west side there are very wide floor spaces, which, however, mask and roof over the northwest and west conduit ponds, represented above only by blowing cones.

On May 14, at 9:30 a. m., the lakes were depressed about five feet below their banks with about twelve fountains in action. The floods of the previous evening had partially buried the great north dome, but it was being rapidly rebuilt and there was similar strong constructional activity by border fountains southeast, southwest and on the east side of the main lake. The fumes were greatly diminished.

On Tuesday, May 15, 1917, at 2 p. m., the reaction of subsidence had depressed the lakes 15 feet and there was much overhang. Heavy crusts covered the southeast pool, continuously snapping and making a dance of splinters on the surface. These splinters drift in the wind so as to make a ripple pattern on the surface of the lake and when the melt wells up cracks it becomes coated with this grit on the overrolling edges as though with coal dust. The crusts would break up about every 40 minutes. There was a heavy curtain

across the southeast grotto which was fountaining inside, and at the lake level under the southeast station three tunnels were revealed by the subsidence, corresponding to three spatter heaps above. These tunnels appeared to lead to a honeycombing in the bench in the direction of the southeast sinkholes of February. There was active fountaining in the main lake with streaming southward.

On this day the writer, assisted by Mr. Horace Johnson, made some experiments at the east cove with air and oxygen. The compressed air tank was connected with forty feet of half-inch pipe, the terminal of which was drilled with small holes. This terminal was immersed in the lake during break-up spells with the air turned on, but except for a little bubbling no definite effects were seen and the tendency to rapid crusting made the conditions unsatisfactory. A glass bottle of oxygen was attached to the pipe and immersed in the lake through a hole broken in the crust, without effect other than the exploding of the bottle. Other bottles were thrown in and either exploded or produced yellow flames through skin. Finally a wooden box full of straw weighted with stones was thrown into the liquid lava and produced a bright flame for some minutes, then explosions as the box sank, then violent fountaining with flames at intervals. Tests by blowing air into a flaming orifice at the northeast margin of the lake produced no effect, showing that combustion was not increased by supplying more oxygen. In general the air tests seem to indicate that the lava, like this vent, is already supplied with air for combustion purposes.

The most interesting result of these experiments was seen on withdrawing the iron pipe, with the perforated end covered with a hot lava shell. On blowing through the upper end, after the pipe had been immersed without air pressure, it was repeatedly shown that a yellow flame burned around the lower orifices, indicating that a combustible gas from the lava had gathered in the pipe. Special experiments will be instituted to discover what this gas is.

On May 16 at 10 a. m., the lake appeared still lower with inner walls about 20 feet high but the crusts were thinner and there was streaming from the central cavern in a curve east and southeast with splashing in the southeast and east grottoes. The pool was very hot and there was overhang all around the borders. The main lake showed several central fountains and many overhanging grottoes, high rampart heaps on the cliff margin north and south and the southwest island stood 20 feet high. All the extensive recent flows showed collapsed surfaces. The east island mass was rising and the northeast floor sinking; the northwest crag was rising and the north chasm sinking; the crag mass was rising and the northwest pond region sinking; the south island mass was rising and the south floor sinking. The southwest crags, southeast bench, old east crag and northeast peak are being encroached upon and buried by the new flows. The northwest and west cones were both restored to full activity, the former 12 feet high and open on the south side, the latter 20 feet high with an open glowing orifice one foot across showing stalactites within. At 12:30 p. m., the lava had risen four feet. There was a broken cone crater over the southeast grotto.

On May 17, at 10 a. m., the lakes were 10 feet below the floors and rising rapidly. The southeast pool had thin skins and was fountaining on three sides, with streaming mostly eastward. In the main lake the streaming was reversed and poured northward and eastward from the crusted southwest cove with strong bombardment of the northern shores. The southwest point had cracked away and subsided below the southwest bench in a triangular mass 50 feet on a side and was separated from the bench by a crevasse 10 feet wide. Border fountains were puffing and Old Faithful was the only locality of central fountaining.

The northwest cone was hissing continuously and at noon it puffed rhythmically while the west cone threw out pasty lava occasionally from a diminished orifice. There was a high grotto dome on the southwest side of the northwest arm and a cracked pressure ridge extended from it to the northwest pond, smoking strongly as though over a tunnel. Streaming was outward from

the northwest arm. Blue smoke rose from the summit of the immense northern grotto dome.

During the morning there was steady rising and at 12 noon the southwest point was mostly submerged, there was much crusting, and strong bombardment southeast. Old Faithful was irregular with explosions averaging about once a minute, through a bubbling spot in a heavy crust. At 12:30 p. m. the lake level was within one foot of overflow at the southeast grotto and at 1 p. m. it was brimming all around both pools. There was not much indication of change of level of the overflow rim of May 13. At 1:15 p. m. there were dribbling overflows at fountaining spots all around and a flow across the isthmus from the main lake. These overflows reached a length of 20 or 30 feet in the east cove and the northwest arm, but subsidence of a few feet followed during the afternoon.

Measurement on May 18, 1917, at 9:15 a. m., made the depression of the southeast pool 70 feet below the southeast rim of Halemaumau, and the level of overflow of the previous day was 57 feet below the rim of the pit.

The lakes were depressed within their inner pits about 15 feet and there were some falls of rock from the inner cliff. The southeast pool was crusted with occasional cracking and foundering, streaming to the southeast and to irregular border fountaining in that direction. The large southeast cone was completely curtained off. A very large dome had been built at the southwest cove, the isthmus was high, the north dome had increased in size with lava puffing and pounding inside it, and occasional cracking was heard from the east and northeast floors. In the middle of the south flood towards the east was a blowing and surging incandescent pot about two feet across, a simple glowing hole through shells of the recent flat flow. The sinking of the lake had completely restored the southwest point, submerged on the previous day. There was bombardment against the south face of the southwest island and open streaming southward from it, the central part of the lake being crusted. The hole in the west cone was still smaller and puffing. The northwest cone was broken and glowing, and fresh driblet flows had poured from it over the site of the northwest pond.

On the lake side of the isthmus there were three grotto tunnels and violent travelling fountains were forming in a semicircle of uncrusted lava and moving from the Old Faithful locality to the northernmost of these. The north end of the main lake was crusted over.

At 1:45 p. m. an unusual northwest wind out of a thunder squall on Mauna Loa blew the pit fumes across the southeast part of Kilauea crater and nucleated there and made visible great quantities of moist warm air rising from the cracks so as to make the whole southeast region appear as though new steam cracks had broken out.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

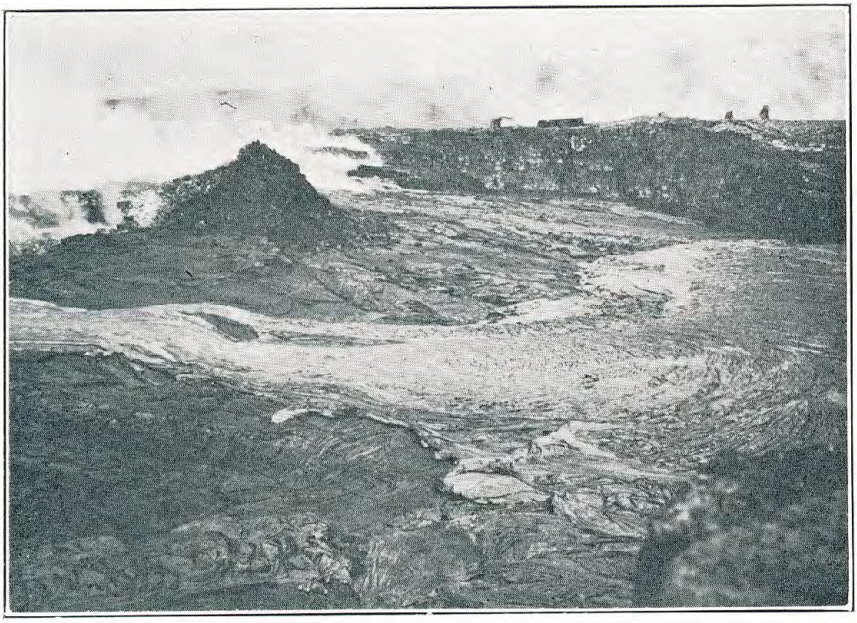
During the week-interval ending with May 18 three small local earthquakes have been registered, and one feebly-indicated chief phase of a distant teleseism. Throughout the interval the seismographic amplitudes of microseismic motion have been unusually small. Volcanic vibration has been strong and "stormy" throughout the week. Early in the interval there was progressive shift of the pens in the sense of tilt to eastward, restoring balance to the disturbance of the previous week. Afterward there was little change.

Technology Station, May 26, 1917.

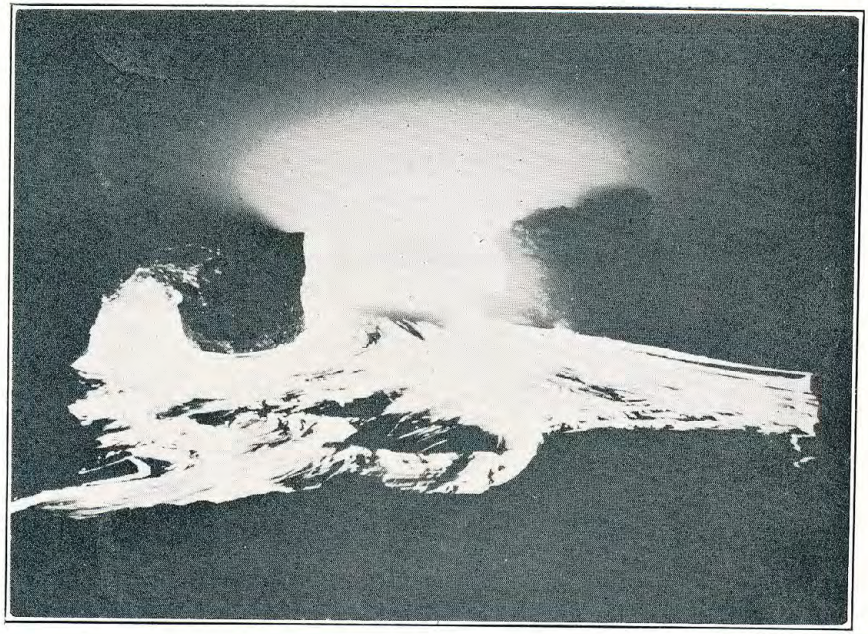
During the week ending May 25, 1917, strong rising has continued with flooding of the floors on opposite sides of Halemaumau northwest and southeast, and such rapid rising of the crags that the large crag-mass is now a conspicuous object even from Volcano House. Its summit is now above the southeast rim of Halemaumau. The lake has risen at the rate of 1.3 feet per day and is now only 46 feet below the rim of the pit.

On Saturday, May 19, at 1 p. m., the lake was nearly level with its rim in places, but it subsided about two feet in 20 minutes. There was little fountaining except at the extreme southeast. At 1:30 p. m. the southwest cove overflowed and flooded the whole south

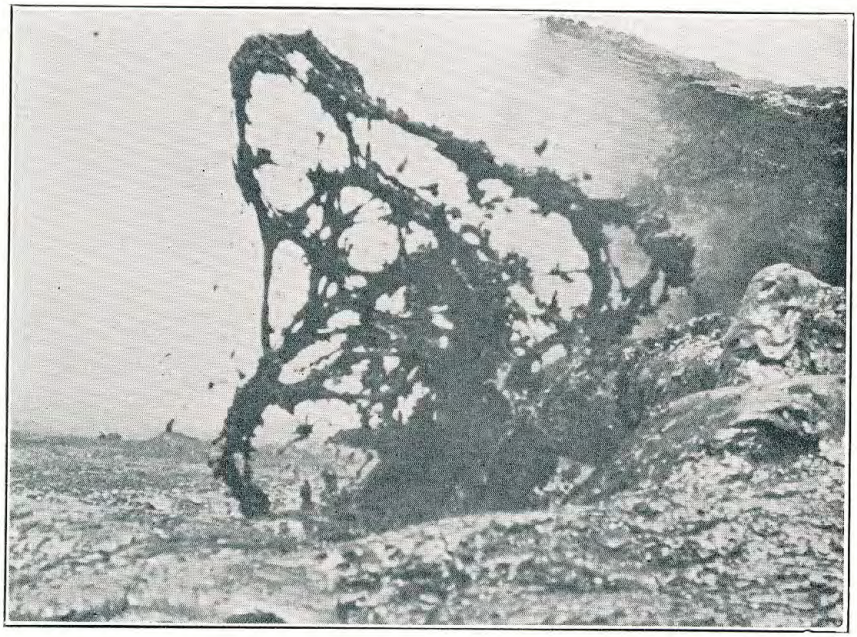
May 28, 1917, 8:30 p. m. Night view of crag mass from northeast.—Photo. Jaggar.



May 29, 1917, at noon. Lava overflows, filling northeast depression.—Photo. Jaggar.



May 28, 1917, 8 p. m. Night view of central cavern and southeast pool during the crag uplift.—Photo. Jaggar.



May 23, 1917. Fountain at East Cove Spinning Pele's Hair; 20 feet distant, exposure 1-100 second; lava spurt about fifteen feet high.—Photo. Jaggar.

floor. At 3:30 p. m. a flow about 200 feet long poured from the northeast bank of the main lake across the northeast floor and an hour later there was overflow at the east cove. The banks of the lake and the southeast island were mostly about two feet high and streaming was rapid from the west. There was much fountaining activity.

On May 20, at 11:30 a. m., there were numerous fresh flows on the northeast floor to be seen from the east station. The lakes were brimming and a broad overflow from the southeast pool extended westward half way across the south floor. This was added to by lava spurting out from the south cone which tended to flow southward. The fumes were thin. At 2:20 p. m. the lakes subsided five feet and there was heavy bombardment southwest. At 2:25 p. m. there were strong falls of rock into the lake from the northeast rampart and from the north dome. At 7:30 p. m. the lakes had again risen and there was overflow into the north chasm.

On Monday, May 21, at 2 p. m., the banks were five feet high with fountaining activity strongest toward the north, and quiet rising in progress in the southeast pool. At 2:30 p. m., there was border fountaining east and northeast.

On May 22, at 10:20 a. m., the inner cliff was ten feet high and there was strong grotto activity southeast and northeast. At 11:30 a. m. there were two rock falls from the bank on the south side of the southeast pool, followed by cracking, foundering and rapid flow towards the east. At 12:10 p. m. there was a heavy avalanche from the rising northwest tabular crag, the debris falling into the northwest arm and producing much fountaining. During the afternoon the lake was stagnant.

The floor levels east and south were now nearly flush with the southeast bench of January. A driblet cone had been built in the middle of the south floor near its east end. The crag-mass was now plainly visible from Volcano House. There was strong fountaining bombardment against the west shore and at the north and northwest. The northeast rampart and the north dome were sulphur-stained. The east island mass was still more upraised on the side of the main lake. The southeast rampart cone was hissing from glowing cracks on its southwest side, the south cone was glowing at its west base, the northwest cone was a glowing tumble of rocks, and the west cone was low with a glowing gash in its middle. A saddle-shaped cone with a lava channel separating its two halves had formed at the northeast rampart, having almost exactly the same location, size, and shape as the January cone at this place. The north half-dome was now 20 feet high, overhanging toward the west and exhibited a continuous flaming fountain within its grotto. There were fresh smooth flows over the sites of the northwest and west ponds with crack-and-founder pattern, mostly from the northwest arm. New floods covered the southwest wall valley. Old Faithful was active and the east side of the main lake appeared to be building points which divided it into coves. Curtained grottoes were numerous. There was much Pele's hair on the south floor.

On May 23, at 8:45 a. m., half of the southeast grotto dome collapsed and this broke up the crusts and started rapid eastward streaming. The southeast pool was about ten feet below the floors. From 10:30 a. m. to 1:30 p. m. the lake rose until it was only two or three feet below the level of overflow. There were numerous fountains and the central crags were obviously rising as the shore spatter levels were higher toward the middle region than elsewhere. There was streaming from the northwest and much quiet crust. The north dome was now curtained and a puffing fountain was active beside it. There was much breathing of gas from under heavy crusts and an occasional uplifting of skins as balloons. It is worthy of note that the large pooled overflows are festooned with a brittle skin when they first flow out but in a short time these skins crack and founder in the pooled lava beneath, releasing great quantities of gas. There results a very thick crust with large blisters on its upper surface six or eight inches in diameter. This crust is much flatter and more stable than the wrinkled shells and the pooled area shows marked slumping through con-

traction and loss of gas when solidification is complete.

On May 24 at 11:30 a. m. there was a fresh broad festooned overflow from the southeast cove over the south floor. The lake was now 20 feet below the floors and the south side of the isthmus between the two pools had collapsed to an open channel through which was rapid flow from the main lake to the southeast pool amounting at times to a cascade. The southeast, west and northwest cones, and the southwest rampart dome were all glowing. There was a fresh driblet flow in the north chasm and the north dome appeared lower. The west and northwest cones were puffing slightly. The high inner bench and southwest island showed overhang. The main lake was crusted over, but there was shoreward rush and bombardment at the northwest tunnel leading to the northwest pond and at the southwest shore leading to tunnels under the south floor. Smoke had increased. Some very small rock falls were heard and there was much appearance of caving from the inner cliff. At 12:15 p. m. the lake had risen 10 feet and was rising strongly.

On Friday, May 25, 1917, there was strong overflow at 9 a. m., and thereafter until noon the lake subsided about five feet. The lakes were at first joined by a wide channel covering the remnants of the isthmus, and after the subsidence the north side of the isthmus was revealed as a partially sunken large flat islet with channels on both sides of it. The southwest islet was still in place. The overflow floods covered the east and south floors, drowned the south cone and spread all over the northwest and west floors, greatly widening the floor area and encroaching on the talus and the older benches. The south and east talus was now mostly covered. There was tremendous bombardment against the northwest table crag and this table showed an extraordinary uplift of 15 feet since the previous day, carrying with it a bench of fresh flows around its base on the east and north. It showed fresh breaks from north to south in its summit at the east end and at its base at the west end. Instead of tilting this tabular mass is rising bodily owing to inflow beneath it of pasty bench magma impelled by the weight of lava floods much larger than it in area in the lake basin itself and on the floors northwest and northeast.

Measurement on May 25 at 9 a. m. made the southeast pool 46 feet below the rim during the overflow. The floors had now been built up to the January level southeast and northwest and it was very evident that the lake shorelines were tilting toward these directions of maximum overflow. The northeast floor was now the lowest area, but as the northeast shore appeared to be tilting up, no channel was yet available for flooding it. The great overflows east, south and northwest were first covered with broad trains of festooned skin; this would crack and founder and then the whole surface would solidify smoothly, except for hundreds of immense blisters, and subside by several feet. The northwest cone continued to puff.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week interval ending with May 25 one small local earthquake has been registered, and one doubtful wave group.

The seismographic amplitudes of microseismic motion have been of normal value or less. Volcanic vibrations have been strong steadily, with stronger wave groups also. There have been no conspicuous net changes in the direction of the writing levers (tilt)—though the ordinary diurnal changes have taken place.

Technology Station, June 2, 1917.

The week ending Friday, June 1, 1917, has been marked at Halemaumau by gorgeously brilliant spectacles of rising and very rapid uptilting of the inner crags. All of these crags came into full view from the Volcano House recalling the scene pictured in the early eighties, when there were similar crags above the rim of Halemaumau. The overflow level at the southeast bench on May 31 broke all records since 1894, reaching a height only 22 feet below the rim of the pit. The lake itself was only 20 feet down. Fountains and blowing cones during the week have spurted high above the rim of Hale-

maumau so as occasionally to be visible from the Volcano House. The pit as seen from Uwekahuna bluff was remarkably like a moon crater, showing outer and inner concentric smoking cracks and ridges, irregular peaked inner crags, but differing from the lunar rings in exhibiting an active glowing lava lake. The end of the week shows a sinking of the lava, expectable just before the solstice, by analogy with former years.

At 9 a. m. Saturday, May 26, the lake was nearly brimming and the central crags showed continued rising. Fresh overflows glowed on the southeast and northwest floors. There was much fountaining and the cones were puffing. Streaming was away from the west and northwest coves and through a broad channel to the southeast pool. The lake appeared stationary with much quiet crust. The northwest tabular crag had now again lifted a bank of fresh flows 20 feet high around its base, and rocks falling from its cliffs gave evidence of movement there. The northeast floor and north chasm were clearly subsiding. The west side of the old summit crag of the crag-mass had fallen away. In the evening there began a prolonged period of heavy overflowing destined to continue six days.

In the morning and past noon of May 27 tremendous floods of lava rose at the west and northwest cones and poured over the floors in a great horseshoe encircling the lake on the west, south and east. The northeast floor remained a great depression 25 to 30 feet below the level of overflow, owing to its remoteness from the source conduits, the tendency to build higher at the west maintaining the ancient habit of the pit. During the afternoon the lake subsided 10 feet, glow rims appeared all around the lake and flows and then the latter broke up their crusts by the cracking and foundering process, leaving a smooth surface where before were heavy festoons. Then the gas-vents of the northwest and south cones reasserted themselves where they had been flooded, and the south cone built itself up 3 feet high with splashing and some violent spraying. The southwest crags had been submerged, but they reappeared as low piles of crusts. Southeast and southwest border cones, a fountain above the central cavern locality, and Old Faithful were persistent features.

The northwest wall cavern was now drowned. The west cone maintained itself as a dome with an upwelling fountain beside it. The great half-cone at the edge of the lake southeast grew to be 15 feet high. During the afternoon there was violent bombardment of the north table and the shore of the central peninsula south, but much of the lake was covered with quiet crust. The east and northeast lake margin was rising and thus blocking overflow in that direction.

From 8:30 to 11:30 p. m. the lake was again overflowing, mostly from the west and there was violent spurting above the southeast cone and the southwest rampart, so that the flings of melt could be seen rising high above the edge of Halemaumau.

Rising continued. Apart from the western well-springs, the lava overflowed the lake margin in short driblet flows at the east cove but wholly failed to reach the northeast depression. There were other driblet flows at the north chasm and under the east station. The southeast pool overflowed southward in a wide torrent which curved around to the east, and other overflows poured from the southwest, west and northwest arms of the lake. The south cone at first showed a steady wide blue flame, but this was drowned under the floods. Many flames appeared from under crusts around the lake margin. There was much piling up and scraping of border slabs of crust. In the late evening the southeast cone became quiet, but two fountains over the central cavern built half-ring ramparts.

The high pressure kept up for three hours, but at 11:30 a. m. the lake surface, which had been darkly crusted, cracked up with foundering of crusts and thousands of bubble fountains, then the new flows started cracking and foundering and glow-rims of subsidence appeared all around. The cracking and foundering of the flows began at the northwest and spread from there indicating that the greatest thickness of crusts was first reached in that conduit region.

Measurement at noon Monday, May 28, 1917, made the depression of the southeast bench of overflow 28 feet below the rim of Halemaumau. In contrast to this the bottom of the northeast depression was 59 feet below the rim, and the 1894 bench valley was 65 feet below the rim. The depression of the lake at the moment was 35 feet and above it the heights of the crags were:

Old east crag, 10 feet;
Crag mass, 47 feet;
East island, 45 feet;
Southeast cone, 12 feet.

At 9 a. m. there were short overflows east and west. During the morning the lake subsided 5 feet and then recovered. There was violent bombardment of the east bank, and the streaming was eastward as usual. The crag mass, east island mass and northwest table all appeared higher. One of the flows of the morning had poured from the southeast bench northward to the base of the 1894 ledge. At 1 p. m. the west cone, an open over facing westward, was vomiting out lava which spread over the floor north and south. These flows extended themselves to the south and east as before during the afternoon. The northwest cone had built a high driblet heap.

In the evening a singular cataclysm happened. A brilliant flare and rush of smoke over Halemaumau was seen from the Volcano House at 7:15 p. m. Watchers at the rim of the pit saw a sudden tumble of benches with great clouds of dust and gas brilliantly illumined by multiple fountaining. Apparently the lake subsided about 15 feet in the late afternoon, and a sudden readjustment of the bench magma lifted the central crags and perhaps opened crevasses into which the lake magma flowed so as to lower it temporarily. At 7:45 p. m. there was a profound canyon-like inner pit with the central cavern revealed as a great glowing vault. There was high incandescence and the current was rapid eastward. The southwest island had toppled over to the north.

The south island mass had risen suddenly above the rim of Halemaumau, making a distinct shoulder in fresh glowing flows outpoured only that afternoon. The outer ledge of the east island mass had broken away and risen so as to make a second mushroom beside the earlier east island. The latter had broken away from the eastern escarpment and subsided a little, and adjacent to it on the northwest a lava pond 50 feet in diameter had opened at the site of the sulphur hole. The old east crag and adjacent rampart had risen bodily 10 feet, cracking away from the southeast bench at the site of the former east gulch. The northwest tabular crag was now above the rim of the pit. The crag mass rose so much with westward tilt that its serrate northeast peak had suddenly become its summit, whereas only that morning the middle peak had been the highest. The spatter markings along its base on the lake side were fully 40 feet high.

The northwest cone had become a flaming pile of crusts, and the west cone a glowing hole. There was another similar hole at the west base of the tabular crag northwest. There was noticeable increase of glow in the luminosity of the cracks of the fresh flows, as though oxidation of the gases in the crust cavities had increased, some of the orifices showing whitish yellow heat. Some of the lake fountains also were extraordinarily brilliant. The inner cliffs around the main lake appeared from 40 to 90 feet high. The walls of the southeast pool were horizontally banded with spatter lines for the upper twenty feet, but the lower half appeared massive like aa lava. During the evening the lake rose slowly.

At noon, May 29, the lake by rising had recovered almost its usual aspect and was brimming level with its inner cliff. The sulphur hole pond was fountaining. The northeast depression appeared elevated and the subsidence of the lake edge on that side, next the east island, now made possible an overflow into the depression. This took place, and three overflows poured from the lake north, northeast from the east cove, and east at the east gulch. The east cove flow became dominant and cascaded into the northeast depression in a steady torrent 40 feet wide for two hours. The filling was about 800 feet long and from 10 to 15 feet deep and extended from

under the east station to the north chasm. It finally penetrated the middle crevasse of the 1894 ledge with a short driblet flow.

With intermissions the flows continued and at the west cone two high spiracles were built. These spatter heaps were 15 feet high, and at 6 p. m. the southern one was spouting umbrella shaped flings of melt with a gulping noise and a bell-like ring. These spurts could be plainly seen at the Volcano House. There were two cones northwest also, the lower one in process of rapid building. There were strong gas pressure and overflows all around the lake.

On May 30, at 3 p. m., the banks of the lake were 2 feet high, there were few fountains and the hissing was slight at the northwest cone. The west cone was not spurting, but driblet flows were in motion near it on the floor. Otherwise there was no fresh overflow since the previous day. The northeast pond was floored over and a conical spatter heap, now inactive, had been built there. Streaming was from the northwest as usual.

On the morning of May 31, fresh short overflows appeared southeast, east, northeast, north, northwest and west. The depression of the southeast bench at the lake margin was 20 feet and against the wall 22 feet. This was the maximum overflow of this period. The lake subsided from four feet below its bank to twelve feet down during the morning. There was a glowing pond of collapse south of the northwest cones. The west cones were surrounded by domed up flows. The central cavern was visible.

June 1 was rainy, but the crags rose greatly and smoke increased.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week interval ending with June 1, 1917, one small local shock has been registered: and one teleseism, the record of a shock of very considerable energy in the region of the origin.

The seismographic amplitudes of microseismic motion have ranged from small to moderate values.

Volcanic vibration has been strong, both in the steady run, and in sporadic wave-groups or "storms". A well marked storm of considerable duration accompanied the sudden, spasmodic uplift of the crag mass, islands and peninsulas in Halemaumau on the early evening of May 28.

There has been no notable change in pen-shift in the sense of tilt during the week.

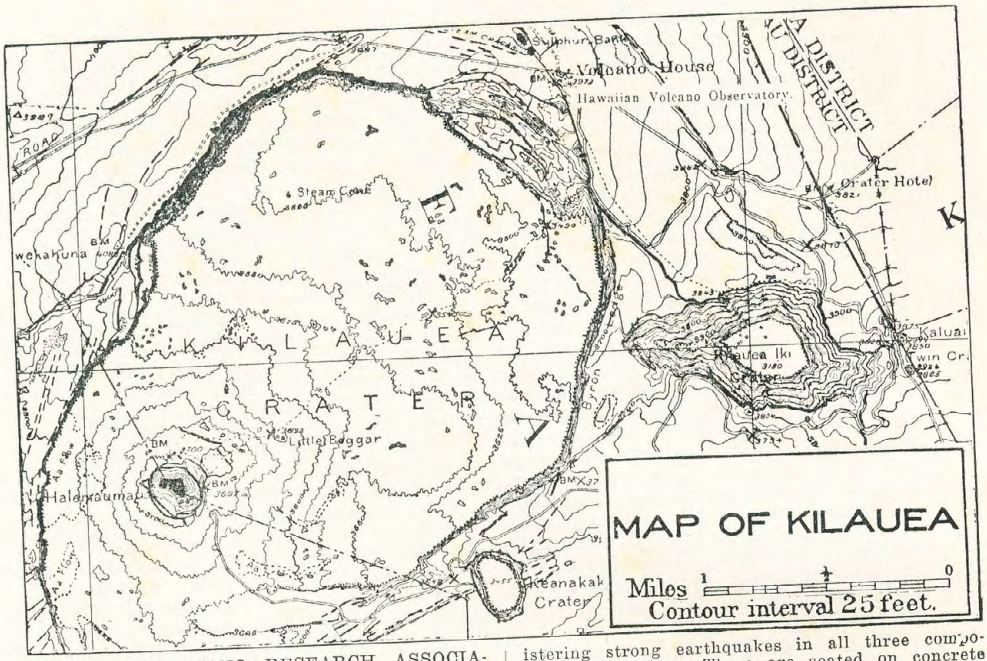
Very respectfully,

T. A. JAGGAR, JR., Director.

Editorial Note.

A very complete series of moving pictures of the volcano by day and by night, has recently been made by Mr. Burton Holmes, the noted lecturer. These will be shown in conjunction with Mr. Holmes' lecture tour approximately as follows:

November 15th, commence Philadelphia, Pittsburg, Washington, Baltimore. January 15th, on Sundays and Mondays, New York; Tuesdays, Orange, N. J. Wednesdays, Brooklyn; Thursdays, Worcester; Fridays and Saturdays, Boston.—Editor.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, JUNE, 1917. No. 6

TECHNOLOGY STATION, June 9, 1917.—During the week ending June 8, 1917, the Halemaumau lava column has subsided to a depth of 75 feet below the rim, from a maximum height of only 22 feet depression on May 31. The liquid lake in three days reached its lowest for the subsidence which has so far occurred. Sunday, June 3, showed depression of 78 feet, though only the day before the bench crags had stood at their highest elevation well above the edge of the pit. On June 2, however, the crags subsided gradually and continued to do so during the week, the lake apparently compensating this, perhaps by a rising of its pasty bottom lava, for the level of the liquid surface has fluctuated but little, and has risen slightly at the end of the week. Another high level is to be expected after the solstice about the end of June.

On Saturday, June 2, the lake appeared 20 feet below its inner cliff, or some 40 feet below the southeast Halemaumau rim. At fifteen minutes after noon there were two rock tumbles into the lake northeast, and from the summit of the crag mass, sending up puffs of brown dust. The southwest islet had reappeared. Rocks were falling about the 1894 bench northeast, and from the summit of the crag mass, and all signs pointed to subsidence in progress. In the morning, however, the crags above Halemaumau as seen from the Volcano House had appeared at their highest, and the following by measurement were above the rim of the pit: northeast peak, east island, crag mass, central peninsula, south peak, northwest table. The two east island peaks and the old east crag had risen strongly since May 31, exhibiting south of the east crag a new ridge of elevation in fresh flows.

After noon there was sinking until 3 p. m., the lake showing inner walls 30 feet high. Then the lake appeared to rise somewhat relative to its inner pit. At 3:45 p. m. there were avalanches north and east. At 5:30 p. m. there was a fall of rock from the south side of the southeast pool, inducing much fountaining. The lake appeared rising. At 6:15 p. m. there were heavy falls southeast, and at 6:50 p. m. an avalanche at the east cove. During the afternoon and night the crags sank below the rim, only the cragmass and the northwest table remaining partly visible from Volcano House. The glow at night was moderate and the fumes increased.

Measurement on June 3, 1917, at 9 a. m. made the lake depression southeast 78 feet and that of the east island summit 14 feet. The lake had thus subsided the equivalent of nineteen feet per day for three days. The east island had sunk 30 feet in twenty-four hours. This crag was now 64 feet above the lake.

The inner walls appeared 40 feet high, and the northeast floor had subsided to a much flatter attitude in place of its strong slant northeastward. With it had gone down the east island mass and the northeast peak, and much of the northeast cliff over the main lake had fallen in. Gaping crevasses appeared in the northeast floor, which had subsided 10 feet along with the 1894 bench, carrying down much new debris. Rocks were falling in the valley back of that bench. The southeast shelf remained high, the other floors parting from it along a north-south crack, which became a crevasse under the east station. The southern floor area remained relatively high. The northwest tubular crag had subsided bodily within the elevation ridge around it, and dense smoke rose from cracks at its base on the east, south and west. Rocks were

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L. W. de Vis-Norton.....Secretary

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falling from its cliffs. A crevasse extended westward from it, but the western floors were still high. The crag mass had tilted back towards the lake, its three peaks now appearing of equal height. The west and northwest cones were broken heaps and a pressure ridge connected the former with the west cove of the lake. The lake appeared smoky and stagnant, with northern fountaining.

On June 4 at 10:30 a. m. it was evident that sinking continued, though the lake southeast was only 20 feet below the inner bench and exhibited a new spatter level 5 feet above the liquid. The floors were much lower, parting along smoky fissures from the high southeast shelf. The northeast floor had settled back nearly horizontal. There was fountaining southeast and about Old Faithful, and an occasional central fountain migrated eastward through the narrows leading to southeast pool. The northwest table was lower and the crag mass appeared much as in January, the western peak being now again the summit. The south cone was glowing and the fumes appeared thinner. At 2:30 p. m. the lake appeared still higher relative to the subsiding benches, with much fountaining east. That this effect was really subsidence of the benches was shown by abundant falls of rock from the 1894 bench northeast and from the north and northwest walls of Halemaumau.

On June 5 at 3 p. m. the north arm of the lake was found widened owing to the falling away of the northern part of the east island promontory. A grotto northeast near Old Faithful became very active, with high spurting and bubble fountaining.

On June 6 at 4 p. m. the lake was about 60 feet down and the general appearance of Halemaumau was very different from that of the previous week. In general the settling of the floors had followed the scheme of the February subsidence, low northeast and southwest, high northwest and southeast. The recession of the lake in the inner pit and the increased smoke made all but the southeast pool difficult to see, and the first impression of the observer on the brink is of extensive tumbled benches and tabular crags, much smoke, and little lava. The lake really, however, is little changed, and its margins have subsided with it. The south and east island masses have sunk lowest, so that the inner bench about the southeast pool was only 20 feet high except at its southeast end, where the shelf stood twice that height above it. There was much bombardment and building of stalactites under this shelf, and from this cove smoking cracks extended north and south along the break between the lower and higher floors. The southward cracks glowed and led to the glowing heap of the south cone. Crusts were jammed in the western entrance to the southeast pool and from them rapid streaming poured eastward. The southwest cove was crusted over and the southwest islet had become a peninsula attached on the east, while a narrow channel encircled it on the west.

The southwest floor had sunk more than the northwest floor along the crack or tunnel line, which was marked now as a pressure ridge from the west cone to the west cove. The northwest crevasse was widening, with subsidence on the lake side tending to leave a shelf next the wall. The northwest table had sagged downward in the middle along a north-south axis, bending like a plastic substance. Settling had made the northeast floor continuous with the north chasm so that the latter could no longer be distinguished. The cracks in the northeast floor, parallel with the

1894 bench, had widened into crevasses 3 feet across in places; very hot air rose from them, and red glow could be seen in the smaller ones at a depth of four feet.

The new lower inner bench, 4 feet high above the lake, was wide on the southwest and west. The north end of the lake was inactive with southward streaming. Not much motion was in evidence, but a fall from the central peninsula into the southeast channel at 5:15 p. m. showed that subsidence was still in progress. Heavy smoke rose from the northeast inner cliff, from the ends of the northwest table, from the southeast cracks, and from the western pressure ridges.

The lake was 10 feet lower at 3 p. m. on June 7 and the smoke was heavy. There were central fountains and rapid eastward streaming. The west cone was glowing from a gash on its southern side, and the pressure ridge from it extended down the slope to the lake like a long mole-hill.

Measurement on Friday, June 8, 1917, at 10 a. m., made the depression of the lake 73 feet, indicating a rise of 5 feet in 5 days, whereas the summit of the east island had subsided 17 feet in the same period. The summit of the crag mass was the only interior feature now visible from Volcano House. The following were heights above the lake surface:

Marginal bench south of southeast pool	10 ft.
Southeast shelf	46 "
Floor under south station	33 "
Northeast floor	11 "
Summit Crag Mass	64 "
" East Island	42 "
" Northwest Table	63 "
" Central Peninsula south.	49 "
" Northeast peak	46 "

Smoke had diminished and the lake was higher in the morning. There was much quiet crusting, and occasional blowoff of gas with fountaining at the central cavern. Streaming was eastward in southeast pool and rapidly southward in the southwest cove. At noon there was subsidence with central and southwestward fountaining. The southeast cove was quiet. The northwest cones puffed slightly.

At 5 p. m. the lake was 5 feet lower and more active. There were fountains southwest, west, at the Old Faithful locality northeast and at the southeast. Streaming was now northward from the southwest cove and from northwest to east and southeast. Flames rose from the south and west cones and in flares from the central cavern. There were occasional falls of spatter margins.

Fresh rock tumbles lay under the upper walls, drawn down by the subsiding floors, on the south, west, northwest, northeast and east. The northwest table was lower, its east end now a sharp pressure ridge, and a valley had developed north of it beneath the wall shelf which extended westward. There was a pressure ridge extending west from the northwest arm. The meaning of these western pressure ridges extending from the sites of conduit wells to the lake, is that tunnels beneath have had their walls pressed together by the wedge effect of the subsidence of the bench magma within a funnel-shaped pit and the tunnel roofs have accordingly arched upward. Such a ridge may thus be an interesting index of a tunnel beneath.

A crevasse in the south and southwest floors was developing parallel to the upper wall, preparatory to making a shelf there as usual if sinking continues, and this merged eastward with cracks under the southeast bench. The west end of the latter was a smoky tumbled slope, where the sinking of the floor had dragged down great masses of rock from the upper cliff.

The Observatory has again the privilege of assisting at chemical investigations of Halemaumau conducted by the Geophysical Laboratory of the Carnegie Institution of Washington. Dr. E. S. Shepherd of that laboratory, who was here in 1911 and 1912, arrived at the volcano on June 8 for a protracted stay, and equipped with improved apparatus for the collection of volcanic gases.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with June 8, 1917, six small local earthquakes have been registered, and the chief phases of two distant teleseisms with small amplitudes and vague indications of phase. Microseismic registration has been as

usual. Volcanic vibration has continued to be registered, with seismographic amplitudes somewhat greater than normal, both in the steady run and also in rather numerous and prolonged storms. In the early part of the week interval there was a sharp movement of the pen-levers in the sense of tilt to eastward, followed soon by a rapid partial recovery, after which no noteworthy changes occurred.

June 16, 1917.

During the week ending June 15, 1917, the lava lake of Halemaumau has remained stationary except for daily fluctuations of from 10 to 15 feet, the maximum depression of the lake reaching about 90 feet below the rim of the pit. The crags have continued to subside slowly and the smoke has increased. An upward spurt of 20 feet in the level of the lake at the end of the week is probably a movement of pulsation characteristic of approach to the turning point at the solstice.

On June 9, at 4 p. m., the lava column was lower though the shore-line of the southeast pool appeared unchanged. The benches were lower by at least ten feet. The smoking area under the southeast bench had collapsed to a chasm full of debris suggestive of development of a new cove of the lake. There were new smoking cracks on the upper southeast bench. Near the former cavern locality northwest the bench crack had now developed a low cliff through subsidence of the floor on the lake side. There were new falls of wall rock on the floor west and south. The northwest arm had developed by collapse, a chasm extending westward from the lake. The floor west of the crag-mass now sloped toward the latter just as in February, the crag-mass having subsided extensively. The northwest table was lower, showing only about 20 feet of cliff above the northwest floor. The main lake was in a deep inner pit, the peninsula of the southwest islet showing walls 15 feet high above the liquid, while the eastern walls of the main lake under the several crags appeared at least 60 feet high. Fountaining was about as usual, the surface current being very slow to the southeast. The west and northwest cones were whitened with solfataric deposits and there was a glowing gash on the south side of the west cone. Smoke had generally increased.

On June 10 at 5 p. m. conditions were much the same, with evidences of continued subsidence. The southeast chasm had collapsed farther and glowing lava could be seen within it. The northeast crevasses had widened. There were some marginal falls of rock into the lake, but the shoreline level relative to the benches appeared unchanged.

At this time a very instructive growth of pressure ridges smoking strongly, was shown, one of them extending from the northwest pond locality to the northwest arm, another from the west pond locality to the west cove, and a third from the south pond locality to the south cone and chasm. Each of these ridges gave evidences of a tunnel beneath which the subsidence and compression of the bench magma had crushed in so as to arch up its roof. It was worthy of note that each of the smoke places about the benches and crags corresponded to a formerly mapped pit, chasm or tunnel in location, and dense smoke is always an evidence of an open gas chamber beneath. Such places were the southeast chasm and cone, the pressure ridges, the north and northeast depressions and the central cavern tunnel. The large crevasses do not smoke.

On Monday, June 11, at 2:30 p. m., it was evident that there had been heavy tumbles of shore into the lake north of the east island so as to widen the lake towards the north, and the northeast grotto was fountaining with great vigor.

At 3:30 p. m. on June 12 it was evident that sinking continued, as the floors which had subsided under the cliff of the southeast bench appeared lower and that cliff was scaling off from time to time. Toward the north the cliff merged into a crevasse bounded on the lower side by huge slabs tilted at a high angle, and here rocks were falling frequently.

At 11 a. m. on June 13 the southeast pool was 20 feet below the marginal

bench, there was heavy fountaining in a grotto under the southeast bench, and there were falls of rock into the lake from the central peninsula and from the south margin farther east which occasioned much fountaining.

At 2 p. m. on June 14 the lake as seen from the northeast was somewhat higher, the inner cliff of the southeast pool rising only ten feet above the lake. The eastward streaming was rapid, with traveling fountains which formed from time to time in the central region and migrated through the southeast channel. The lake appeared rising, but the smoke was very dense toward the north. At 2:15 p. m. the north pool showed much fountaining. At 2:30 p. m. the lava subsided a few feet and strong fountaining developed in the central cavern. Thereafter the lake continued to sink to a depth from 15 to 20 feet below the inner bench southeast and there was a very heavy fall from the east island bank into the lake. There was glow in the southeast chasm and the south cone had developed an open pot. The crag-mass appeared distinctly lower as though slowly subsiding bodily, so that the whole lake could be seen from the northwest margin of Halemaumau over the top of the crag-mass. The northwest floor had gone down with it. The smoke at the southeast chasm had greatly diminished with the appearance there of the live lava. At the north pressure ridge, however, next west of the former north chasm, yellowish-white smoke rose rapidly in dense masses.

Measurement on June 15, 1917, at 10 a. m., determined the depression of the lake to be 71 feet below the southeast rim of the pit, a gain of two feet of elevation in seven days. In the same period, however, the crag-mass had subsided six feet and the east island four feet.

On this morning the lake was high and rising to levels above the highest spatter marks of previous days. There was strong constructional activity, building a very large crescent-shaped spatter cone under the crag-mass, and others on the northwest, west, southwest and southeast. The southwest island and peninsula were submerged. The streaming was rapid from the west toward the north and east. In the southeast chasm there was a fountaining pot between the southeast pool and the south cone. A piece of the bank fell from the south side of the southeast pool. There was strong bombardment on the north shore of the northwest arm. In the southwest cove there was one shore grotto in action, but otherwise the pool south of the submerged peninsula was crusted over. The lake overflooded the floor between the two knobs of the east island. The west and northwest cones were smoking quietly, but smoke in general had lessened. This rise reached its maximum about noon, and the lake fell away in the afternoon, revealing again the peninsula of the southwest islet.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with June 15 three definite local earthquakes of very small seismographic amplitude have been registered; also three doubtful wave-groups of local origin, and the feebly registered chief phases of two teleseisms. Microseismic motion has been registered as usual. Volcanic vibration has continued stronger than normal, both steadily and in storms. There has not been any noteworthy shifting of the pens in the sense of tilt other than its usual diurnal changes.

June 23, 1917.

During the week ending June 22, 1917, the lava lake has subsided 44 feet, with more or less continuous clatter of falling rocks and a sinking of the inner circle of floor all around, leaving a marginal shelf on the northwest and southeast. The inner floor has carried down with it all the crags, the lake tending to keep its shore line relatively unaltered.

Measurements on Saturday, June 16, at 10 a. m., made the depression of the lake 87 feet. The crag-mass rose 60 feet above the lake and the east island 51 feet. There was strong subsidence since the previous day, and the streaming was swift to a cavern under the southeast bench, where a caldron boiled violently at the lake level. Here

and elsewhere the grottoes showed stalactites. After 10 a. m. the lake appeared rising. In the main lake the streaming was outward from both the northwest and southwest coves. The spatter dome under the crag-mass had partially collapsed and the new inner bench was 10 feet above the lake. A grotto near Old Faithful was puffing. The subsidence of the crag-mass at its north end had carried down the floor west of it, leaving a south-facing escarpment in place of the pressure ridge which formerly extended westward from the northwest arm. A pressure ridge had formed across the south floor from under the south station to the south cone, marking apparently the course of a tunnel from the old south pond. There were other pressure ridges and cracks on the south floor. Fire could be seen in the west cone. Rocks were falling at the east crevasse and above the east end of the 1894 bench. Rocks were in motion, also, southwest where the floor had gaped away from the wall, forming a wall crack four feet wide. The peninsula in the southwest cove was now restored. Blue-white smoke rose in dense masses on the north and northeast, and other smoking places were the northwest and west cones, the northwest escarpment, the southwest floor, the central peninsula and the southeast cove.

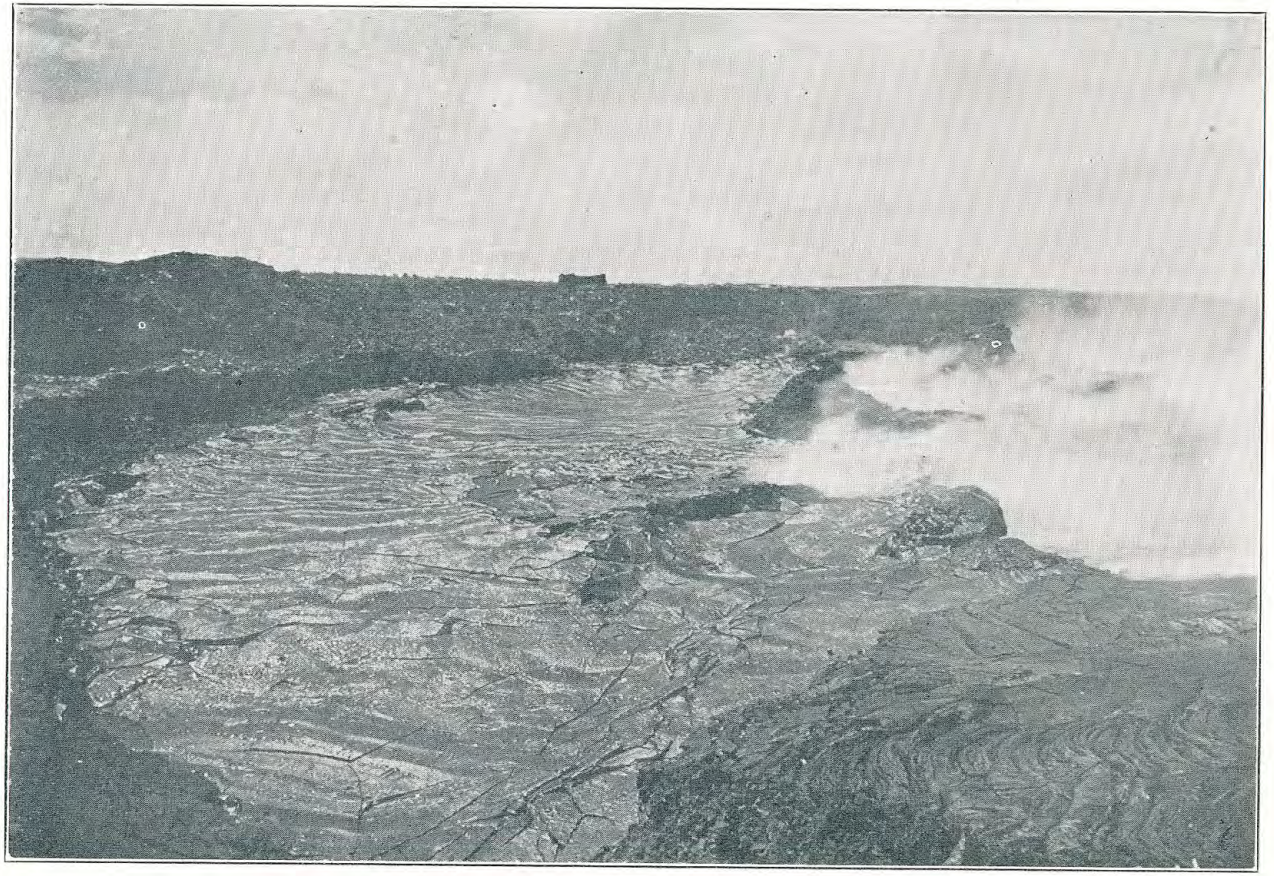
During the next two days the floor on all sides subsided heavily and the smoke increased. The northwest shelf became a high cliff extending from the west station to the northwest table. The latter had lowered until its upper surface was level with the shelf. The northwest floor and crag-mass, and the northeast, east and south floors had all sunk until the floors were level, or even sloping toward the lake. The southeast chasm was now a cove of the lake on the site of the former south cone. A smoking cone or pile of slabs had developed on the floor farther west along the course of the pressure ridge. The southeast bench near its west end surmounted great yawning crevasses separated by upright slices of bench ready to fall, and the shelf was extended westward under the southwest and south stations above an inner cliff along which the floor had subsided. There was a tumbled smoky pit in the region of the north peak. The northeast peak, the east island and the south island mass remained much as before, but all had gone down en masse.

On June 19 at 3:30 p. m. the inner cliff over the lake was still only 10 to 15 feet high, and the west and northwest cones were still smoking quietly. Streaming was swift to the southwest cove and to the southeast pool from the northwest. The peninsula in the southwest cove showed a flat upper surface about six feet above the lake. There was a new narrow inner bench two feet above the lake. The principal fountaining was on the southwest, southeast and northeast.

On June 20 at 11 a. m. the benches were still lower and rocks could be heard falling almost continuously from the northeast shelf and the 1894 bench. The highest part of the northwest table at its western crag was now below the floor shelf. The lake was relatively high and appeared to be rising above the inner bench of the previous day, and some spatter benches were in process of building. The southeast cove had built a glowing blow-hole in spatter on its western bank and this was flaming and hissing strongly. Otherwise the cove was crusted over. Streaming was now outward from the southwest cove to the north and east. There was violent bubble fountaining and down-sucking at Old Faithful and heavy bombardment against the north bank of the lake. A new sulphurous spot was developing east of the east island. The general condition represented by this week's subsidence appears to be a conflict between sinking bench magma and relatively rising lake magma.

On June 21, after a slight earthquake felt at the Observatory at about 7 a. m., a visit to the lake at 9:30 a. m. revealed a lava column still low and falling. This was the day of the solstice. Rocks were falling in the northeast crevasses. There was an open pool in the crust of the southeast cove. Streaming was eastward from both the northwest and southwest. Six fountains were in action and there was evidence of spatter building on the shores. At

May 16, 1917. Elevated northwest table crag, from north station.—Photo. Jaggar.



May 16, 1917. Depressed northeast floor of overflow, from north station.—Photo. Jaggar.

the moment the lake was bordered by a rim about two feet high hanging with stalactites. There was a great splash mark across the point north of the southeast cove occasioned, evidently, by a recent tumble into the lake from the high southeast bench, the edge of which was broken and crumbling.

On Friday, June 22, 1917, at 10:30 a. m., the depression of the lake was 115 feet, showing an average fall for seven days of over six feet per day. The crag-mass stood 54 feet above the lake and the east island 39 feet. There was evidence that the low level had been reached, for the fumes were thinner and no rocks were heard falling. Between 10:30 a. m. and noon there was strong rising of about five feet, so that the lake was brimming flush with the inner bench and was easily accessible at the southeast cove.

An exploration of the northeast floor on this date showed that the subsidence of the floor had left a 15-foot cliff along the 1894 bench, making the trail down much more difficult. The northeast crevasses were six feet wide in places and the old east crag was partially buried by debris from the high southeast bench. The north ridge, formerly the east end of the northwest table, had sunk so far as to become a depression under the old north rest-house with a tumbled slope on the northwest table side. The northwest table was far below the shelf left by the May floor. A tumbled pit emitted smoke at the side of the north chasm. The northwest cone was on a slope beneath a strong straight wall made by the northwest shelf. Great crevasses had developed at the west cone and extended from these southward.

The southeast cove was open, with surface streaming to its south end. There was rapid streaming eastward in the southeast pool, a large spatter dome was building on its south side, another appeared on the west shore of the lake, and others were being constructed southwest and northeast. There was still heavy smoke from the northeast cliff over the lake.

In the evening at 9 p. m. the lake was about five feet below the inner bench, showing stalactite margins, six or seven fountains, and vigorous streaming. The fumes were somewhat thinner. There was a glowing filigree at the spatter bank of the southeast cove and a blue flame could be seen near the summit of the central peninsula. Low-roofed caverns appeared to extend under the bank at the east cove and at the central cavern, with a bright orange glow and quiet blistered skins on the still pools that could be seen inside the cavernous spaces.

On this afternoon the summit of Mauna Loa showed unusually conspicuous fume which condensed in large puffs about sundown, and drifted northward. The cloud, however, was soon dissipated and appeared to be moisture condensed above the snow drifts owing to a chance atmospheric condition. Mr. Alfred Castle and Mr. Knollenberg visited Mokuaweoweo on June 19 and found heavy snow fields in the crater on its eastern side and the usual fuming toward the west.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with June 22 four definite local earthquakes have been registered—one of intensity barly perceptible to the senses—and three wave-groups of doubtful character. Microseismic movements have been registered as usual. The seismographic amplitudes of volcanic vibration have continued larger than usual. There has been little shifting of the pens in the sense of tilt; even the diurnal variations have been less than usual.

June 30, 1917.

During the week ending June 29, 1917, the lava lake has remained about 100 feet below the rim of Halemaumau, with small oscillations and sufficient rising to produce small overflows and a pronounced inner bench platform. The change from subsidence to slight rising on June 22 was definite, and occurred simultaneously with the solstice, but the maximum rise for the first week after the solstice has been not more than 15 feet. The broad areas of inner bench began to show pronounced tilting towards the end of the week.

On Saturday, June 23, at 9 a. m., the

fumes were thinner and the lake surface hot, with three or four fountains and with streaming motion from the north into both the southwest and southeast pools. The spatter bench was generally higher and a new spatter heap had been built at the entrance to the central cavern. The crags and floors appeared unchanged. A smoking pressure ridge had gradually developed, extending from the east cove north to the sulphur hole. A similar line of fumy broken crust, partly ridge and partly valley, extended from the southeast cove across the south floor to the southwest pool.

On June 24 at 11 a. m. the lake was rising, and at 1:30 p. m. there was slight overflow at the southeast cove. At 2 p. m. the lake subsided about four feet and there was great increase in fountaining activity.

On June 25 there was strong rising with slight overflow in the early afternoon, the high level lasting about three hours. The southeast grotto was very active and tended to undermine the wall under the southeast bench. Later there was subsidence by about five feet and increased general fountaining.

On June 26 at 7 a. m. there was strong overflow on all sides so as to flood the floors northwest, west, east and southeast. The floods left broad, flat, festooned crusts. At 2:45 p. m. the inner cliff was 10 feet high on all sides, with but little fountaining activity. The fumes appeared thicker.

At noon on June 27 the banks were only three feet high and the lake appeared quiet and rising, with some thick crusts and few fountains. The smoke was moderate. The pit under the north station had become a pronounced hole about 100 feet in diameter, containing a funnel-shaped tumble of broken rocks smoking vigorously. At 2:15 p. m. the lake lava appeared about five feet below the inner bench, with much activity on the side of the crag-mass. Across the main lake near its northeast shore Old Faithful fountain broke periodically. Fire could be seen in the sulphur hole northeast of the east island. At 2:30 p. m. the southeast pool was depressed eight feet below its banks and there was much fountaining against its south wall. There were many fountains in the main lake and continuous bombardment at the inner end of the southwest pool. At 9 p. m. the lake appeared about 11 feet below the inner bench, with strong streaming to the west and to the southeast, and fountaining southeast, southwest, near Old Faithful, and in a new cove which is developing at the north end. Blue flames played from cracks in the south floor west of the southeast cove. Some slabs were heard falling toward the northeast. Smoke was increasing along the crack east of the east island, and a ridge was developing farther east along the line of the old northeast crag of January last.

On Thursday, June 28, 1917, at 10:15 a. m., the lake was subsiding until noon. Occasional falling slabs were heard, there was rapid streaming to the southwest and southeast, with thin crusts, and five or six fountains were in action. Spatter banks fell in on the south side of the southeast pool and at the east end of the southwest pool. Inspection revealed a pronounced new inner platform all around the lake about five feet high. Pits of collapse are becoming pronounced at the north chasm and west pond.

On June 29 at 9 a. m. the lake was about 15 feet below the floors, but within an hour it had risen five feet. The main lake was crusted heavily, the streaming was slow southward, with fountaining against the crag-mass and against the south shore of the southeast pool. At 11 a. m. there was slight subsidence with reversal of streaming from slow outward to rapid inward at the southwest cove. Crusts broke up vigorously and swift streaming was resumd into the southwest and southeast coves. During the morning the very pronounced smoking of a tumble of rocks at the base of the southeast bench ceased and the stones collapsed into a pot 10 feet in diameter, where lava spurted and a great banner of blue and yellowish flame played continuously so as to stain the walls with sulphur coating.

It was now becoming evident that very marked tilting changes were going on in the bench magma. The north pit had almost entirely ceased to fume, and there were slabs falling in the northeast crevasses and under the southeast

bench near the southeast cove and the east cove. The whole northeast floor appeared to be rising toward the north and sinking toward the south, while the south island mass was similarly tilting southeastward. The development of the new southeast pot was a part of this process, and the smoke cracks were increasing from these westward across the south floor. In this direction the lava of the southeast cove streamed swiftly under a tunnel roof and there was similar streaming under the south floor from the southwest pool, with very heavy smoke developing. The southern bench block apparently was breaking along this south floor line with uplift of the central crags. There was yellow sulphur stain on the south floor near the southeast cove. The spatter margins of the southeast pool on both sides showed elevation 15 to 18 feet above the lake in the central region, whereas they showed depression at the southeast cove, the bank there being only five feet high. Angular measurement showed that the eastern and southern crags were rising. The western crag-mass, on the other hand, was slightly subsiding. This all checked with the recent weighting by overflow, which was all around the crag-mass, giving it no opportunity to tilt, whereas the southern and northeastern floor blocks were weighted only at one corner.

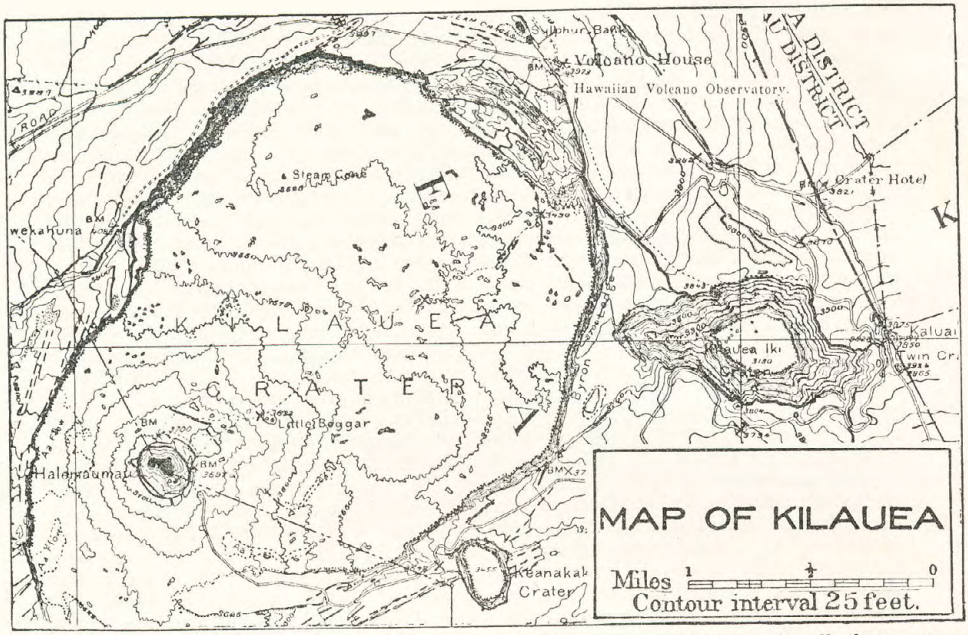
The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with June 29 two local earthquakes have been registered, both of moderately small seismographic amplitude; and two teleseisms, one a chief phase only of a shock of low power as world-shaking earthquakes go, and one a well and completely registered shock from an origin distant approximately 1600 miles, with large seismographic amplitude. This latter probably delivered a greater quantum of energy at this station than any teleseismic disturbance hitherto recorded here. It probably emanated from a submarine origin.

Microseismic motion has been registered as usual. The seismographic amplitudes of volcanic vibration have been larger than normal—a prevailing condition for several months of late—and "storms" have been fairly frequent. Early in the interval under report there was a marked shift of the pens in the sense of tilt to west and north, followed by conspicuous fluctuations which did not produce any notable net change —that is, the shifts have remained to the time of writing.

Very respectfully,

T. A. JAGGAR JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering N-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol a, or max. a, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

VOL. V. HONOLULU, HAWAII, JULY, 1917. No. 7

July 7, 1917.

During the week ending July 6, 1917, the lava column of Halemaumau continued to rise until Tuesday, July 3, but thereafter the lake was stationary or falling, so that the net result for the week appears to indicate stationary conditions.

On Saturday, June 30, at noon, the inner bench stood ten feet above the lake and there was great activity in the grotto on the south side of the south-east pool. There was also central fountaining in that pool and much fountaining activity in the main lake. Streaming was from the west toward the north and southeast. After 12 o'clock noon the southeast cove showed boiling and inrush under the south floor as though towards a sinkhole. At 1:30 p. m. the southwest cove, seen from the south station, showed strong bombardment in the end grotto, with a few large central fountains.

On July 1, at 1:45 p. m., it was evident that the lava lake had risen and overflowed the bank at the east cove, but, at the moment, the lake was about four feet below its shores. It was now rising rapidly with some fountaining in the middle of the southeast pool. At 3:30 p. m. the lake had risen nearly level with its banks, and at 4:30 p. m. overflow took place at the east cove and extended only about three feet beyond the previous flow. Overflow continued for about thirty minutes, followed by subsidence three feet below the bank. There was then much fountaining in all the arms of the lake and in the grotto.

On July 2, at 11:45 a. m., the lake overflowed the bank at the east cove, but this was short-lived and at 1:00 p. m. there was rapid subsidence, so that the inner cliff was ten feet high on the south side of the southeast pool. At 2:00 p. m. there was recovery which continued until the level of the lake was only two feet below its banks. Then subsidence recurred with much fountaining activity.

On Tuesday, July 3, at 2:00 p. m. the inner cliff was about seven feet high at the east cove and there was much activity in the southeast cove. There was the usual central fountaining. In the northeast arm the lava level was within three feet of overflow and slow rising appeared to be in progress. To the southwest quiet crusted conditions prevailed. On the northeast floor it was evident that there had been a flow from the east cove within a few hours, as glowing cracks were visible all over the fresh lava there.

In the later afternoon, at 4:30, it was evident that sinking had started in and the heavy fall from the south point into the channel produced strong effervescence there. Fumes appeared to be increasing toward the north.

On July 4, at 1:15 p. m., the inner bench was ten feet high all around the lake and conditions were extraordinarily quiet. There was only one active grotto on the south side of the southeast pool and central fountains were absent. At 2:40 p. m. there was little change, and the surface streaming was from the west toward the north and southeast. At 4:30 p. m. there was a heavy fall of rock from the East Island mass into the southeast pool, followed by much fountaining. At 7:00 p. m. the inner cliff was fifteen feet high and the fountaining activity was everywhere strong.

On Thursday, July 5, at 2:00 p. m. the lake was still low and there was very strong streaming, boiling and rumbling at the grotto of the southeast cove. The central cavern was also a scene of activity and all conditions

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L. W. de Vis-Norton.....Secretary

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pointed to subsidence, following the higher levels of the early part of the week.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with July 6, only one weak local earthquake was registered, and that had doubtful phase characteristics. Microseismic motion has been registered as usual. For many weeks the seismographic amplitudes of volcanic vibration waves have been greater than the previously normal value. This has remained true during the week under report here. Otherwise these movements have been as usual of late. Shifting of the pens in the sense of tilt to the west and north has gone on slowly and steadily in the past week, accompanied by the usual diurnal changes.

July 14, 1917.

During the week ending July 13, 1917, the Halemaumau lava pool has continued to fluctuate with some overflow of the tilted bench block of the south floor and crag. Toward the end of the week there was pronounced subsidence with undermining of the old northeast bench of 1894.

On July 8 at 2:30 p. m. the height of the inner bench was only about five feet and after 4:30 p. m. there was pronounced rising for an hour and a half. The lake at 6 p. m. was level with its margin at the east cove and at 6:10 p. m. it overflowed there slightly. Then subsidence set in with much fountaining.

On Monday, July 9, at 1:15 p. m., the lake was depressed ten feet below its margin and rising. The streaming was rapid toward the southeast, there was no fountaining in the central region, fumes were very thin and there was bombardment at the southeast grotto. At 1:40 p. m. there was a fall of rock from the east island point into the lake followed by turbulence. On the south margin of the southeast cove a blowing cone had developed and was noisy, while at the west margin of this cove there was rumbling effervescence in the cavern which appeared to lead to a sinkhole under the south floor. At 3:35 p. m. there was collapse at the southeast grotto followed by a second tumble of rock from the central peninsula into the channel.

On July 10, at 11:30 a. m., the inner wall was twenty feet high and there was active fountaining at the southeast grotto, slow streaming eastward through the channel and the fumes were thicker. There was much activity in two grottoes on the west shore of the main lake under the crag-mass. At noon it was evident that bombardment was in progress northeast and some central fountains were playing in the Old Faithful position.

On this day an examination of the south floor showed that a new long flow of considerable width had poured from the southeast cove westward and the south floor had been thereby depressed, while the central peninsula had risen. At 12:30 p. m. there was much fountaining in the north central part of the main lake and great activity at the base of the crag-mass. At 1:30 p. m. streaming was rapid through the channel southeastward and a pronounced rise came within a few feet of overflow at the southeast cove.

On Wednesday, July 11, 1917, at 2 p. m., it was evident that the southeast cove was nearly obliterated by overflow and half of the blowing-cone was destroyed. In the southeast pool the shore bench appeared ten feet high above the lake on the south and half that height on the north side of the pool and there was no fountaining. Fumes were thick but the lake appeared rising and there was sharp puffing occasionally, like a locomotive, from the remnants of the blowing-cone. At 2:55 p. m. a heavy

avalanche fell from the northeast side of the east island. The northern cracks were fuming densely and it appeared that the northeast cliff made by the elevated May floor was becoming a rising crag.

At 1:30 p. m. on July 12 it was evident that a large block of rock had fallen away from the central peninsula. The inner cliff was 20 feet high on the south and 10 feet high on the northeast, so that the south bench was rising and the northeast bench at the east cove apparently sinking. There had been much falling away of the sides of the east island. Fountains were few. At 3 p. m. there was great activity in the south grotto but no fountains elsewhere, and the streaming to the southeast sinkhole was rapid. The 1894 bench northeast was crumbling slowly, as the talus blocks there could be seen or heard in motion every few minutes. The northeast floor beneath was slowly sinking and the large crevases under the 1894 bench were widening.

On Friday, July 13, at 1:30 p. m., the northwest margin of the main lake as seen from the north station was 10 feet high, there were a few fountains in the west arm and the fumes appeared moderately thick. The bench on the south side of the southeast pool, on the other hand, was fully 25 feet high and that pool was extremely quiet. At 3:10 p. m. there was a heavy avalanche northwest and a few minutes later another farther north, the rocks falling into the northwest arm and starting effervescence there.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with July 13 four small local earthquakes have been registered. The strongest of these was felt in Hilo, but not, so far as is known, in the vicinity of the Observatory. The seismographic amplitudes of microseismic motion have at times been greater than normal, but in general of usual values. The seismographic amplitudes of volcanic vibrations have continued as usual in recent weeks, stronger and stouter than the general normal. There was pronounced shifting of the pens in the sense of tilt to the west and north, necessitating readjustments, in the early part of the wek-interval followed by slight returns and then comparatively slow and small oscillations.

July 21, 1917.

During the week ending July 20, 1917, the Halemaumau lava column has risen slowly to a level not lower than 90 feet below the rim and the end of the week shows slight overflow of the inner bench southeast, renewed hissing at the northwest cone and construction of spatter domes at the lake margin. These are all signs of rising.

On Saturday, July 14, at 2 p. m., the southeast pool was fountaining in five places and its border was 20 feet high on the south and 10 feet high on the north. At 3:20 p. m. there was a strong rock slide from under the southeast bench. On this day there was much movement of loose rocks under the 1894 bench northeast. Inspection from the north at 3:40 p. m. showed that there was much fountaining in the north arm of the lake and high spurting from the Old Faithful grotto on the northwest side of the east island mass.

On July 16 the lava was higher and at 2 p. m. the west bank of the main lake appeared only five feet high and the northwest inner bench appeared submerged. There were active grottoes southeast and south and much spurting in the southeast cove. At the east cove the lake was only two to three feet below the bank. Fumes, however, were thick. At 3 p. m. there was subsidence by about two feet, streaming increased in speed and there was strong bombardment at the S. E. grotto, while five or six fountains broke into activity around the southeast pool. At 5 p. m. the writer examined the lake after an absence of two weeks and found little marked change. The south bench block showed increased tilt and there were recent flows from the southeast and east coves. The south floor exhibited a distinct valley extending from the southeast cove to the southwest cove, and the floor of this valley was much broken and smoking. The last remnant of the summit of the old east crag of January was now nearly completely buried under talus and recent flows. There was a small flaming cone west

of the southeast cove. The east island had crumbled down somewhat, especially on its east and south sides, and the northeast peak was now lower than formerly and more ridge-like in form, the ridge trending north and south. The crag-mass and northwest crag both appeared lower and the north pit appeared deeper.

Measurement on Tuesday morning, July 17, 1917, indicated depression of the lake surface slightly over 100 feet. From 10 a. m. to 12 noon the lake was streaming rapidly to the southeast and showed much bubbling activity, with thin crusts. There was inrush under the bank at the west side of the southeast cove and fountains were numerous bombarding the west side of the main lake. A view of the west and northwest floor region showed the effects of continued subsidence, leaving a high shelf from the west niche southward with the bare cliff wall interrupting the shelf in two places, west and southwest. The south crags were highest on the side of the main lake. The smoke appeared thinner on this day and at the shore of the lake, under the northwest crag-mass, two inner spatter levels were visible, the upper being the floor of June 22-25 now some 20 feet above the lake. The newer inner bench was only half as high and was well marked in several places. There was smoke under the west niche, at the north margin of the lake, along the south valley and at the west cone.

In the early evening of July 18 the lake was brimming level with its banks and slightly overflowing the inner bench at the southeast cove. The streaming was from the west. There were fountains at the Old Faithful locality and at different times on the northwest, southwest, at the east cove, and under the southeast bench. In the southeast cove there was high gas pressure which caused the marginal fountain to spurt its spray from 70 to 80 feet vertically, and once a similar spurting fountain was seen to break out at the south side of the narrow leading to the southeast pool. The crusts moved along the shores with a crunching noise. There was flame and glow at the northwest cone. After descent to the shore of the lake at the east cove, the lake was seen pushing crusts eastward in overriding layers and occasionally floods of lava would overflow the stagnant crusts with a piling-up effect from west to east. The gas pressure in the lake induced continuous ballooning of the crust all over the surface, and there were many spurts of blue and some yellow flames from gases which broke through the balloons and through cracks in crust. The lake appeared not more than 90 feet below the rim. About 6:45 p. m. subsidence set in so as to lower the surface one to two feet, the crusts broke up, streaming became rapid and violent fountains developed along the shore of the east cove and migrated eastward. There was also increased fountaining elsewhere. Heavy bombardment under the southeast cliff threw spurts 60 feet into the air. After about twenty minutes the lake recovered, the surface became quiet and rising ensued.

On July 19 the lake remained high and the fumes thin. On Friday, July 20, similar conditions prevailed and slow rising of both lake and benches appeared to be in progress. The south block was more tilted down at the southeast and up toward the west. The peninsula extending west from the south crags into the southwest cove was also upraised, with its highest point at its western end some 15 feet above the lake. The west bank of the lake across the narrows leading to the southwest cove was only five feet high.

Fumes on this day were moderately thin and the streaming was from the north and northwest to the southeast, and towards a large continuous fountain at the west cove. The southwest cove was quiet. In the southeast cove the streaming had reversed and was now eastward where the current united with that from the southeast pool to expend itself in bombardment under a long spatter dome which had been built under the southeast bench. There were only five or six fountains in the lake and some large stagnant crusts. The inner bench was wholly submerged. There were no fresh overflows, however, except possibly on the east bank of the southeast cove. The northwest cone was hissing strongly and steadily, and as this cone is over a main conduit, this high gas pressure may presage a rise.

At 10:30 a. m. subsidence set in and strong fountaining appeared at three points along the northeast shore, at the north shore, and toward the southwest and southeast. The central fountain continued its activity in the western region. It appeared to indicate meeting currents from south and north.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week-interval ending with July 20 four local earthquakes have been registered. One of these was felt distinctly at Kilauea as a sharp, sudden jolt. Another, a few minutes later in occurrence, was felt in Hilo, but no report of its having been felt near the station has come to hand. The remaining two shocks were of the usual unfelt sort. The motion of volcanic vibration, and microseisms, and pen-shifts in the sense of tilt have all been as usual, with no changes or events of noteworthy character.

July 28, 1917.

During the week ending July 27, 1917, the Halemaumau lava at first overflowed the benches, but since has remained stationary and the only change of importance has been a widening by collapse of the southeast cove. The depression of the lake, measured twice during the week, was 103 feet.

At 2 p. m. on Friday, July 20, the lake was level with its banks at the east cove. At 2:30 p. m. it overflowed the east side of the southeast cove and a wide flow poured over the west bank of the main lake. Thereafter the lava subsided three feet and remained so until 5:30 p. m. Rapid rising then recurred and overflow at the same places was resumed at 6:20 p. m., but in less volume.

On July 21, at 2 p. m., it was evident that there had been strong overflowing at the east cove during the morning, but now the lake was four feet below its banks. There was little fountaining and the fumes were thin. Streaming was swift southeastward.

From 10 a. m. to 2 p. m. on July 22 the lava lake was rising from a level relatively low with reference to the rim of the inner pit. The central cavern was at first open but became submerged during the morning. During the low stage the lake rushed rapidly under an arch into the tunnel at the southeast cove toward a smoking place in the south floor valley coinciding in position with the February sinkhole. In the center of the main lake continuous fountains played where currents met from north and south. There were other fountains southeast, northeast and north. Heavy shells of rock fell into the lake from under the southeast shelf and from the east island mass. The fumes were moderate. At 12:30 p. m. the lake had become coated with quiet crusts and there was hardly any streaming motion. From 1 to 2 p. m. the lava was brimming level with the bank at the east cove, and during the afternoon there was slow subsidence to a level about 10 feet below the margin.

At 9 p. m. the lake was again low relative to the inner pit and the central cavern was open. Streaming through the southeast pool was vigorous and there were fountains north, northeast, in the middle of the main lake, along the shore of the east cove and under the southeast shelf. Hanging stalactite curtains were abundant and there were glowing and flaming cracks in the floor above the southeast cavern and a high chimney on the floor of the elevated channel in the southern crag mass over the interior of the central cavern.

In the slow moving, thinly skinned, glowing lava which streamed out from the central cavern, blisters one to two feet in diameter would suddenly appear, swollen up from below through the action of rising gas. Some of these burst, leaving rings, others within the cavern were small bubble fountains. The most remarkable kind were travelling blisters, which moved rapidly sidewise with a wriggling motion and vanished, leaving a wake like a fish darting along beneath the surface of water. The cause of this travelling appeared to be a pressure impelling the gas bubble from the region of thicker and heavier crust outside the cavern toward the heated thin-skinned region within.

Measurements on Monday, July 23, 1917, at 2:15 p. m., made the depression of the lake 103 feet below the southeast station and the following were the heights of the several crags:

Central peninsula of southern block 60 feet above the lake.

Northwest table 59 feet above the lake.

East island 48 feet above the lake.

North summit northwest crag mass 48 feet above the lake.

Old summit northwest crag mass 47 feet above the lake.

Floor features were elevated as follows:

Northwest cone 22 feet above the lake.

Northeast floor 18 feet above the lake.

Margin southeast cove 7 feet above the lake.

South floor valley 7 feet above the lake.

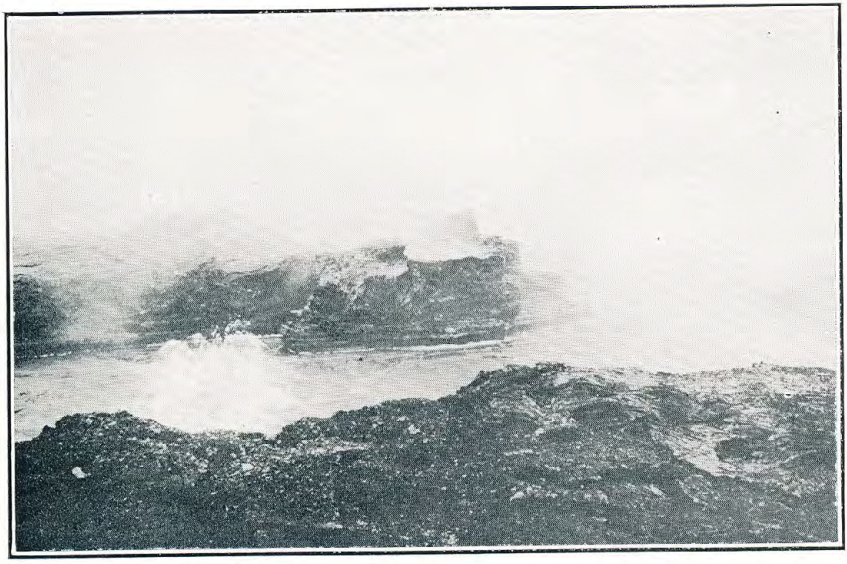
It had now become evident that the southern crag block was rising strongly in response to the weight of recent overflows at the southeast cove. The central peninsula of this block was now the highest feature above the lake. The peninsula extension from this into the southwest cove was also much uplifted and 30 feet high at its western end, with southeastward tilt. There was also elevation in the east island mass so as to create a new straight tumbled slope southward from the northeast peak, indicating that the surface west of this line was rising higher than the remainder of the northeast floor. This was a response to the weighting effect of the fresh overflows at the east cove. That rapid motion was in progress was shown by very heavy falls of rocks from the southern mass into the channel and into the southeast pool, also from the point of the east island and from the shore of the east cove. The depression of the lake within the southeast inner pit appeared 20 feet, but this was due to rise of crags rather than sinking of lake. Toward the south-southwest there was a pronounced marginal fall-off of the southern crag block due to its rising above the western end of the valley extending from the southwest cove to the southeast cove. The old northwest crag mass appeared raised on the lake side and the northwest table appeared higher. The smoke had increased in density. Streaming was from north and south in the main lake toward the southeast pool and the central and southeast caverns were open. The northeast pit appeared to be reforming. A heavy fountain was seen to form in the southeast cove and migrate into the tunnel under the south floor changing to a swarm of bubble fountains as it did so. There were many shifting bombardments of the shores of the lake and spells of rising in the intervals. It was evident that a spasm of rising of the bench magna was in progress, the adjustments of the lake to this process causing much migratory fountaining and thin crusts. The northwest cone was no longer hissing but there was a large area near it stained with sulphur corresponding apparently to the roofed-over northwest pond beneath. The walls of the southeast pool were 40 feet high on the east, with strong bombardment at their base where the tunnel leads to the south floor.

The strong rising movements of the crags revealed clearly the fact that the east, central and southern crags and the northwest crag mass all have adjacent tunnels which would separate them off as islands if the roofs of the tunnels could be removed. In each case these roofs originated as solidified surfaces of arms of the lake just as ice persists longest in narrow channels among islands in a river. There was hot fume rising from the cracked tunnel roofs southeast, southwest, in the center, northeast and northwest, and the various pressure ridges recently reported all give evidence of tunnel locations.

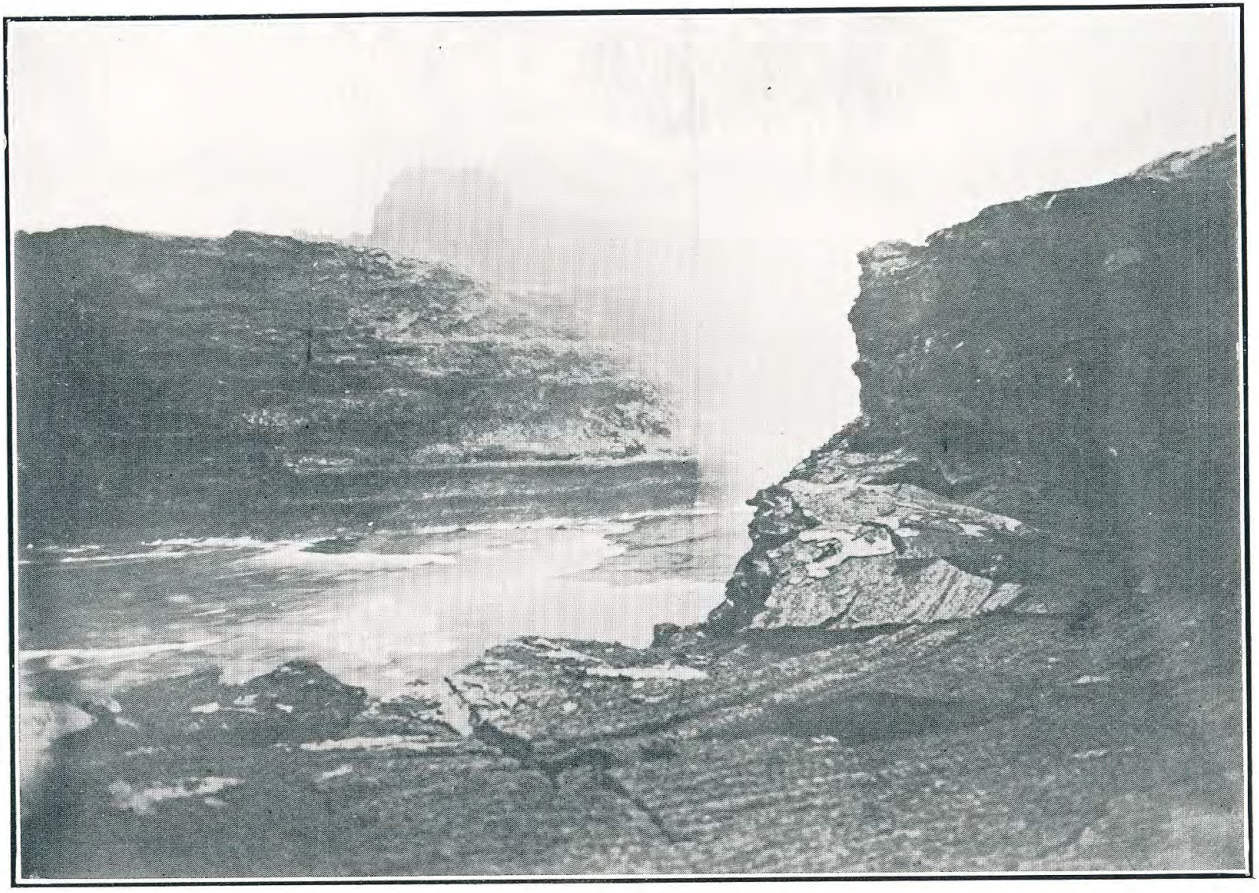
On July 24, at 10:30 a. m., there was little change, the lake was slightly higher, fumes were moderate and fountains were few. At 11:30 a. m. there was subsidence with swifter streaming, eight or ten fountains developed and there was streaming into the northeast cove east of Old Faithful fountain. This cove had been enlarging at the expense of the northeast peak. There was white stain at the glowing heap over the southeast tunnel.

On July 25 from 6 to 8 p. m. there was very active streaming and high incandescence of grottoes and fountains. The inner beach at the southeast cove was 8 feet high. Streaming almost torrential at times poured southeastward

May 30, 1917. Moving lava overflow on southwest floor, men making fresh lava specimens. West cone on left, source of flows.—Photo. Jaggar.



June 14, 1917. Migrating central fountain in southeast pool, looking west from bank of lake toward central cavern.—Photo. Jaggar.



June 14, 1917. Bright lines of channel torrent of lava 50 feet away. From north bank of channel, center of pit, looking S. W.—Photo. Jaggar.

through the central channel from the north and southwest arms of the lake. The southwest cove was dark and crusted. Many large fountains travelled from the channel to the east cove and others formed under the southeast shelf. The crust at the northwest arm would occasionally break up and fountaining develop at the northwest bank. There were alternations every 20 to 30 minutes from swift streaming with fountaining to slow current and less fountaining. The general result was a rising during the evening which led to drowning of the central cavern where there was slow outward streaming, at first eastward with blistering skin, later northeastward and more rapid. There was glow and flame at the northwest cone, the central chimney and the southeast heap. There was puffing to the north. In the late evening the incandescence decreased and there was some crusting across the central channel.

On July 26 at 2 p. m. the lake was relatively high and hot, there was a new narrow inner bench, crusts were thin with rapid southeastward streaming, much bubbling and little fountaining. A crack appeared to be developing across the central peninsula above the tunnel. The shore bench of the eastern coves was from 6 to 8 feet high.

On Friday, July 27, 1917, at 11 a. m., measurement showed the depression 103 feet as on July 23 and the crags very slightly lower or unchanged. The lake was rising and crusted until 10 a. m. and thereafter it remained high, with moderate streaming from north and southwest, fumes thinner and fountains few. Fuming had increased under the west shelf. The most important change was the collapse of the southeast cove on its east side which had enlarged it to double its former size. There was bombardment at two places along its shore bench which stood five feet above the liquid.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

During the week ending with July 27 no earthquakes have been registered. Microseismic motion has been as usual. Volcanic vibration has been registered as in recent weeks, stronger than the earlier normal, but not different from recent values. There has been no noteworthy change in the position of the writing levers (tilt) except for the usual diurnal change.

August 4, 1917.

During the week ending August 3, 1917, the Kilauea lava column has maintained its level as before, only a slight net subsidence appearing by measurement at the end of the week. On Aug. 2 in the afternoon there was a magnificent breaking up of some of the benches accompanied by a sharp rise of the peak in the center of the pit and collapse of the roof of the central cavern so as to leave a chasm in the cavern's place. This cataclysm was accompanied by no special rise or fall.

On Saturday, July 28, at 2:30 p. m., it was evident that the southeast cove had widened further on its east side; this cove was very active. At 3 p. m. the inner bench was generally about ten feet high and Old Faithful could be distinguished in the northeastern part of the main lake. Fumes were thick and the lava was stagnant except for two fountaining grottoes on the southeast aspect of the northwest crag mass. At 2:50 p. m. there was renewed activity to the southeast.

On July 29 at 2:45 p. m. the inner cliff south of the southeast pool was about 20 feet high while that at the east cove was only half as high. Shore fountains were active on the south side of the southeast pool and in the southeast cove. At 3:30 p. m. the north arm was fountaining in many places, the Old Faithful interval was about 40 seconds, and the northwest grotto was noisy.

At 3 p. m. on July 30 slow rising was in progress. First there was fountaining southeast but later the lakes became very quiet and fumy. The south mass was evidently rising more, its wall over the southeast pool being now 25 feet high, whereas across the pool to the northeast there was no change and only about 10 feet of inner cliff. At 4 p. m. the grotto south of the southeast pool was spurting high, but the north pool remained quiet except for Old Faithful, which broke the surface at intervals.

On July 31 at 2:30 p. m. the north

pool was again quiet and the south grotto active. By 3 p. m. rising was in progress and the east cove bank was only six feet above the southeast pool, where rapid streaming poured southeastward to churning grottoes in the southeast cove.

On Wednesday, Aug. 1, 1917, at 1:40 p. m., there were numerous fountains. An hour later the activity had decreased except for a vigorous grotto building a spatter heap under the southeast shelf.

On Aug. 2 at 2:10 p. m., the main lake was very stagnant except for one grotto under the northwest crag mass. The bench at the west appeared 15 feet high. The southeast pool was also very quiet, its south inner cliff appearing 25 feet high. There was no change in the fumes, which were rather thick.

At 2:45 p. m. the east island began to collapse, fully half of its table falling away into the southeast pool. A few seconds later the roof of the central cavern began to fall in and portions of the adjacent south bench. Then the eastern half of the bank around the southeast cove went in with a crash and a heavy block fell from the northwest crag mass. The lake seethed with many hundreds of fountains. The central peaks adjacent to the collapsed cavern, on its north side, rose bodily about 10 feet and split asunder, so that a sharp pinnacle shaped like a steeple separated off and remained pointing upward on the eastern side of the mass. The remainder of the roof of the central cavern had now tumbled, clear through to the southwest cove, leaving a canyon floored with broken rocks, afterwards partially flooded by the lake on the east side. The raised bench clinging to the central peaks was now fully 40 feet above the lake and the south bench 30 feet high. The mass of the east island crags subsided somewhat, a channel of collapse forming over the submerged tunnel east of them.

This whole movement may be considered a readjustment of the craggy crusts of the bench magma, undermined by the central, northeastern and southeastern tunnels. Cracks developing above these tunnels have recently been mentioned, especially over the central tunnel, where there was a flaming chimney. The hot gases blowpiping through these cracks finally ate through, instantly the weights of the newly separated crust blocks were differently disposed on the pasty under-lava, this paste flowed toward the center away from the broad and heavy floors, and the central peaks, of much smaller area, were thereby lifted. The general readjustment due to this movement caused the other collapses.

Measurement on Friday, Aug. 3, 1917, at 5 p. m., gave the following data:

Depression of lava lake, 109 feet.

Height above lake of central peak, 74 feet.

Height above lake of south crag, 59 feet.

Height above lake of east crag, 49 feet.

Height above lake of southwest crag mass, 46 feet.

Height above lake of northeast floor, 23 feet.

Height above lake of south valley, 12 feet.

On this day at 2:30 p. m., looking from the north, the north side of the east island mass was seen to be fractured and tumbled, some 20 feet below the northeast inner cliff. There was much fume and few fountains. The grotto under the south bench was active and a great splash dome had been built 10 feet high and 20 feet wide under the southeast bench on the east side of the widened southeast cove. There was rapid streaming under the south floor. The east face of the central steeple showed upright laminations or beds, red and white in color, each layer four or five inches thick, similar to those formerly seen on the west side of the east island. At 5 p. m. the great southeast spatter dome completely collapsed into the lake. The northwest crag mass was now covered with rugged lumps. The floor level at the east cove appeared upraised somewhat and an inner bench only five feet high had formed under the east island remnant. Much of the south end of the east cove platform had fallen away.

The following report from the Whitney Laboratory of Seismology is submitted by Mr. H. O. Wood:

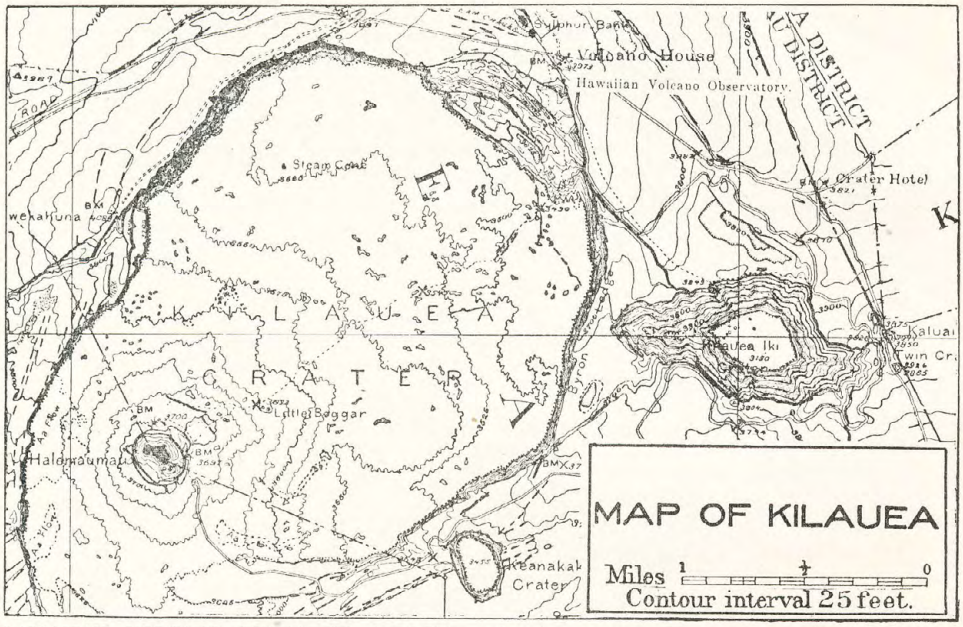
During the week-interval ending with

Aug. 3 six local earthquakes were registered. Two of these were felt plainly, one in the evening by many people and one in the early morning, which awakened some sleepers. Possibly a third was felt in structures qualified to increase the effect of the vibration. Also one teleseism of moderate to small world-shaking energy was registered. Microseismic motion has been as usual. Volcanic vibration has remained as usual recently.

Accompanying the earthquakes there were pen shifts as in the sense of tilt first one way and then the other. It is always uncertain whether such shifting is due to instrumental yieldings or to changes in position of rock blocks here. There were no net changes of noteworthy magnitude.

Very respectfully,

T. A. JAGGAR, JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous 1000.0		2500.0
XI.	Catastrophic 2500.0		5000.0
XII.	Great catastrophe 5000.0		10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol a, or max. a, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, AUGUST, 1917. No. 8

Annual Address of the Director. August 23 1917

The Results of Six Years of Work

By T. A. Jaggar

Scientific Discoveries

The annual address of 1916 proposed a Kilauea volcano museum. Earlier addresses reviewed our beginnings and stimulated progress in making Mauna Loa accessible. The Observatory on July 1 completed six years of work if we include the preliminary observations in 1911 made by the Technology expedition of that year. It becomes my pleasant duty here to review very briefly the really wonderful advance in volcano knowledge that has resulted from measurements and experiments at Kilauea, an advance much assisted by the outbreaks of Mauna Loa in 1914-16 and the accessibility of Halemaumau during the past seven months.

In 1911 the volcanic heat and liquidity were supposed to increase downward indefinitely in the center of the pit. In 1917 by actual soundings, we know the lava lake to be less than 50 feet deep, occupying a saucer or channel in the cooler and stiffer lava of the lake bottom, of the islands, and of the benches.

In 1911 most geologists still thought that steam actuated volcanoes. In 1917 it is known that only 4% or less of the Kilauea lava-gas is steam and even this in part may be burnt hydrogen. Burning sulphur, hydrogen and carbon gases we now know are powerful heating and oxidizing agents in and about the liquid lava, making great natural blow-pipe flames and effervescing through the hot liquid as in a Bessemer converter.

In 1911 the lava islands were spoken of as "floating." In 1917 we know them after years of careful measurement and record to be uplifted hummocks from the bottom of the shallow pools. The consolidation of this bottom lava raised into an island, proved in February, 1917, to be clinkery lava or aa, hitherto almost unknown in Halemaumau but common on Mauna Loa.

In 1911 the main well or shaft in the crater was believed to be under "Old Faithful" fountain near the center. In 1917 at least eight such shafts are known, kept open by the rising rush of gas bubbles escaping continuously from solution in the main stiff lava column below. (Plate I). This lava foam rises to the surface, explodes in contact with air and circulates rapidly in a labyrinth of passages of its own making. Thus are produced the spectacular fountainings and streamings of the slaggy lava, so awe-inspiring to the traveller on the brink.

The maps, profiles and photographs, made at short intervals with transit and camera, give the history of measused changes of outline and relief.

In 1911, at great expense, one temperature of the liquid at the surface of the lava was obtained with an elaborate cable trolley system, after secrifice of much costly apparatus. In 1917 thirty-four measurements of temperature were made from the flaming cones on the floor and all through the lake to its bottom. This work was all done by direct

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L. W. de Vis-Norton.....Secretary

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contact of special thermometers encased in steel pipes, and at an expense which was trivial in proportion to the results attained. These results showed that the puffing flames are hottest, the fountains and the bright lines of the lava lake less hot, the lava just below the surface still less hot, and the interior of the stiff bench lava filling the pit from side to side probably least hot of all. (Plate 2).

In 1911 no proof existed of any law or order in the risings and fallings of Kilauea and Mauna Loa lavas. In 1917, after six years of careful measurement and record, definite proof exists of half-hourly, daily, monthly, semi-annual, and longer term tides and periods in the movements of the fluid. Furthermore, response of Kilauea to the heavings of Mauna Loa was indicated in 1914-16. A diagram (Plate 3) showing the earthquake spasms and eruptions in Mauna Loa reveals five marked coincident movements of the two volcanoes in two years, and an immediate return of the lava column in great volume to the Kilauea pit after the Mauna Loa floods had ceased. This diagram records one hundred and twenty separate weekly surveys made with transit. Such charts and measurements were never made before, and these are barely a beginning. Already they have been successfully used for prediction.

Scientific Theories.

In 1911 the causes of volcanic activity were conceived in as great variety as the individuals who imagined them. A volcano was a steam engine: a volcano was not a steam engine. The earth was hotter downward: the earth was not hotter all the way down. The earth was heated from without inward: the earth was cooling from without inward. The argument in each case was based, not on accumulated measurements and records, but on the validity of this or that observer. One said, "Flames and smoke are abundant at volcanoes": his opponent replied, "Flames and smoke are unknown at volcanoes." Such arguments as "craters have steam, therefor craters are steam engines," or "lava runs like water, therefor lava on Mauna Loa cannot be connected with Kilauea," are based on false assumptions due to insufficient record of the nature, consistency, temperature and chemistry of a lava column.

In 1917 the steam engine argument falls when the lava is proved to contain little steam and the so-called visible steam proves to be warm air moistened with rain water. The argument against connection between the two volcanoes falls when we know a lava column to be a duplex substance nearly solid, full of gas, and heating itself and foaming when locally uncorked. An eruption of Mauna Loa so conceived is an opening of the vent of a pent-up furnace whose gases were previously but slightly escaping with quiet effervescence through a small orifice at Halemaumau. The effect of the unplugging immediately reacts at the smaller vent, as shown by our charts, but not at all after the fashion of a watery liquid. In 1917 I do not believe a volcano to be a steam engine, but think of it as Nature's glass factory, actuated by burning gases.

No more need be said about causes and theories. The cause of volcanic activity is subject for a volume, not for a paragraph, but every theory of value in science is essentially a grouping of hard earned facts. The cause of volcanic activity will only first be stated when at ten such stations at ours, in ten different regions of the globe, experimental records have been kept for years of the rise, heat, consistency, release, flow and cooling of lava. I have myself

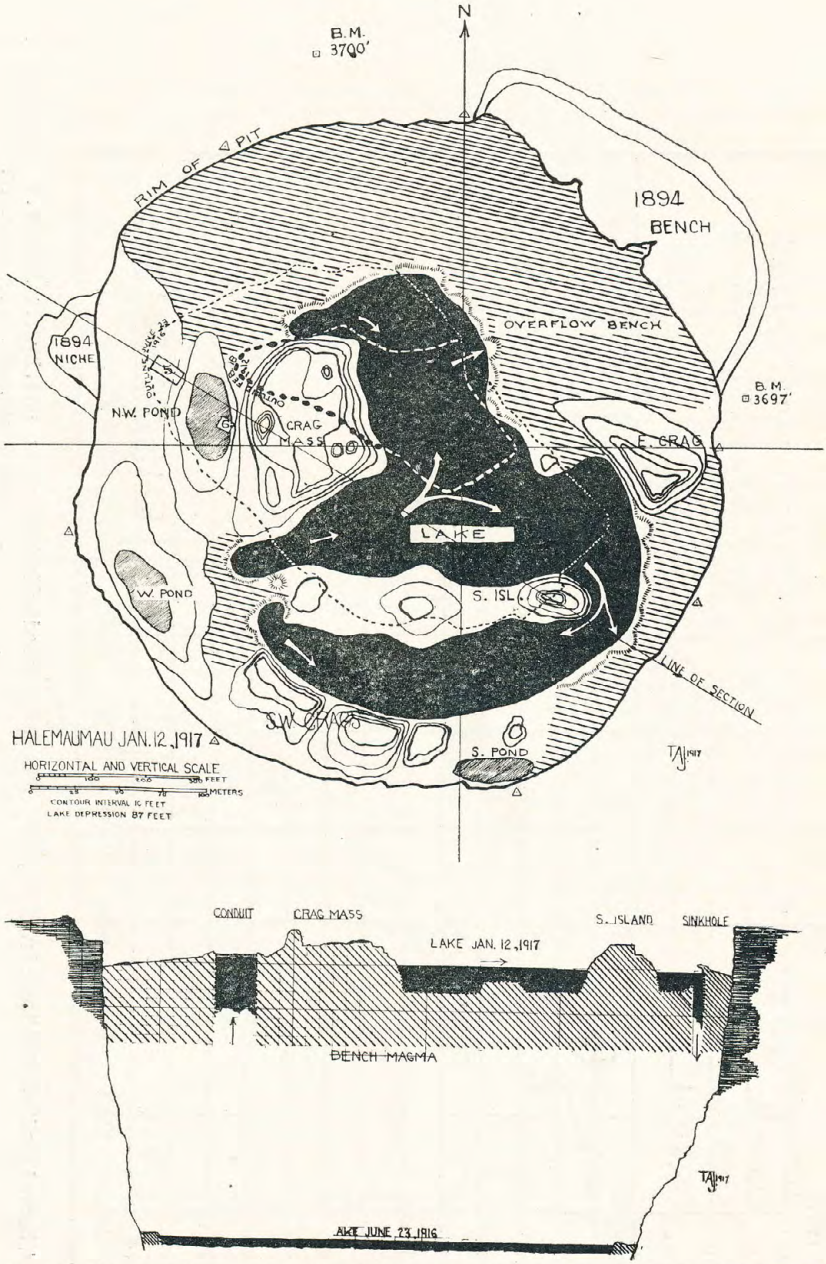


PLATE 1.—Map and diagramatic section of Halemaumau, Jan. 12, 1917. Lava lake in black, crusted conduit ponds shaded, overflow benches diagonal lines, raised crags contoured. Course dotted outline lava lake of Feb. 18, 1912. Fine dotted outline June 23, 1916. Rectangle (5) site of lava spring of June 5, 1916. Rectangle (6) west corner of pool June 6, 1916. Note that N. W. corner has been conduit source on all these dates. Slight slope lake surface from conduits W. to overflow bench E. Bench magma elevated on conduit side W. S. W., subsided on sinkhole side E. N. E. Section without vertical exaggeration, lower profile shows simple rising pool of June 23, 1916. Shoal shown in lake bottom was revealed by subsidence February, 1917. Depths from soundings and subsidence records. Note progressive shoalings from W. to E. Diagramatic sinkhole E. shows ridge of accretion on lake bottom margin which produces cascade ledge when subsidence takes place. Surveys with transit by T. A. Jaggar. Bench marks (B. M.) U. S. Geological Survey, trig stations Hawaiian Volcano Observatory. Meridian approximately 155° 17′ 8″ W., lat. 17° 24′ 33″ N. This is a typical survey of kind made frequently at Halemaumau.—*From Am. Jour. Sci., Sept., 1917.*

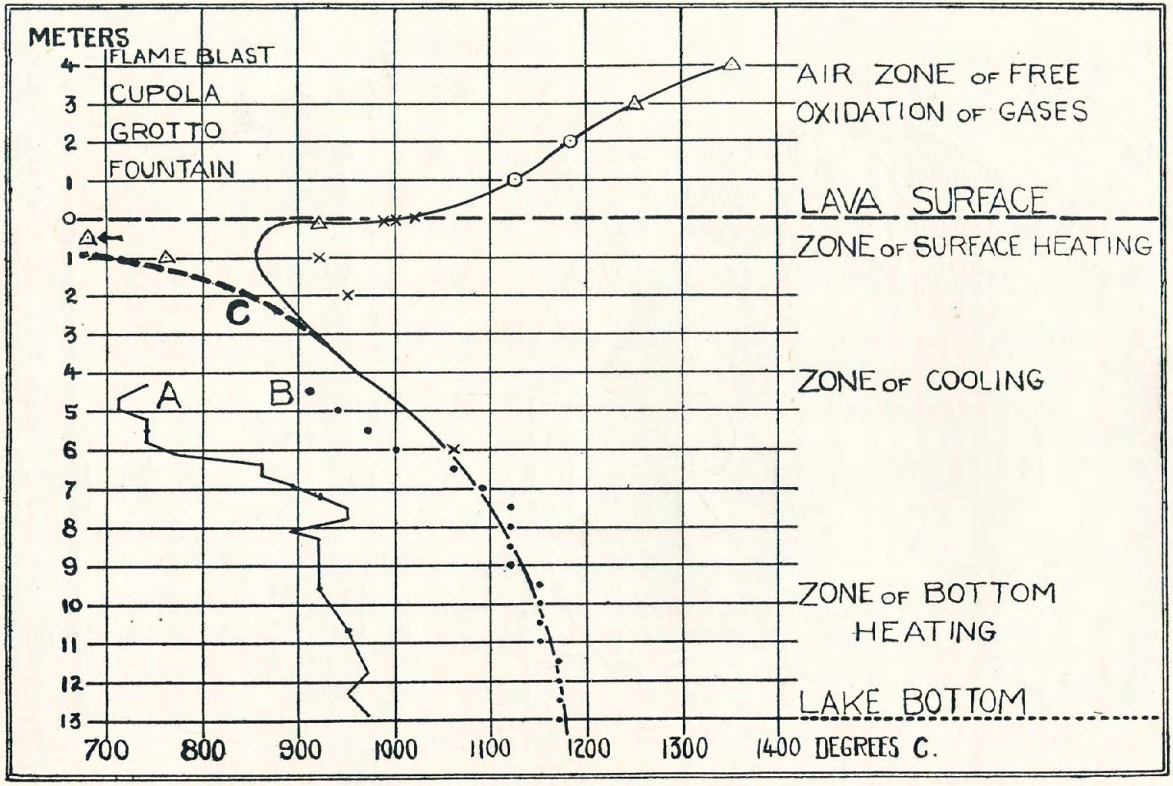


PLATE 2

Thermal gradient of Kilauea lava lake, temperatures measured with Seger cones, 1917, by T. A. Jaggar.

From Jour. Washn. Acad. Sci., July 19, 1917.

seen and studied eight different volcanic systems in eight different lands, but only as result of the six laboratory years at Kilauea have I begun to learn a little about fundamental causes.

Equipment and Output

The foregoing statement of actual discovery embodying the results of six years of progress is more formally set forth in published scientific papers. Such papers hitherto published are only a skimming of the richest surface cream which rises from the full record books now stored on the Observatory shelves. It has been my task to expend the very limited funds available for this work, so as to secure, during the first official five years of the Observatory which ended June 30, 1917, the largest possible accumulation of records, leaving the work of digesting them to the future. In view of this policy the showing made in actual experimental discovery, revealed by the contrast, not of theories, but of known facts between 1911 and 1917 gives high promise for the future.

The record books, maps, photographs, seismograms and geological collections at the Observatory, accumulated during the years, form to my thinking a vastly more valuable asset than any mere apparatus or buildings. Equipment in apparatus or buildings can always be improved or repaired with money. The equipment in records is wholly unique in preserving the sequence and dimensions of changing volcanic processes of two great volcanoes during a highly significant period. Were these records lost, they could not be duplicated even if a nation's ransom were offered as the price.

As to output, listed figures showing weekly and special reports, scientific papers, bulletins, photographs, and lantern slides were exhibited in last year's annual report. There are thousands of negatives and notes and instrumental tracings. The real output, however, of the establishment for which the subscribers of the Hawaiian Volcano Research Association are responsible, is the net effect on scientific progress of all these activities, on the community, and on the scientific and traveling world, and the example set urging others who live in volcanic lands to establish volcano observatories and so develop the science for its humane and technical ends.

Motives

The establishment has made records for six years. The Research Association has interested one hundred and fifty local people. The exchange list has reached two hundred other institutions and individuals. The work and the archives are growing in service and value, other institutions have increased their coöperation and interest and have expressed great concern at the mere mention of possible discontinuance. Discontinuance is not possible without forfeit, therefore is unthinkable. I have outlined above the scientific results of our work, but in now taking up the method of its continuance, it is necessary to analyze clearly our motives.

These motives are record, research, exhibition, publication; prevention of disaster; scientific hospitality, publicity, and propagandism. Truly a motley array of impulses, including commerce and education, foreign missions and the three-ring circus, with movie men to photograph the performers. And all to be carried by a modest wooden building on the edge of an active volcano, equipped with apparatus much of which is borrowed.

It is highly desirable to sift these aims down to their fine essentials, or to scrape off the parasitic growths and learn what is at the core of our problem. Research, publication and exhibition are matters of aftermath. Hospitality to visiting men of science and publicity are luxuries, not essentials. Prevention of disaster cannot be routine work, it is rather a goal to be striven for. There remain but two dominant, compelling and all inclusive motives for the work of the Hawaiian Volcano Observatory, these I insisted on in my first address of 1913, and these I reiterate even more strongly after showing results. The fundamental motive for an observatory is recording, and then improved recording and then more recording of a different kind. And following upon this is the propaganda of recording, extended to distant lands.

The future observatory in its scientific work will build a summit camp on Mauna Loa and make it accessible for prolonged visits. It will increase the precision and the frequency of the mappings of Halemaumau. It will collect the gases and take soundings and temperatures in many parts of the lava column. It will perfect telephotographic methods, apply the spectroscope to volcanic flames, improve scientific methods of taking moving pictures of the lava, establish voluntary earthquake stations around Mauna Loa and determine for a protracted period the daily tides in the lava lakes.

These things are all matters of recording, and improved recording means new facts. The grouping of new facts, as I have shown above, is the whole of science. These records thus improving, will always be our supreme achievements won through privilege of our possession, in Halemaumau, of the most marvelous natural geonomical laboratory on the globe. It is for you who dwell in Hawaii to say whether, with your wealth and your brains, you will build and extend this work as your own creation or whether you will yield it up to others.

Scope

Just a word in this place about expansion of the work to include studies of other geological processes. There is much to be said for Hawaii as an ideal center for geophysical measurement in the field of erosion processes on the land and deep sea processes off shore. Nearly twenty years ago I presented to the Carnegie Institution a plan for a geophysical institute in Hawaii. Still earlier there was printed in the annual report of the Director of the United States Geological Survey an estimate which I drew up for a topographic and geologic survey of this territory.

But all of this, interesting as it may be, is not the work of the Hawaiian Volcano Research Association as expressed in its constitution. Our proper work, namely **permanency** of volcanic recording and **extension** of volcano recording, is nowhere near accomplished. The first means an endowment here. The second means propagandist work in California, South America, New Zealand and Java, the Philippines, Japan and Alaska. Both of these, permanency and propagation, are absolutely essential to the determination of a volcano science, a science which by itself is of vastly too large a scope for any one man or group of men, to say nothing of the money required.

I can best illustrate this point by referring to such a laboratory as the Mt. Wilson Solar Observatory of the Carnegie Institute at Pasadena. That establishment has perhaps twenty times the income and twenty times the staff of our observatory, but it is devoted wholly to the study of the physics of the sun. I asked the Director, Dr. Hale, if he could send me a spectroscopist to study Kilauea flames, a subject certainly of interest to astronomy. His reply was that he could not afford to go outside of their proper field, namely the sun. The only distinguishing feature about Mt. Wilson for solar study is that the air is clear. In our case the distinguishing feature of the Island of Hawaii is that the two greatest and most active volcanoes on the globe are there and only there. Shall we then dissipate our energies and our money in that unique field after a start which has been concentrated and encouraging?

The Volcano Observatory Propaganda

With substantial scientific discoveries started, and invaluable record books accumulating; with bulletins, reports and articles accredited to Hawaii going into the libraries of the world; with travellers and scientists asking for photographs and asking to visit our plant; with Japan extending its volcano work; in view of all this progress, how can the Research Association join "hands around the Pacific" to get new work started in such colonies as British New Zealand or in Java?

Remembering the terrific disasters by scalding, drowning, suffocation and earthquake which these lands have suffered, conjured up in the mere names Krakatoa and Tarawera; disasters which are bound to decrease in terror with increase in knowledge, as we learn methods of prediction, of safeguard and of rescue; there should be strong appeal to the imagination of all members of

this Association in the vision of new observatories in new places.

Besides the humane motive there is the scientific query, what are these distant volcanoes doing at the same time, while Kilauea lava is rising and falling? If there are summer and winter risings at Kilauea, are there summer and winter risings in New Zealand? The answer, yes or no, is a new discovery in science, yet to be made.

What use is there in knowing, do you ask? Answer, in order to discover how to predict, to determine the thickness of the earth crust, to connect volcanoes and earthquakes, to find out why the New Zealand eruptions are different from ours, and ours in turn different. In short, to solve the volcano mystery which underlies all the dwelling places of men.

But more than all these things there is the certainty of the supreme satisfaction of realizing that right here in Hawaii, on these little islands favored by possessing sugar as commercial asset and volcanoes as scientific asset, we will have built the famous center of a new science, and will hold the reins of a new chariot of enlightenment wherewith to do our bit in carrying wisdom to the remote and stricken peoples of earthquake lands.

At the moment the disaster cry is drowned by the sobbing of a war-saddened world. But the war shock has awakened our new world consciousness, and we remote from war may well give our utmost to make the rest of the world less terrible. Nature's ruthlessness has only lately stricken Salvador. The frightful disasters of Messina and San Francisco are recent memories, lives lost by scores of thousands, and property by the thousand million in money. The Whitney endowment which first sent me to Hawaii required investigations "conducted with a view to the protection of human life and property."

If the dignity of missions, to link the world in loving kindness, was worth the devotion of Ellis, Bishop, Bingham and Coan, then is the protection of life, through science, a worthy service for their successors. It is peculiarly appropriate that they should force the pagan fire goddess to give up her secrets in alleviation of distress.

The Opportunity for Hawaii

It has been asked why little Hawaii should do this? Why not some eastern endowment of millionaire origin? Answer, the eastern institutions will be only too anxious and ready to take this opportunity away from Hawaii and to build up their fame on what Hawaii rejects. The implication would be that Hawaii is not interested in her volcanoes, takes no pride in their possession, or in having started a unique scientific institution designed for the welfare of mankind, and is glad to be relieved of the financial burden of its maintenance.

Of some hot, stagnant and slipshod tropical colonies which I have visited this imputation might be true, but not of Hawaii. The volcanoes of Hawaii, which have deposited her sugar soils, are as much the property of this energetic people as the older hills which store the waters of irrigation, or the indentations of the shoreline that harbor our ships. For an educated folk possessing these things, as well say, "Why doesn't some eastern institution build our wharves and our ditches?" The issue is not ownership or responsibility. The question at stake is simply, "Will you face the responsibility of that ownership as the privilege of a wealthy and highly cultivated community, knowing that these volcanoes are famous and unique, and knowing that they may give Hawaii a world fame as a scientific center controlling subordinate stations all around the Pacific Ocean? Or will you shift the responsibility because there is little financial return?"

Is the Future Observatory to be Hawaiian?

The volcano laboratories at Kilauea have been made use of thanklessly as a convenience in the past by travellers from distant institutions. The **Hawaiian** Volcano Observatory has reached the parting of the ways. The question is squarely before Honolulu and the Territory whether you wish the present establishment to be Hawaiian and to continue to grow and deal solely with

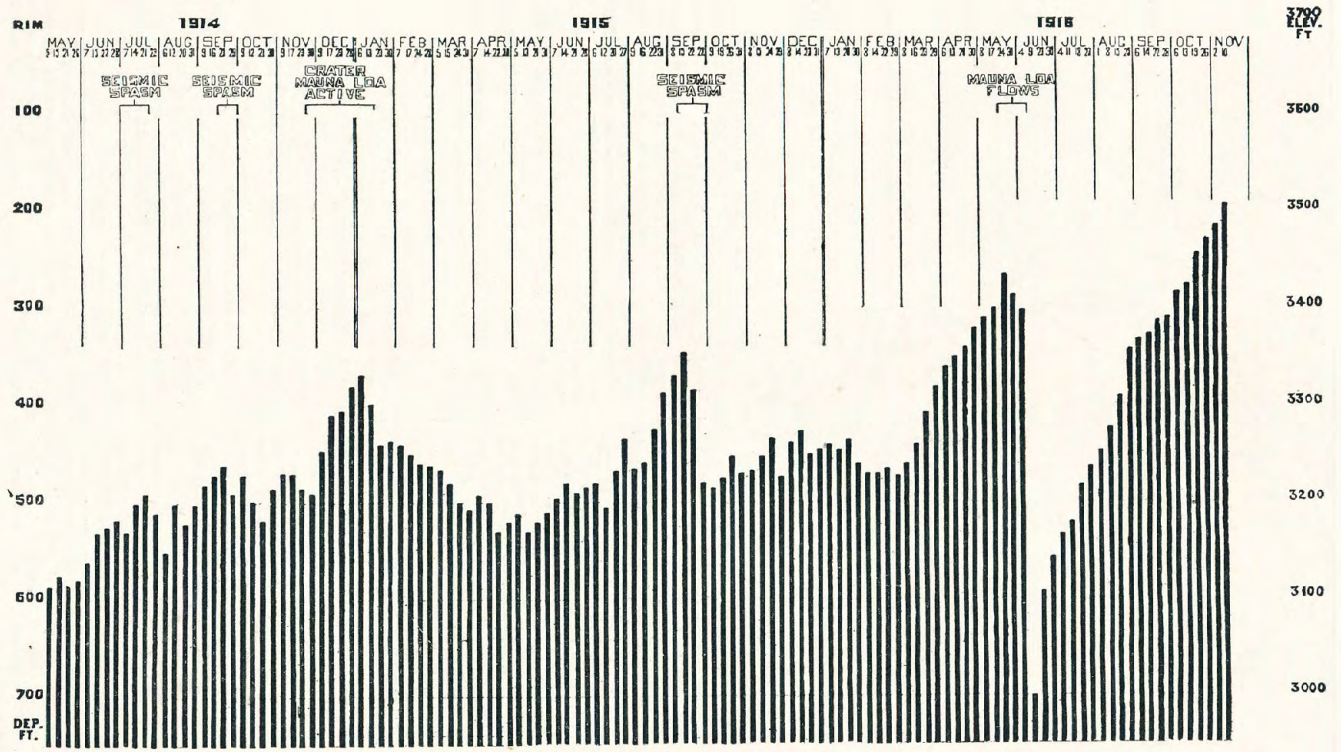


PLATE 3

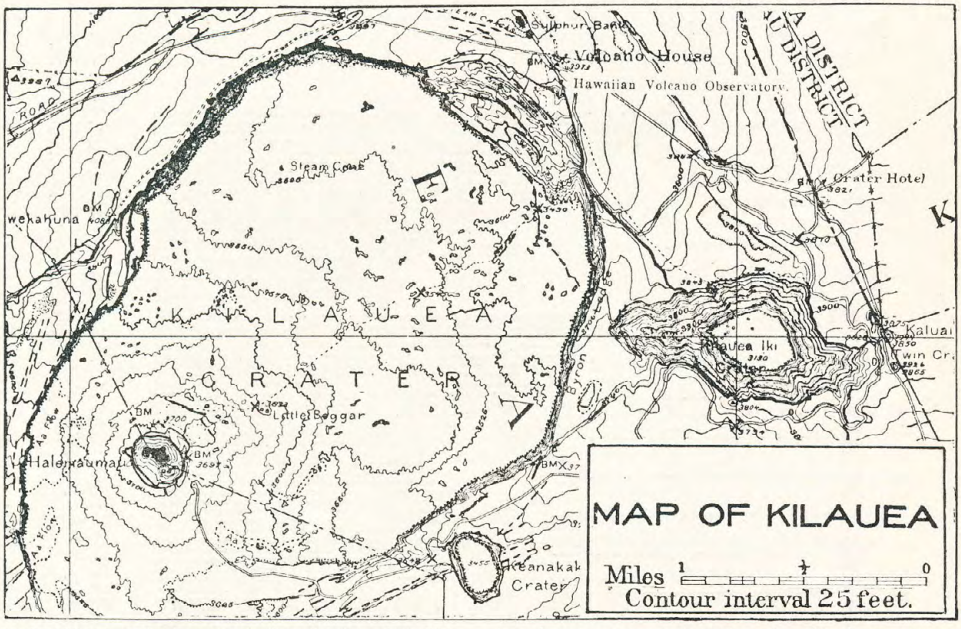
Diagram showing fluctuation of level of lava in Halemaumau, in relation to seismic and volcanic activities of Mauna Loa, 1914-1916. Measurements from 120 weekly surveys by T. A. Jaggar shown.

Reprinted from Am. Jour. Sci., April, 1917.

volcano research. There is no other question before this Association.

The three stated purposes of our society are to record volcanic activity, to attract scientific men and to promote volcano observatories. We have no other aims and the Observatory has no other aims. Therefore this Association is and necessarily must be opposed to giving precedence at the Observatory to any studies not volcanological. We should heartily welcome in this field an expert student of the moon with his telescope, for the lunar volcanoes teach us much concerning our own volcanoes. But we would surely not attempt to finance him. In the same spirit of hearty hospitality we would welcome a student of the deep sea bottom. But we could not afford to charter his ship. It must not be imagined that volcano research is geology. The idea of perpetual record at observatories is hardly mentioned in the geological text books. The work of our Observatory is variously physics, chemistry, surveying and meteorology unitedly concentrated on two volcanic vents. We have no aim except to study those vents and all their ramifications. The ocean may affect them, the sun and moon may affect them, but we are not specializing on ocean, sun or moon. We are specializing on volcanoes and volcanoes only, and all work must be directed to that end.

The executive Board of our Association has earnestly supported the Director of the Observatory in determining that the work shall be continued and shall deal with volcano research. It remains for this honorable society and this community, through loyalty to the Islands and pride in their fame, to decide on what scale the work shall endure, and whether the Kilauea laboratory shall be permanently **Hawaiian.**



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by the Massachusetts Institute of Technology.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. Publications to date have been weekly reports since the summer of 1911, now reprinted in Honolulu in monthly form. The Massachusetts Institute of Technology will publish annual reports, of which the introductory number was printed in 1912.

The weekly bulletin as it appears in the Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and R. W. Shingle is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol a, or max. a, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, AUGUST-SEPTEMBER, 1917. No. 9

Editorial Note.

The October monthly report will contain full details of the proceedings of the annual meeting of the members of the Association, together with the reports of the President and Treasurer. The necessity for printing the August and September issues together has precluded publication of the financial reports until next issue.

L. W. DE VIS-NORTON,
Editor.

Volcano House, Aug. 11, 1917.

The net movement of the lava column during the week ending Aug. 10, 1917, has been by measurement in the nature of subsidence at the rate of about one foot per day. The total of eight feet difference, however, is insignificant and well within the daily range.

At 10 a. m. Saturday, Aug. 4, measurement made the depression of the lake 114 feet, of the S. crag 50 feet and of the summit of the central crag 35 feet below the S. E. station on the rim of the pit.

The lake was five feet lower than on the previous day, streaming was from the N. arm to the S. E. pool and the S. W. pool was crusted over except for a fountain in the tunnel at its inner end. There was an overflow floor in the central chasm and no visible tunnel below, and lines of vertical scraping appeared at the N. E. base of the central spine. The S. E. dome had entirely collapsed and there was only slight evidence of the S. E. tunnel. On making the circuit of Halemaumau the writer observed no marked changes N. W. and W. The peninsula extending W. from the central crag into the S. W. cove had been elevated and there was an inner overflow floor at the E. end of the S. W. cove. The sulphur stain had increased on the tumbled rocks surrounding the N. W. cone.

On the afternoon and evening of this day, with bright sunlight over Mauna Loa, whitish fume was very conspicuous above Mokuaweoweo rising in still air, while below at Kilauea the N. E. trade was blowing. This frequently happens in August owing to the combination of clear afternoon air and the seasonal declination of the sun, which brings it over the summit region.

On Aug. 6, at 3 p. m., there had been slight overflow of the inner beach at the E. cove and the lake was now about one foot below it. In the grotto under the S. bench there was much activity and also at the S. E. where there was swift inflow. There was occasional strong activity under the S. E. shelf. The S. W. cove grotto appeared quiet and most of the lake was crusted and inactive. There was occasionally quite loud puffing from the N. W. cone.

On Aug. 7 at noon the fumes appeared thinner and grotto activity was slight. The N. end of the E. island mass appeared to have recently slumped. Occasionally there was swift inflow under the floor S. E.

On Aug. 8, at 2:30 p. m., the inner bench stood 10 feet above the lake, the central crags appeared higher than ever and the central chasm had widened by collapse of its walls. The channel leading to the S. E. pool had apparently narrowed. The S. W. and N. W. coves were crusted over and streaming was outward from them to grottoes N. E. and S. E. A very large spatter dome had built over the grotto on the S. E. opposite the crevasse leading toward the S. station from the E. side of the S. E. cove and here there was a perpetual fountain within the dome with flames playing above and hot blue fume

WEEKLY BULLETIN
of the
Hawaiian Volcano Observatory

Published Monthly at Honolulu, Hawaii, by the Hawaiian Volcano Research Association

L. W. de Vis-Norton.....Secretary

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of sulphurous acid rising rapidly in puffs. These fume puffs were conspicuous even at a distance. There was another high cavern grotto at the Old Faithful locality on the W. side of the E. island mass and the Old Faithful rhythmic fountaining had ceased action in the central region. The recent collapse of the E. island mass appeared to have invaded the Old Faithful sinkhole region. Slight puffing was heard toward the N. and from the N. W. cone where bright yellow sulphur was increasingly conspicuous. There was marked growth of the new inner floor at the central chasm and the E. cove. Fume was abundant, especially toward the north. No marked changes of elevation were discernible in the northwestern crags and the profiles of the old crag mass and of the E. island mass had now become singularly ragged like irregular saw teeth.

On Aug. 9, at 6 p. m., the inner bench was about eight feet above the lake at the E. island and central chasm. The raised bench at the E. cove was 20 feet high. The S. E. grotto dome was 15 feet high. As seen from the E. cove the central crag appeared an immense group of high turrets with a towering spine rising 40 feet above the lake on the eastern side of the mass. The E. face of the upper part of this spine showed vertical laminations, due probably to a former plastering of foundered crusts against the submerged N. wall of the central cavern during the spring of 1917 before the present uplift had taken place.

There were southeastward streaming, blistered thin crusts and migratory fountains. There was a flaming grotto under the S. bench. The spectacle presented by the great S. E. dome grotto as seen from the E. cove was magnificent, the continuous fountain inside the dome plashing and rumbling and building luminous stalactites which would occasionally become overweighted and bring about the collapse of huge shells of the roof into the fiery flood beneath. Occasional fountains would spatter over the surface of the E. bench. Streaming was outward from the S. W. and N. arms of the lake. The N. W. cove was crusted over and heavy crusts cracked and foundered occasionally in the middle of the N. arm, developing much bubble fountaining, while active grottoes splashed and rumbled under the E. and N. banks. The surface of the E. island and the old N. W. crag mass appeared to consist of tumbled swarms of small crags. A high ridge of broken blocks extended southward from the N. E. peak to a sagged area of the N. E. floor whence the surface sloped upward, both eastward to the cliff overhanging the E. cove and northward to the edge of the tumbled N. pit.

Measurements on Friday, Aug. 10, 1917, after 11 a. m., made the depression of the lake 117 feet beneath the S. E. station. At 11 a. m. the lake appeared low, the inner bench 12 feet high, streaming was rapid, and the fumes appeared thinner so as to make the W. side of the pit quite visible from the E. and S. E. The S. E. dome was moderately active and there were bubble fountains at the E. cove. There was a low glowing cavern under an arch of floor at the central chasm. By noon this cavern was submerged and the rising lake was quiet and crusted, with fountains at only the N. E. and S. E. grottoes.

Volcano House, Aug. 18, 1917.

During the week ending August 17, 1917, the lava lake has maintained a downward tendency similar to that of the previous week, crags and lake both subsiding. At the end of the week the lake depression was about 125 feet.

On Saturday, August 11, at 2:15 p. m., there were travelling fountains in the southeast channel and both south and southeast grottoes were active. At

3 p. m. the inner cliff was about 15 feet high in both north and southeast arms and a fall of rock from the central crag into the channel started much effervescence of bubbling fountains. There were large fountains in the north arm and the fumes on this day appeared thinner.

On August 13, at 2:45 p. m., the lake was low and the usual grottoes active; streaming was swift with central fountaining in the southeast channel. At 3:50 p. m., a large block of the spatter margin fell from the northwest point of the central crag mass and started fountaining activity in the west central region. At 4:30 p. m. there was a rock slide under the east station.

At 12:30 p. m. Tuesday, August 14, there was little change in the general appearance of the pit. The lake was about five feet below the inner bench at the east cove. It appeared relatively high and rising, with thin fumes. There was no appearance of fresh overflowing anywhere. The southeast dome was high and stained yellow with sulphur; inside was an active grotto, and from the great crevasse in the shelf above brown dusty fume arose. Streaming in the lake was towards the southeast from both the southwest and northwest arms. The peninsula in the southwest cove was unchanged. Seen from the northeast, the east island mass now appeared relatively low compared with the central crag mass.

On August 15, at 1:15 p. m., the lake was slowly rising with grotto activity south and southeast. At 2 p. m. the east cove was being bombarded and there was much fountaining in the southeast arm. At 2:15 p. m., from the west, the north cove was fountaining, but the cove under the east island was quiet. At 2:30 p. m. looking from the southwest, two large cones were seen to have been built southwest and west of the east island mass, enclosing active grottoes. This region has lately been concealed by smoke from the north bench.

On August 16, at 1:30 p. m., the lake was lower and very quiet with almost no fountaining even at the grottoes. Fumes, however, showed no increase. At 2:20 p. m. it was evident that the lake had risen about three feet and the only activity was at the grotto under the south bench. At 2:25 p. m. and again five minutes later rock falls from the spatter margin of the lake fell from the central crag mass into the channel and into the central region.

On Friday, August 17, 1917, at 1:30 p. m., the west banks were about 15 feet high, fumes appeared thicker, especially toward the north and the lake was quiet. At 1:45 p. m. looking from the northeast the only fountaining activity discernible was in the south and southeast grottoes and the streaming as usual was in their direction and comparatively slow.

The following reports from the Whitney Laboratory of Seismology are submitted by Mr. H. O. Wood:

During the week interval ending with August 10 four small local earthquakes have been registered. None were felt. Microseismic motion has been as usual. Volcanic vibration has been stronger than usual, and more sustained in the stronger spasms, even in reference to the recent weeks. Abrupt pen-shifts were produced by two of the earthquakes, otherwise pen-shifts in the sense of tilt have shown no noteworthy characteristics.

During the week interval ending with August 17 two small local earthquakes have been registered. The seismographic amplitudes of microseismic motion have varied within ordinary ranges. Volcanic vibration has been strong and spasmodic. Pen-shift in the sense of tilt was not particularly noticeable in the early part of the interval, but toward its close there has been marked eastward shifting.

Volcano House Aug. 25, 1917.

During the week ending August 24, 1917, the lava column of Halemaumau continued to subside slowly until about August 22. After that date there was rising and on August 24 there was overflow on the northwest side of the lake. There has been much falling in of lake margins during the week and at least one avalanche from the high wall of Halemaumau under the east station. Visitors are warned to give heed to the danger signs at this time.

On Saturday, August 18, 1917, at 11

a. m., the lake and crags in general appeared lower. The east island mass had so far subsided and crumbled that the north arm of the lake was clearly visible above it as seen from the southeast. The innermost spatter rim was five feet high, the west bank eight to ten feet high and the bench at the southeast cove ten to twelve feet high. There was a heavy curtain across the entrance to the southeast dome, the grotto under the south bench was active and there was vigorous fountaining along the west shore. Streaming had reversed at the west so that it was now pouring from the north arm swiftly into the southwest pool. The flow into the southeast cove was slower. There were six to eight fountains in all. Crusts were of medium thickness and the only noise was of plashing. In general the lake appeared stagnant with very slow sinking in progress. Smoking places were the southeast cove, central crag, south crag, southwest peninsula, west cone, west talus, north talus, east base of crag mass; the heaviest smoke of all was from the north bench and next in density was the fumarole at the edge of the northwest table.

There was at the northern base of the steeple crag in the center of the pit, at the top of the spatter bench, a glowing and fuming sulphurous crack which appeared to portend a coming fall of rock. The pit under the north station had increased in size and depth, and in plan was extended into a crevasse eastward. The old crag mass appeared a little lower with a strong northward slope exhibited in the recent bench levels on the lake side. From its southern base the lake shore bench rose toward the south from a level five feet above the lake to a level fifteen feet above the lake at the southwest side of the southwest cove. On the north side of the peninsula extending into the southwest cove four terraced levels appeared.

On August 19, at 2:30 p. m., the lake appeared still lower with its west bank about 15 feet high, there was much fountaining in the north arm and an active grotto was splashing at the base of the northwest crag mass. At 2:45 p. m. there were heavy falls of rock into the lake from the south and southeast benches and later there was crumbling of the margins of the lake, in the region of the east island mass.

On August 20, at 2 p. m., crumbling of the banks was still in progress and a large block fell from the northwest crag mass into the lake. After all these falls fountains boil up where the fragments sink beneath the lake. There were fountains on this day in the west central part of the lake, and in the channel leading southeast, and the south and southeast grottoes were active. There were blowing noises from the northwest cone. The fumes were thick. At 2:20 p. m. there was a prolonged avalanche on the northwest and about this time many small slides were heard from the north inner cliff. At 2:40 p. m. rising was in progress and there was noisy spurting of lava under high gas pressure from grottoes N. E. and E.

At 2 p. m., August 21, 1917, the smoke N. W. was thick and the main lake was quiet. The southeast pool showed several fountains and the usual activity in the southeast and south grottoes. There was much smoke from the south floor. At 2:45 p. m. the view from the southeast station showed great activity in the southeast cove and the northeast grotto. In the evening at 6:30 p. m. a large fragment fell from the north side of the central crag mass into the channel so that violent effervescence ensued.

On August 22, at 2 p. m., the whole lake was quiet with only slight activity at the south and southeast grottoes. At 3:20 p. m. the roof of the southeast dome grotto collapsed. A few seconds later there was a prolonged tumble of rocks from the southeast shelf followed by intense effervescence in the lake beneath.

On August 23, at 2 p. m., conditions were much the same with no fountaining except at the southern grottoes. At 2:10 p. m. a heavy avalanche fell from the upper wall under the east station and some large boulders were carried down to the floor beneath. The east island bench appeared about 10 feet above the lake which seemed to be rising.

On Friday, August 24, at 2:20 p. m., it was evident that a strong rise had taken place. The lake was level with

the west bench, the northwest floor was flooded with fresh lava and there were many fountains in the north arm. Fumes were still thick toward the north. The northeast, south and southeast grottoes were spurting actively. At 3:10 p. m. a fall of rock took place from the northwest table crag and started many fountains in the northwest arm, the lake having sunk about five feet within the hour.

Volcano House, Sept. 1, 1917.

During the week ending August 31, 1917, the lava in Halemaumau pit has slowly risen without any pronounced changes. The building of spatter domes over border grottoes has been resumed and very small overflows of border benches have taken place. Fumes have diminished.

On Saturday, August 25, 1917, at 2 p. m., there was no marked change in the level of the liquid lava, the only activity was in the southeast pool and the fumes were thinner. At 2:15 p. m. streaming was rapid through the central channel southeastward, there was strong fountaining in the southern grottoes, but conditions were quiet northeast.

On August 26 at 1:15 p. m. conditions were unchanged. At 1:40 p. m. there was a fall of rock from the east island mass into the channel, followed soon after by another tumble from the central crag mass. In the course of ten minutes the lava subsided ten feet and remained so for about half an hour. Then rapid rising took place until at 4:15 p. m., there was slight overflow of the inner bench at the east cove.

On August 27, at 2 p. m., the north arm of the lake was depressed five feet below its banks, there were few fountains, fumes were thinner and there had been rock falls from the northwest face of the east island mass and from the north side of the central crag mass. Hissing from the northwest cone could be heard. At 11:30 p. m. glow could be seen at the northwest cone. There was a big flaming chimney 25 feet above the lake in the central steeple crag, and a second smaller one 15 feet above the lake on the east side of the steeple. The fissure feeding these chimneys was a crack back of the spatter veneer. From 11:30 p. m. to 2 a. m., August 28, this chimney flared continuously while a border fountain just below bombarded the lake shore on the north side of the base of the steeple. When the fountain ceased, however, the chimney flame died out and the chimney became a dull red. Repeatedly it appeared that when the fountain began the flaming was renewed and the interior of the chimney gradually acquired a yellow glow. The flame was dependent on a local fountain 25 feet below the orifice indicating clearly that the fountain set up gas combustion with an inrushing air draft as at the base of a furnace. During the night there was occasional general cracking and foundering of the crusts on the central and northern parts of the lake. The southwest arm was mostly quiet and crusted. Streaming was to the north and to the southeast. There were fountains east, southeast, south, west and northeast. The south grotto was hung with stalactites. There was occasional bright fountaining in the north corner of the lake. Fluctuations of height were very slight during the night.

Measurements on Tuesday, August 28, 1917, at 4:15 p. m., determined the depression of the lake to be 111 feet and the height of the central crag mass above the lake 74 feet.

Conditions were little changed. There were four or five fountains making blowing and plashing noises. The southern grottoes were hung with stalactites. The crusts made cracking and crunching noises. Hot bluish fume rote from the central chimneys. Streaming was outward from the southwest and north arms and carried blistered skins rather rapidly through the channel southeastward. Hot fumes arose from the east grotto. A current streamed from the northwest arm to the north bank of the lake.

On August 29 at 11 a. m. the lake was higher and rising, the liquid brimming level with the rampart of the west bench. Streaming was radial outward from the center of the lake to the north, to the southwest and to the southeast. There was central fountaining, and other fountains played southeast, south, east, in the southwest cove, against the north bank and on the north side of the

east island mass. A new splash dome was being built in the southeast cove. The inner bench at the central chasm was about two feet above the lake. The central chimneys continued active. Smoke in general had diminished.

From 5 to 7 p. m. on August 30, conditions were still those of a rising lake, with streaming outward from the northwest arm to the north, to the southeast and to the southwest. There was steady hissing at the northwest cone and a new sulphur cone had formed on the bank at the east cove. The lava puffed and pounded in a grotto on the west side of the east island mass.

Examination of the southwest arm from the west showed that this arm had been widening and extending itself eastward in the directions of the south valley and the central chasm. At its extreme south corner there was a small glowing chimney 10 feet above the lake with a grotto beneath leading to the south valley tunnel. The great central crag mass, seen from the west, was a very impressive object, composed of towering peaks 70 feet high at its eastern end, flattening out to a long deck or plateau at its western end some 30 feet above the lake. This great block had parted from the south floor body at the central chasm and was now in process of rising bodily in the center of the pit. The northwest cone was a sulphurous driblet heap with a glowing crack in its summit.

A change which has gradually been taking place lately back of the edge of Halemaumau southwest is the development of a solfataric patch some 75 feet in diameter with increased heat at the cracks and deposits of bright yellow sulphur mixed with alum. There is also the odor of sulphur vapor both at this patch and the great southwest crevasse. These places lie east and west of the southwest station.

A notable feature of the bench magma in the pit at this time is the continuous valley encircling the uplifted central area. Heavy banks of Pele's hair have accumulated on the southeast shelf and on the edge of the pit above.

After dark on this day an elongate flame crack was seen above the south grotto and other flames at the central chimneys. There was strong fountaining against the north bank of the lake. Streaming was very sluggish.

On Friday, August 31, at 10 a. m., the lake was high, spatter grottoes were building, there was hissing at the inner end of the southwest cove as well as at the northwest cone, fumes were thin, the southwest cove was stagnant, streaming was to the southeast, and there were the usual chimneys and grotface of the central crag mass indicated toes. Small falls of rock from the north that that block was in motion.

For the week ending at 10 a. m. August 31, 1917, one moderate local earthquake was registered by the seismographs of the Whitney Laboratory. This happened on the afternoon of August 24. Microseisms and volcanic vibrations have both been moderate to slight in amplitude. Seismographic registration of tilt has indicated an almost stationary condition with the pens in a middle position. What movement there was toward the end of the period indicated a very slight change of tilt westward and southward.

Volcano House, Sept. 8, 1917.

During the week ending Sept. 7, 1917, the lava lake has continued to rise slowly at a rate averaging about a foot a day.

On Saturday, Sept. 1, 1917, at 1:45 p. m., the lake appeared to be rising slowly and there was strong activity in the south grotto and on the east side of the old northwest crag mass. The north arm was quiet and much concealed by smoke. There was the usual activity in the southeast grotto.

On Sept. 2 at 2:15 p. m. there was much fountaining in the north arm and west grotto. At 2:30 p. m. the southeast grotto seen from the southeast station, and also the south grotto, showed fountains and the streaming to the southeast was fairly rapid. At 3 p. m. some fifteen fountains were in action mostly in the northern and southeastern arms. A cone was forming on the new lava of the east cove overflows and spurts of fire appeared through the cracks in the summit of this dome. The dome was covered with yellow sulphur stain. From 5 to 7 p. m. the lake was clearly rising and this eastern glow cone

was puffing strongly and flaming. It evidently surmounted a fountaining cavern, the presence of which was revealed by inrush and fountaining at the adjacent lake shore. The fumes were thinner on this day. There was dull glow in the central chimney and a very bright chimney surmounted the south grotto.

On Sept. 3 from 2 to 4 p. m. conditions were much the same with the lake surface about four feet below the fresh overflow of the east cove. The grottoes were mostly curtained. The east cone exhibited no gas pressure and its cracks glowed dark red. Close examination revealed smooth stalactites within these cracks and brownish spatter driblets around the orifices. Fumes on this day were moderate.

On Sept. 5 at 2 p. m. the lake was lower with considerable activity in the north arm and the west, south and southeast grottoes. The lake was subsiding and at 2:50 p. m. there was a heavy fall from the south bench at the entrance to the southeast cove. A few minutes later another block fell from the central crag mass. In both cases the debris fell into the lake and produced bubble fountaining.

On Sept. 6 at 2 p. m. the lake was nearly brimming level with the inner benches and very quiet. It was evident that there had been fresh flooding of the bench at the east cove where there was active bombardment, as also at the southeast. At 3 p. m. the lake level was within a foot of overflowing on the northwest, west and east, and these were the three principal localities of fresh overflow. Seven to eight fountains were in action and the streaming was outward from the southwest and northwest coves toward the southeast and north. The fumes were thin. The highest central crag appeared distinctly higher than the steeple crag next it on the east. There were fresh overflows on the floor of the central chasm. The central chimney was dark but the one over the south grotto was very bright. The eastern sulphurous cone of Sept. 2 was now buried under fresh flows. Spatter heaps at the lake border had been built under the old crag mass and at the south southeast and east.

Measurements at 3:15 p. m. on Friday, Sept. 7, 1917, made the lake depression 104 feet and the central crag rose 74 feet above the lake while the old crag mass was now only 38 feet above the lake.

There were four to five fountains and the streaming was outward from the northwest and southwest towards the north and southeast. The central crag appeared higher. The overflow bench appeared about three feet above the lake. The south and southeast grottoes were heavily curtained. There were fresh half-domes of spatter at the central chasm and east cove. There was fountaining northeast, north, south, southeast and west. The chimneys were fuming, but not glowing by daylight. Streaming was rapid in the southeast channel. The crusts were thin and blistered and the radiation from the lake surface was hot at the southeast station. There was occasional fountaining at the east cove. The old crag mass, the northwest table and the east island crags appeared unchanged and no fresh overflows were discernible.

On the seismographs of the Whitney Laboratory during the week ending 10 a. m. Sept. 7 only one very slight local earthquake was registered. This occurred in the early morning of Sept. 6. The microseismic and volcanic vibrations have been of small amplitude. The seismographic registration of tilt has indicated increasing inclination of the piers towards the north and west. On Sept. 6 the north-south component of the Bosch Omori pair of pendulums was restarted after several months during which the instrument has not been in operation.

Volcano House, Sept. 14, 1917.

During the week ending Sept. 14, 1917, the lava lake of Halemaumau has been essentially stationary. At the end of the week there was a slight rise and overflow of the east bench.

On Sept. 8 at 2:15 p. m. the lake appeared rising rapidly with the inner bench about 6 feet high. There was vigorous fountaining south and southeast and great activity under the new spatter dome at the eastern entrance to the central chasm. There was high spraying under the overhanging shelf southeast. The fumes were fairly thick.

On Sept. 9 at 1 p. m. the fume was thinner and there was much activity in the north arm. The inner bench stood five feet above the lake but from 5 to 7 p. m. the lake was lower with inner bench 8 to 10 feet high. There were the usual grottoes in action and occasional central fountains. There was glow in the south and central chimneys; the latter, however, greatly diminished. Occasionally the crust broke up and increased fountaining occurred. There was a spatter grotto at the east end of the southeast arm and also at the east cove.

On Monday, Sept. 10, a new east-west crack had developed extending from the south side of the east island crag across the floor of the east cove. The lake was 8 feet below the inner bench, six or seven fountains were in action, streaming was to the north, to the southeast and to the southwest, there were two active grottoes in the southeast cove, one under the south bench, one under the old crag mass, one at the east and one northwest. There were others in the north and southwest arms. The smoke and streaming were moderate and there was much spatter building. The orifice of the central chimney was sulphur stained. The central crag now appeared higher than the level of the May shelf. The east island mass was developing a wall which faced northeastward towards the chasm which separated the crags from the northeast floor. The wall on the west side of the southeast cove had broken in and a large yellow sulphur patch appeared on the floor above. It was evident that the central masses were still rising for the banks at the east and southeast coves were only three feet above the lake, whereas they rose much higher in th region of the central channel.

At 3:15 p. m. on Tuesday, ept. 11, 1917, there was no change. The central region was quiet, the fume moderate, streaming was to the southeast and four grottoes in action were visible from the northeast rim. A clear view of the old northwest crag mass showed that it had developed two benches on its east side inclined stepwise to the north about 30°, while between them was a fresh terrace or spatter bench about 10 feet above the lake which sloped very slightly north.

On Sept. 12, at 3 p. m., eight or ten fountains were in action, fumes were thick and the lake was low. About 5:50 p. m. there were two avalanches from the east island crags and ten minutes later there was a large fall from the south bench at the point marking the entrance to the southeast cove.

On Sept. 13, at 2:30 p. m., the inner bench was 10 feet high and there were fountains in the usual grottoes except the one under the south bench which was quiet. At 3:10 p. m. the crust broke up in the southeast arm and there was cracking and foundering with many fountains.

On Sept. 14 at 3:30 p. m. there was evidence of a strong rise. The lake was very high, brimming level with the floor at the southeast cove and there was a fresh overflow at the east cove. At the west shore underneath the old crag mass a high cone had been built with a glowing chimney in its summit. The northeast chasm extending from the east cove to the north arm had widened and the rise of the lake now brought the north cove into view as seen from the southeast station. The old crag mass appeared lower as though there had been recent overflows northwest and west. At 3:40 p. m. there was a crust across the central channel, but cracking and foundering were going on in the central region and to the north. The southeast grotto was quiet and the southeast cove crusted. About 4:30 p. m. this crust broke up and there was heavy bombardment at the east end of the lake. Grottoes south, east, west, northwest and northeast were splashing and puffing and there was also fountaining against the south bank of the southwest arm where the streaming was eastward. A tumble of fresh broken masses under the middle part of the central crag mass on the south shore of the channel made a new shore point there. The northwest cove had changed its shape from a deep inlet to a shallow cove as though the bank had built out. A hot chimney was in action over the south grotto and streaming moved in a wide zone covered with festooned crust southeastward from the channel.

The seismographs of the Whitney

Laboratory have registered only one feeble local earthquake during the week ending 10 a. m., Friday, Sept. 14. Microseismic motion and volcanic vibrations have been slight. Tilting has been increasingly strong to the west and was moderately so to the north until Sept. 13, when this northward tilt suddenly decreased with great rapidity in the course of a day. Simultaneously there was a sudden change of weather with a shift of the wind from fresh northeast trade wind to calms and light southeast breezes.

Volcano House, Sept. 22, 1917.

During the week ending Sept. 21, 1917, the Halemaumau lava column has risen slightly, building pronounced spatter ramparts on the shores of the several coves and slightly overflowing the banks in those coves. The central crags have risen along with the lake.

The past three months have maintained extraordinarily uniform conditions in the Halemaumau pit. The lake has kept its level about 100 feet below the rim of the pit, and its form has changed but little. In plan it consists of three radial arms each about 400 feet long measured from the center, and each tending to bend so as to end in a hooked cove. The northern arm bends to the westward, ending in the northwest cove. The southeastern arm bends to the south and west and ends in the south east cove. The southwestern arm hooks to the eastward at its inner end. These two southern arms bend toward each other and there is strong evidence that they are connected through the central chasm and southern valley by subterranean tunnels in the bench lava. The most conspicuous object in the pit is the great central crag mass which has slowly risen during the summer until it stands 76 feet above the lake. The activity throughout the summer has been as uniform as the other features. There has been slow surface streaming from the west and northwest, ending at fountaining grottoes north, northeast, east, southeast and southwest. Rising and falling in pulsations of gas inflation, lasting each about 20 to 30 minutes, and with fluctuations from day to day of from five to twenty feet at different times, there has been a river-like stream pouring through the central channel into the southeast arm, and the most conspicuous fountaining activity and general turbulence have been in the southeast cove. The conduit wells west and northwest from which all the streaming proceeds, have been masked under tumbled debris and crusted floor lava, but from time to time glowing and hissing cones have indicated that the wells still persist there.

This review is presented at this time because Sept. 23 is the date of the equinox, a time when changes in the crater are likely to occur. Previous experience would lead to expectation of subsidence at this time. It should be noted that the entire summer has been a period of extraordinary drought, of very little seismic activity on Hawaii and of no perceptible volcanic activity on Mauna Loa.

On Saturday, Sept. 15, 1917, from 8 to 9 p. m., the lava lake appeared relatively high with vigorous fountains east and southeast, others fairly persistent west and north and occasional outbreaks in grottoes southwest and northeast. The northern and western regions were crusted over while surface streaming poured southeastward. Flaming chimneys glowed above the west and south grottoes and there was dull glow in a chimney 20 feet above the lake on the east corner of the steeple crag which formed the eastern summit of the central crag mass. Occasionally a central fountain would break through the crust near the eastern end of the southeast arm and eject very high spray as it migrated into the southeast cove. Rising and falling motion was slight. During the subsidences the western and northwestern crust would occasionally break up with cracking and foundering and brilliant patches of upwelling melt.

On Sept. 16 from 5 to 7 p. m. there was little change. The newest overflow bench at the east cove stood five feet above the lake and on all sides a rim of overhang with stalactites hung about three feet over the liquid. Streaming was to the north, to the southeast and to the southwest. In the southwest arm the streaming was against the southern shore from the union of convergent currents jouring from both east and west. Spatter construction on this day was

conspicuous. A flaming filagree cone had been built over the east grotto and there were cones at the southeast and east coves. The latter was evidently active within, as strong pulsatory heavings of the crust along the shore of the cove indicated a tunnel connection between the cove and the cone. There was high spatter overhang and a long flaming chimney above the grotto on the south side of the southeast arm and similar conditions obtained at the grotto on the east side of the old northwest crag mass. At the northeast cove marking the northern end of the cleft line that separated the east island mass from the northeast floor, a shore cone of horseshoe shape had been built with the opening toward the lake.

There was occasional violent longshore bombardment at the east and also at the southwest. In the north arm sliding heavy crusts moved over each other in a general southward direction making a noise of scraping.

The shore of the northwest cove had been so built out as to change what had been a deep inlet into a relatively slight embayment—that is, the inner part of the cove had become solid floor. Inspection of the north pit showed that it was increasingly deep with convergent talus in its bottom. The northwest table crag which appears to have changed not at all for many weeks was seen to be heavily covered with a mat of filamentous lava or Pele's hair like the southeastern shelf.

On Sept. 18 at 3:45 p. m. the general conditions were high lake with high gas pressure and constructional activity on the margins. There was stagnant crust in the conduit region west and northwest and more or less shore bombardment in other directions, but no central fountains. The eastern and southeastern spatter domes were shiftingly very noisy with gas pressure. Three or four long domes of this kind had been built towards the east. A wide streaming zone covered with festooned crust poured from the central channel southeastward, the channel itself and the central region being crusted over. Dense smoke rose from cracks at the north inner cliff above the lake. In the north arm there was cracking and foundering crust and the lava brimmed level with the rampart in the northwest cove where there appeared to be fresh overflows. There were shore fountains northwest, northeast and southwest and streaming poured from the lake center into the southwest arm. The grotto on the south side of the southeast arm was closed in by a spatter curtain but the fountaining inside kept a bellows-like wavy motion going in the outside crust, while 10 to 15 feet above in the south bench ragged crevices glowed and ejected bright jets of burning gas. Occasionally these chimneys would spurt and puff noisily with lava spray.

The east island mass now appeared to be rising highest at its southeastern end as in previous times. The central crag mass was highest in the middle. The old northwest crag mass appeared to be definitely suibsiding on its northern side and this movement was in some way connected with the flooding of the northwest floor and the building out of the shoreline there. The northwest table crag had its upper surface tilted strongly eastward and its summit remained slightly below the May bench level. This crag, along with the northeast floor and southeast shelf, has not shifted for a long time. The cone localities over the west and northwest conduit wells have lately changed very little. The bank at the east cove was only from two to three feet above the level of the lake.

On Sept. 19 from 5 to 6 p. m. the lake was brimming at the southeast and northwest ramparts, there was fresh marginal overflow at the southeast cove and the liquid stood three to four feet below the floor of the east cove. There was a spurting crack over the southeast dome. Heavy fountaining would break out occasionally in the center of the channel leading from the southeast arm to the southeast cove, and such fountains would migrate to the west bank of that cove. Other outbreaks showing sudden release of gas from beneath the lake crust took place at the east cove and the south grotto. There was the usual surface flow zone moving southeastward in the southeast arm. In the stagnant crust south of this zone large balloons were incessantly

lifted by inflation of the surface crust from below. These balloons swelled to heights of four or five feet and formed in series of five or six large folds or blisters sometimes ten to twenty feet long. They would swell up until they extended themselves lengthwise to the bright line at the margin of the streaming zone where the gas would escape as the crust was lifted clear of the incandescent fluid so that the bubble would then collapse.

Until 5:30 p. m. the lake action was quiet with the north arm and central region heavily crusted and fountaining west, east and southeast. The central crag mass appeared very high. At 5:30 p. m. there was general cracking and foundering so that the lake subsided about two feet, with hundreds of bubble fountains and strong evolution of heat and gas.

Measurement on Friday, Sept, 21, 1917, at 2:30 p. m., made the depression of the lake in the central region 97 feet below the southeast station. The overflow level marking the maximum recent rise at the southeast cove was three feet higher. The central crag summit rose 76 feet above the lake. These measurements indicate a rise of the lake of 10 feet in two weeks and a rise of the central crag since Sept. 7 of two feet.

On this day the inner bench stood higher above the lake than of late, appearing about five feet high at the southeast cove and eight feet high at the east cove. There was strong shore bombardment south and southeast. Streaming was rapid to the southeast with thin blistered crusts, very hot radiation from the lake surface and no festooned flow zone. The streaming through the central channel carried along blocks of crust and there were central fountains here and in the southeast arm. Occasionally a large central fountain would form in the southeast cove. There was occasional heavy shore bombardment under the central crag mass. About 3 p. m. the heavy spatter curtain in front of the south grotto collapsed. The northern and western regions were crusted over, the central crag appeared higher than ever and fumes were thin. There was much rumbling noise and the fountains broke heavily without much gas spurting. In general the conditions indicated either subsidence or a lifting of the central crags.

The seismographs of the Whitney Laboratory for the week ending at 10 a. m. Sept. 21, 1917, registered two local earthquakes which occurred a few minutes apart in the very early morning of Sept. 15 and were generally felt in Kau and Hilo. The first earthquake at Volcano House was a prolonged rocking motion. The second one was slight. Microsesimic motion during the week has been moderate and volcanic vibration slight. The movement of the pendulums in the sense of tilt had changed from strong westward and slight northward to slight westward and stronger northward, indicating tilting motion in general to the northeast.

Volcano House, Sept. 29, 1917.

During the period immediately following the autumnal equinox of 1917 there has been no subsidence of the lava of Halemaumau but rather a rising. Crags and lake have both risen and one pronounced overflow has taken place.

On Saturday, September 22, at 4:30 p. m., the lake as seen from the northeast was high and brimming against a definite spatter rampart in the southeast cove. The shore there stood about one foot above the liquid while at the east cove and central chasm the bank was about three feet high. There was little change in general conditions. A broad festooned flow zone with blistered crusts streamed southeast from the central channel, the north and west regions were crusted over, the south chimney was flaming, the central crags appeared very high and there were occasional spells of rapid current pouring into the southeast cove. The noise to the southeast was of puffing and plashing. A row of half-dome grottoes had been built along the southeast rampart, there were strong fountains along the west bank and to the southwest and east. The spatter rampart in the southeast cove had been building out so as to widen the shore bench at the foot of the cliff under the southeast shelf.

On September 24, at 1:30 p. m., the same description would apply. The southeast domes were a little higher and another dome rampart had been built

across the eastern entrance to the central chasm. The rampart activity to the southeast suggested that of January, 1917, to the northeast. The crust was folding up and ballooning on the east side of the south grotto. It was evident that there had lately been much scaling off of the high spatter veneer on the north side of the central steeple, but the central crag mass showed no signs of lowering.

On the evening of September 25 there was no change. The lake was dull and inactive and the fumes appeared a little denser.

On September 26 at 3 p. m. the only change notable was that the lake appeared depressed with reference to the central crags about five feet in excess of its stand of the previous day. The shore bench at the east cove and the central chasm appeared 8 feet high while at the southeast cove it was only 5 feet high. The northern and western parts of the lake were crusted over and the south and southeast and east grottoes were open and active. The fumes were as usual and the height of the crags with reference to the Halemaumau rim was increased rather than diminished. There were no marked falls of rock but some caving in of the lake shores was reported.

At 9 p. m. on September 27 there was strong rising in progress with pronounced overflow into the south valley from the southeast cove.

Measurements on Friday, September 28, 1917, at 11 a. m., made the depression of the south floor near the overflow of the previous evening 93 feet below the rim of Halemaumau and the depression of the lake at the moment 102 feet. These figures indicated that at the margin of the southeast cove there had been practically no change of level of the lake in seven days. (Ninety-seven feet depression of September 21.) The summit of the central crag mass, however, measured only 13 feet below the rim of Halemaumau and stood 89 feet above the lake. It had risen seven feet since September 21 and probably most of this movement took place about September 27 at the time of the southeast overflow. The east island summit stood 59 feet and the old northwest crag 47 feet above the lake, and both had risen as compared with previous measurements. It is evident, therefore, that a very pronounced displacement of the lava column in the form of sharp uplift of the central crags has followed the equinox.

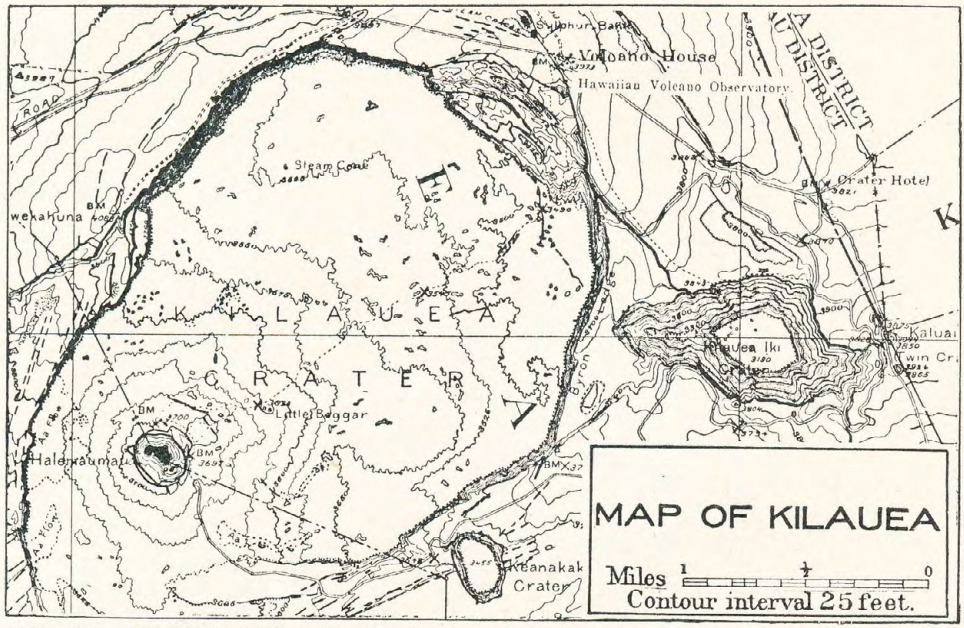
The central crags were pronouncedly higher and the east island crag mass appeared broken and changed in shape. The fumes were clearly thinner and everything indicated a pronounced rise of both crags and lake. The overflow from the southeast cove southwestward was fully 100 feet long. The inner bench over the lake appeared six feet high in the center, east, west and northwest and four feet high at the southeast. The west and northwest regions were crusted over, there were migratory fountains in the center, streaming to the southeast was occasionally rapid and the lava was pounding in grottoes beneath hanging stalactites on the east and west sides of the southeast cove and under the south bench. From the east cove streaming was outward.

The record of seismicity on the Whitney seismographs for the week ending 10 a. m. September 28 shows one small local earthquake on the afternoon of September 22. Microseismic motion has been moderate. Volcanic vibrations have slightly increased, mostly as scattered tremor storms at infrequent and irregular intervals. The tilting motion shown by the instruments was at first stronger to the north and east with decrease in the north component towards the end of the period.

The fume rising from Mokuaweowco which has been repeatedly visible during the summer under favoring weather conditions in the afternoons became strikingly conspicuous on the afternoon of September 27, rising as a column of smoke in still air, although at the lower level of the Kilauea summit fresh and gusty northeast wind was blowing.

Very respectfully,

T. A. JAGGAR, JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, Volcano House, P. O., Hawaii. All scientific exchanges should be sent to this address.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. The work was founded by the Massachusetts Institute of Technology. Publications to date have been weekly reports since the summer of 1911 now reprinted in Honolulu in monthly form. There are also special reports, printed from time to time.

The weekly bulletin as it appears in the Honolulu Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and L. T. Peck is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology, named after an endowment fund of geophysical research held by the Massachusetts Institute of Technology, in memory of Caroline and Edward Whitney of Boston, is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory
ANNUAL GENERAL MEETING AND TREASURER'S REPORT, 1917

Vol. V. HONOLULU, HAWAII, OCTOBER, 1917. No. 10

VOLCANO HOUSE, Oct. 6, 1917.— During the week ending Friday, October 5, 1917, the rising of the lava column in Halemaumau has continued, carrying up the central crags from two to five feet in different places and decreasing the measured depression of the liquid lake by 10 feet in seven days. There has been strong uplift of the east floor so as to increase the height of the cliff at the lake edge. This cliff is fast becoming a new crag or scarp with a steep backslope to the northeast.

On September 29 at 5 p. m. the general conditions in Halemaumau were much as they had been. The banks of the lake seemed a little higher and the central crags towered conspicuously. There were fountains at the base of the northwest crag mass and occasionally large central fountains would develop in the southeast arm and migrate southeastward. There was no evidence of further overflowing.

On October 1 the effect of the recent lift of the central crags was shown in the building of a new inner bench or spatter rim all around the lake, making a ledge about two feet high and some five feet below the floor level which had recently been the lake shore at the east cove and at the central chasm. The new ledge was about three feet below the rampart level at the southeast cove and from six to ten feet below the west floor on the south side of the northwest crag mass. This raised western floor level distinctly slopes downward to the southwest. At the northwest cove the inner ledge was about six feet below the floor.

That the bench magma was still in motion was evidenced on this day by rocks tumbling on a new talus slope on the northeast side of the highest eastern crag of the east island mass and also by rocks sliding on the northern talus slopes adjacent to the northwest table crag. An examination of the northwest floor showed that there were fresh overflows there and behind a spatter rampart at the north cove in the direction of the north pit. These northern overflows were probably formed simultaneously with the one southeast on September 27.

The whole lake at noon on this day was crusted except in the coves where there was streaming toward active grottoes southeast, southwest, north and northeast. The crust across the southeast arm would occasionally break up, founder and reveal southeastward streaming. Around the southeast arm and cove there were four active grottoes; at the northeast cove there were two; there was one at the north cove, and others west and southwest. Conspicuous smoking localities were northeast, north, northwest, three places west and to the southwest. The fume in the central, southern and southeastern regions was thin. The strongly smoking cliff edge at the margin of the lifted northeastern floor block stood from 30 to 40 feet above the lake on the east side of the north cove. About 12:30 p. m. the north arm crust broke up and seven fountains burst into activity, the central ones migrating to the northeast and north. These northern fountains had made much Pele's hair which formed a mat on the inclined surface of the northwest table crag.

On October 3 at 11:45 a. m. grottoes were active north, northwest and west, as well as in the more obvious southern and eastern localities. There was fresh yellow sulphur stain on the flat cone which stood as a low dome above the east cove grotto. The grotto under the southeast shelf was puffing with

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L. W. de Vis-Norton.....Secretary

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gas pressure and a deep rumbling sound came from the south grotto. There was rapid streaming under the bank on the west side of the southeast cove, but the central channel streaming southeastward was sluggish and the northern and western regions were crusted over, with occasional cracking and foundering. The new inner spatter ledge was no longer marked. The lower floor northwest under the high shelf of May, 1917, appeared to be lowering and a large talus cone against the north-northwest wall of Halemaumau was becoming very conspicuous, its base resting on the lower eastern end of the northwest table crag.

Measurement on Friday, October 5, 1917, at 11:30 a. m., made the lake depression 92 feet below the southeast rim of Halemaumau, and the summit of the central crag was now only 10 feet below the rim of the pit and 82 feet above the lake. The east island mass had been tilting rapidly, for its western summit was now the higher for the first time, rising 53 feet above the lake, in contrast to the eastern summit, which was only 51 feet above the lake. In seven days the lake had risen 10 feet, the central crag 3 feet, the western summit of the east island crag mass 5 feet, and the eastern summit of the same only 2 feet.

On this day the bank of the lake was three to five feet high southeast and at the central chasm, and about eight feet high on the west and northwest. About noon there was sharp subsidence of the liquid, a glowing rim of overhang developed around the lake, while central and migratory fountains formed and crusts broke up. The large dome southeast had its fountains completely curtained in and rumbled with a deep note. There was fierce bombardment on the south and west sides of the southeast cove. The south grotto was open with lava pounding within. The writer descended to the east cove, which had considerably changed its shape so as to be nearly rectangular, with its eastern wall much higher than before. There was a distinct steepened ascent from the base of the northeast wall of Halemaumau to this edge of the lake. The top of the cone at the east cove was glowing and flaming in cracks, while beneath could be seen on the lake side a most spectacular grotto 8 to 10 feet high, hung with scalloped stalactites, glowing vividly and flaring with burning gas. This eastern bench over the lake had so much risen that the fountains below no longer spattered over the top of the cliff. At its southern end this cliff parted from the southeast cove rampart along a line of huge fissures, some of which went right through the middle of the eastern spatter dome.

Other signs of fresh uplift appeared along the pressure ridge on the south side of the block forming the central crag mass and also along the northeast side of the east island block. Very pronounced movement of the central region has taken place in the last ten days.

The chimney in the central steeple showed greatly increased smoking with hot brownish billows rising rapidly. There was activity in the north rampart grotto, and the northeast cove showed two active grottoes, the one a filagree flaming crack and the other a rampart dome. In the summit of the northeast inner cliff, which was shattered with huge crevasses, was found a well leading downward, now cool, but evidently formed by the melting action of hot gases. The well had irregular, smooth, lumpy, steel-gray walls with fused surfaces, and the opening descended in a somewhat spiral chimney form, two or three feet in diameter.

In the Whitney Laboratory of Seismology for the week ending 10 a. m.

Friday, October 5, 1917, five local earthquakes have been registered. Two of these were on September 30, respectively about 8 a. m. and between 3 and 4 p. m.; the other three were on October 4, respectively about 2 a. m., 12:48 p. m. and between 8 and 9 p. m. The shock of 12:48 p. m. was strong enough to start a rock slide on the face of Uwekahuna bluff Microseismic movement for the week has been moderate and the volcanic tremor continues to occur in scattered storms in the nature of minute earthquakes. The instrumental evidence of tilting showed increase of tilt to the north and west.

VOLCANO HOUSE, Oct. 13, 1917.—During the week ending October 12, 1917, lake and crags of the Halemaumau lava column have continued to rise vigorously, with increase of gas pressure and some change of habit in the way of prolonged spells of crusting, followed by general cracking up so as to make brilliant displays of fountaining and streaming. The great central crag is now plainly visible from Volcano House and the fume has become thin.

On October 7 at 10:30 a. m. it was evident that the east and northeast floor had continued to rise so that the chasm bounding the east island crag mass on its northeast side had so changed that the floor of the east cove had collapsed to a talus of tumbled blocks extending from the ruin of the east island peak to the lake shore. In this process the sulphur-stained cone of the east cove had collapsed and the cliff over the northeast shore of the southeast arm had risen higher than ever. This cliff now stood at least 30 feet above the lake. At the northeast cove, representing the other end of the chasm, there was a similar collapse and complete change of features in two days. Both the active grottoes had disappeared and in the place of the fissure grotto was a broken solfataric surface and a slope of stained debris. Where the dome grotto had been there was a small cove crusted over. A gulch full of tumbled rocks extended through from the northeast cove to the east cove. The whole east island crag mass was now a tumble of the most chaotic character, made up of stained and decomposed fragments, and this gulch marks the fissure line bounding it on the northeast. There was evidently differential movement between the crag block and the northeast floor block.

On this day there were two spatter rims at the lake shore, well marked at the east and northwest cove, showing lake levels two and four feet above the present lake. About every fifteen minutes there was a breaking up of crust across the southeast arm and a rush of streaming into the southeast cove. The north and west regions were quiet and crusted over. The north rampart grotto was closed in and rumbling. The central chimney on the north side of the steeple crag appeared inactive, but the one on the east side was open and fuming. There was no sign of cessation in the rising of the crags, and the lake appeared high in the coves, especially at the northwest, where the recent overflow rims overlapped in flat fashion as though the lake margin were gaining in height, while the northwest pond locality westward from the old crag mass appeared depressed. Other signs of building up of the rampart so as to lift the actual lake basin appeared at the north, southwest and southeast coves. If the rising continues, overflow may be expected at the coves, but elsewhere the lake is hemmed in by cliffs.

On descending to the lake shore at the east cove irrespirable sulphur fumes were encountered coming from flaming fissures in an active grotto at the tunnel leading to the northeast chasm. At the other end of the new east crag, however, a slide of rock was found between the crag and the southeast shelf which could be followed down to the edge of the lake behind and next south of the east grotto. Here there was a flaming pot and occasional heavy fountaining.

At noon on October 9 the lake was crusted over and rising. The summit of the central crag appeared much higher and nearly level with the southeast margin of Halemaumau. At 12:20 p. m. there was general breaking up of

the crust, many fountains, large and small, and a rush of the surface current to the southeast. This was followed by crusting over again. A new inner ledge had been built under the central crag, and the northwest cove appeared to have a low shoreline. To show the difference in height between the main shore benches in the center of the pit and at the coves, the west rampart, central chasm and east cove floors were each from 12 to 15 feet above the lake, whereas the southeast and northwest cove margins were only from 5 to 8 feet high. The south grotto appeared deep and overhanging, and the southeast dome was closed and hissing. The chimney on the north side of the central steeple was fuming and smoke in general was moderate in volume.

On Thursday, October 11, the lake seen from the southeast and east appeared high, with strong gas pressure and much noisy puffing and spraying at the southeast, south and north grottoes. A cone with glowing fissures had been built above the southeast dome, and this emitted a sheaf of blow-pipe flame 12 inches wide and from 8 to 10 inches long, with incessant gas pressure behind it and reddish color in daylight. At night the flame appeared whitish with blue outer edge. There was streaming in a zone of wide multiple festoons from the center region to the southeast. Fountains played occasionally at the northeast cove and heavy ones spurted at the southwest cove. Fumes were thin. The southeast rampart was only one foot high. There was yellow stain on the benches at the east cove and central chasm. Both the central steeple and central crag mass beyond appeared higher than before and leaning southward. At the west cove next adjacent to the northwest crag mass the bank over the lake appeared to have subsided so that it was lower than its extension to the south. Immediately under this crag mass there was a very low place with broken rocks smoking at the lake shore. Blue fume was rising from the central chimney. At the edge of the lake beneath the east gulch the rampart had widened so as to build out in front of the east grotto of October 7.

At 5:10 p. m. the lake subsided about one foot, showing a glowing rim all around and increased fountaining. At 5:15 p. m. a large central fountain developed and migrated slowly southward with a festooned zone in its wake and a quiet crusted area east of it. This fountain migrated to the south grotto, increasing in violence, flinging high stringy masses into the air, with flame, and spray to heights of 50 feet or more. It was followed by accelerated streaming from the center of the lake in a curve to the south grotto, but when the fountain subsided the normal streaming was resumed to the southeast cove. Heat at the southeast rim of the pit was strong. The crust appeared thin, but blisters were rare. Crevasses had formed back of the edge of the east floor crag where it overhung the lake. There were glowing fissure chimneys above the west side of the southeast cove and over the south grotto.

Looking from the south station at 5:30 p. m. a heavy block of the spatter bench fell into the lake just west of the east island talus, leaving a red-hot wall as a scar. It was evident from this point of view that the southeast arm had recently increased in size by eating back both northward and eastward. The southwest arm showed low smoking flats on its southwest side sloping towards the lake, with shoreline only one to two feet high. The slope of uplift on the south side of the southern crag mass had increased in height and steepness toward the west, bending at its western end sharply into a cliff over the southwest arm. The central crag now appeared level with the brink of the pit. From the south the east island mass appeared to be bodily rising with its west end highest. At 5:50 p. m. there was general cracking, foundering and bubble fountaining all over the center of the lake, followed by the formation of a large fountain there. There was strong bombardment under the southeast shelf and about seven fountains in all in different parts of the lake. At 6 p. m. there was a prolonged quiet spell, with the whole lake heavily crusted except at the north grotto and on the west side

of the southeast cove. At this place there was strong fountaining and spraying. This lasted forty minutes, until the gas pressure became so great that the crust across the southeast arm burst so that long rows of blue flames shot out along the cracks and then a great fountain explosion came suddenly through a heavy crust and was followed by a general break-up.

In the Whitney Laboratory only one small local earthquake has been registered during the week ending 10 a. m. October 12. This occurred between 8 and 9 p. m. on October 5. Microseismic motion has been ordinary and volcanic vibrations have fluctuated in intensity, with occasional stormy spells. The seismographic evidence of tilting showed increase to the north and east on October 5 and 6, followed by a reverse movement without special features on October 7, 8 and 9; on October 9, 10 and 11 the tilt became very strong to the north, with some increase to the east. On the north-south component instrument the pendulum swung to its limit in the north direction and showed tendency to remain in that position.

VOLCANO HOUSE, Oct. 20, 1917.—During the week ending Friday, October 19, 1917, the rising of the lava column has continued, taking effect in bodily uplift of the central crags, small border overflows and renewed overflow from a western blowing-cone. This last development recalls features of the great rise of a year ago.

On Saturday, October 13, it was evident that within two days there had been sufficient rising of the lake to overflow the cove margins southeast, southwest and northwest. At 5:30 p. m. on this day there was temporary subsidence of the lake of about five feet, bringing into view low-roofed tunnels at the east cove, the central chasm and on the west side of the southeast cove. A sharp rise of the central crags was manifest in the increased height of the pressure ridge or slope between the southern crag mass and the south valley. The high southeast shelf over the east gulch exhibited a large crevasse near its edge, forecasting an avalanche there.

The lake was undergoing spells of quiet crusting over, followed by times of cracking up with subsidence. During these times spatter margins along the shore would fall into the melt. There were six or seven fountains in action, stalactites hung before the north grotto, and a long curtain hung before the grotto in the southeast dome. The streaming was toward the east ledge.

On October 15 at 2 p. m. the lake was noisily puffing and rumbling at the grottoes and had been again slightly overflowing at the coves. The southeast cove overflows showed a different pattern from those seen October 13. Again the lake showed temporary depression about six feet below the southeast platform, where there was a high dome grotto. At the north cove, however, a very large dome had been built in the midst of the rampart. The southward leaning of the central steeple recorded on October 11 had now taken effect and the steeple had collapsed to two-thirds of its former height, the red oxidized debris of the ruin occupying the central chasm depression. The east ledge appeared to be lifted higher and part of the block in front of the crevasse of the southeast shelf recorded as pending on October 13 had avalanched into the east gulch below. There were eight or ten fountains in the lake, the crusts were cracking and foundering, there was fairly swift streaming to the north and to the southeast, and the smoke was troublesome, blowing from the southwest. The fountains showed heavy viscous quality in the stringy mass flung up.

On October 17 at 4 p. m. the lake was high at the southeast rampart, which stood only two feet above the liquid. The continued rising of the massive lava under the central crags, however, made the central chasm floor fully seven feet above the lake. There was much smoke from vents in the central region and towards the north and west. Two grottoes were active on the southeast, but most of the lake was crusted over. The east cove grotto

was active and the southeast dome was curtained.

The west bank of the lake now appeared to be rising as a ledge like the east crag. Much of the edge of the latter had fallen away, following the line of the crevasse near the verge. At its southern highest angle this ledge was cracking profoundly at right angles to the shoreline, the pendant blocks overhanging the east gulch. There was now very heavy overhang of a turret-like mass on the south aspect of the central crag, showing every sign of an approaching crash. The west end of the northwest table had already collapsed, and the central steeple had become a rugged stump, while the lower part of the central chimney on the lake side had caved away. There was no smoke from the two chimney orifices, but much fume rose from the north and south sides of the central chasm.

During the next two days, Thursday and Friday, October 18 and 19, a change took place significant of the importance of the strong rise of the lava column which set in immediately after the autumnal equinox. This consisted in an outbreak of liquid lava through the high cracked benches at the west side of the pit where the "west pond" of 1916 has for ten months lain dormant under a tumble of smoking debris. The lava which now welled up here built a blowing-cone 15 feet high at the site of the similar cones of January, 1917. Piled up pahoehoe floods spread from this center in the shape of a fan, extending to and around the northwest cone. Tongues from this flood extended all over the site of the old northwest pond and in the direction of the west cove the new lava covered an oval area extending two-thirds of the distance from the west cone to the shore. The northwest cone, which has become sulphur-stained and during the summer has occasionally hissed and glowed, does not appear to have ejected any lava.

Measurement of the previous Saturday, October 13, made the depression of the lake 85 feet below the southeast station on the rim of Halemaumau. The summit of the central crag was 84 feet, and of the east island crag 60 feet above the lake. The lake had thus risen seven feet in eight days, while in the same period the central crag had risen nine feet and the east island summit 14 feet. The rate of rising of the crags was three times as fast as in the previous week, while the lake throughout the fortnight had risen and fallen irregularly within the inner pit, but by measurement maintained a rate of rising of a little over one foot per day.

The seismographs of the Whitney Laboratory for the week ending at 10 a. m. October 19, 1917, have registered three local earthquakes; two of these were trivial, respectively about 3:30 p. m. October 14 and 6:25 p. m. October 17. A more pronounced, but small, shock occurred about 7:42 p. m. October 16. Microseismic motion for the week has been moderate and volcanic vibration slightly increased in spasms towards the end of the interval. The record of tilt shown by the instruments has been remarkable, the excessive tilt to the north continuing, with, in addition, a tilting movement to the east which on one of the seismographs carried the writing stylus clear off the recording drum. The net effect of this for the two past weeks is a shifting of the plumb-line to the northeast in a series of slow pulsations which appear to be approaching a maximum. As this direction is straight away from the rising bench magma of the Halemaumau crags, the possible relation of such tilting of the ground to volcanic activity seems worthy of investigation.

VOLCANO HOUSE, Oct. 27, 1917.—During the week ending Friday, October 26, 1917, an important culmination of rising lava has taken place, followed by subsidence. The movement of rising was accompanied by extensive flooding of the western floor areas, and at the culmination, which appears to have happened during the night of October 23, the great central crag subsided and the south bench was suddenly lifted until it stood 70 feet above the lake as a peaked crag, the whole block tilting over to the west and exposing by uplift the bare rough lava

wall which had been previously submerged. Before this event, a spectacular cascade from the lake into a well under the central chasm served to forecast subsidence. The highest level reached by the lake was 79 feet below the rim of the pit October 20, and the lowest to date was 98 feet on October 26. From a rate of rising of one foot or more per day, the liquid lava and the crags have subsided at an average rate of about three feet per day for the week following October 20. There was, however, pronounced spasmodic rising after that date to the night of October 23. The liquid lava showed pulsations of subsidence in advance of the bench magma.

Measurements for the week were as follows:

Oct. 20—
Depression of lake, 79 ft. below rim.
Depression of east island crag, 18 ft. below rim.
Elevation of central crag, 4 ft. above rim.

Oct. 22—
Depression of lake, 90 ft. below rim.
Depression of east island crag, 18 ft. below rim.
Elevation of central crag, 2 ft. above rim.

Oct. 26—
Depression of lake, 98 ft. below rim.
Depression of east island crag, 31 ft. below rim.
Depression of central crag, 13 ft. below rim.
Depression of new southeast crag, 28 ft. below rim.

On Saturday, October 20, at 9:30 a. m., the lake was crusted over and mostly quiet. There was activity in the curtained southeast grottoes, and occasional central fountains would break out. About 10 a. m. and thereafter there was general cracking of crusts, multiple fountaining and subsidence of the lake surface. Spatter margins fell into the lake at the east gulch and at the west side of the southeast cove. Rocks were heard falling at the east gulch and at the central chasm. The west cone was continuously hissing, with louder spasms at intervals. There was quick-rising hot fume at the central chimney.

The lake had overflowed extensively at the northwest cove and at the southwest cove, but not at the west. A pressure ridge and crevasses at right angles to the shoreline extended from the lake to the west cone. The southwest cove had built out its eastern shore so as to widen the platform and narrow the pool. There was no fresh overflow at the north cove. The central crag had continued to rise so that its summit was nine feet above ground level at the southeast station. The overhang of its southern turret was so strong that it seemed certain to collapse soon. The central steeple had continued to scale off on its south side, assuming again a peaked form at a lower level, with bright red smooth southern walls. The new spatter margins of the shore stood from 10 feet to 15 feet above the lake in the central region, but at the southeast cove the rampart was only 5 feet high.

On October 22 the crags still remained high, but the lake had sunk 11 feet, so that open tunnels were revealed under the central chasm, at the east cove and on the west side of the southeast cove. At 2:30 p. m. there were in addition deep wall grottoes in the south bench, at the north base of the central crag, and in the southeast and northern ramparts. The central crag grotto appeared to communicate with the chimney smoking vigorously above. Streaming was from a crust in the center of the lake toward the southeast, terminating at the several tunnels. Rocks were heard falling at the east gulch.

Within the central tunnel was a pit separated from the lake by a rampart two feet high. Active lava inside was flinging up spray from a level five or six feet below the lake. At 2:50 p. m. the lake rose, overflowed this rampart and made a cascade which poured continuously into the sinkhole under a dark arch hung with stalactites. A deep rumble came from the sinkhole, blue flame and fume shot out from the arch, and fountains became rare in the lake. At 3:10 p. m. general crusting took place after a violent bombardment

at the southeast cove. The southeast tunnel became quiet and streaming poured from a bright edge of crust in the southeast arm for a distance of 50 feet straight to the cascade sinkhole. At 3:15 p. m. there was general breaking up, with streaming to the east and bombardment under the southeast shelf.

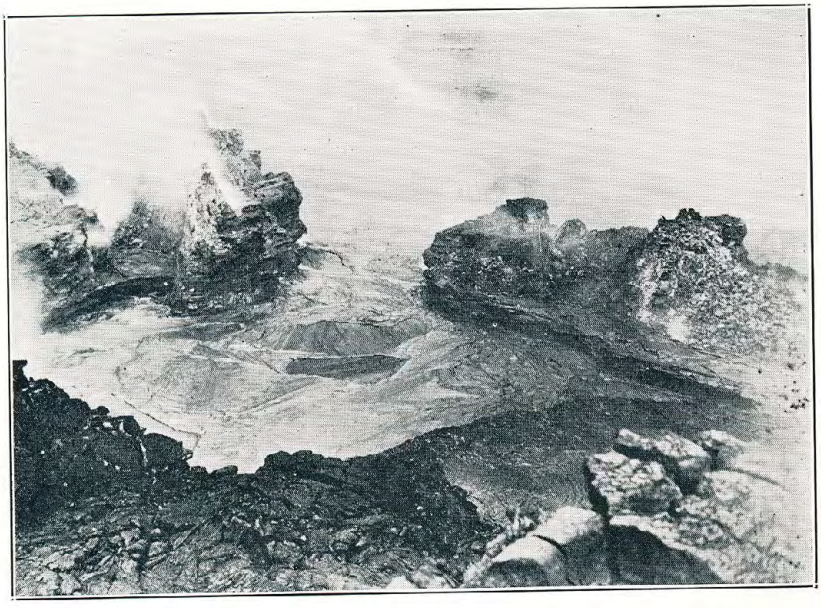
The north and west regions appeared quiet. The west cone continued its incessant hissing. The southeast rampart was about seven feet high and the central chasm floor about 14 feet high above the lake, the latter rising some two feet while it was under observation. A large block of bench on the southeast side of the east island mass had fallen into the lake since October 20 and been replaced by a new ledge three feet high, of fresh lava. Heavy smoke rose from the central, western and northern regions.

On October 23 at 2 p. m. the lake appeared higher measured by the east island but lower measured by the central cavern. Here the exposed arch was higher, the rampart prevented cascading, and the glowing pit inside the cavern showed no activity. The lake streaming was toward the rampart, but not over it. The southern crag mass appeared steeper, especially at its east point, where, at the entrance to the southeast cove, large blocks of the cliff had fallen away and the face was raw and broken clear to the southeast tunnel. The southeast rampart stood about five feet above the lake, which sank, however, some two feet. The crust was thin, blistered and moving more rapidly. Streaming was from the west and north to the east and southeast. Occasional central fountains of very large size would form in the southeast arm. At 2 p. m. there was fountaining at the southeast dome grotto, but later, during subsidence, the other grottoes became active. Very rapid hot fume rose from the central chimney and dense smoke from the south face of the steeple. Fumes as a whole were heavy and increased gas pressure was shown at the fountains. Some fountaining was seen on the east side of the southwest channel.

Inspection of the west and northwest floors showed great increase of piled up pahoehoe lava covering the northwest cone and extending all the way from the northwest cove to a point opposite the western end of the central crag mass. This lava was heaped in glistening black hummocks with short stretches of festooned flow, which indicated trickle northward and westward in the northern part of the area and rather southward and eastward in the southern part. The west cone was no longer hissing and it showed a dull stained surface. The later flows may have come from the northwest cone. The northwest table had fallen away considerably on its west side, and the debris was replaced by a wide floor of new lava built by overflow of the northwest cove.

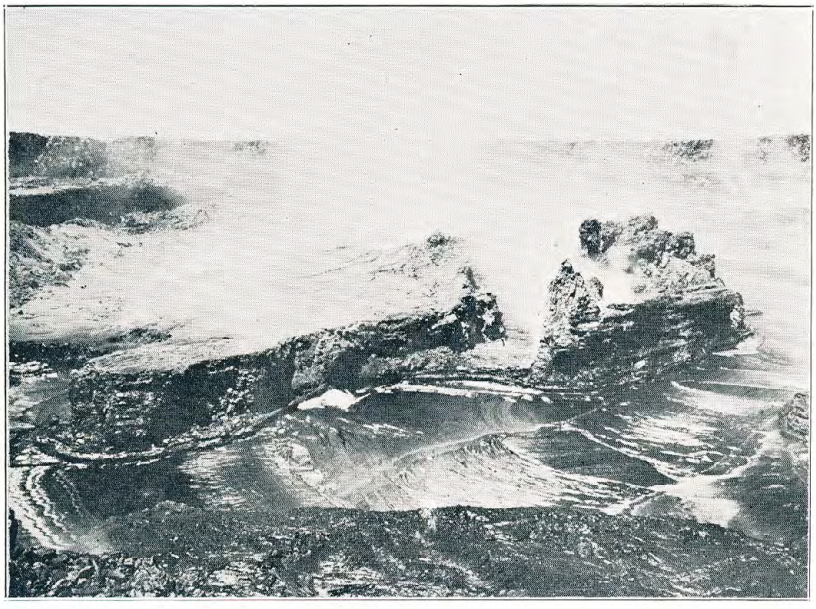
A visit to the pit at 4:14 p. m. October 24 discovered a conspicuous change at the south point bench separating the southeast cove from the southeast arm. Within the twenty-four hours this bench, which had been scaling off and cracking the day before, had risen bodily to form a sharp peaked crag over 50 feet above the lake, the upper bench surface tipping westward at 45° and breaking away from the south crag mass, the west side of the block sliding downward along a north-south fissure extending from the middle of the central chasm southward. The great upturned section revealed a structureless gray upright wall below, recently the submerged cliff at the side of the molten lake, and this surface was irregular wavy and rough, possibly aa, in contrast to the red oxidized bedded layers above. This lower surface was more or less coated with a skin of fresh lava. It resembled the raised underpinning of the east island of February, 1917, which proved on examination to be aa, or block-lava. The new crag had scaled off on its high north side so as to make there a tumble of red talus. The south grotto was destroyed, the west side of the southeast cove was extended deeply, and a new chasm floored with fresh lava extended thence back of the new block through to the central chasm. The central cascade pot was gone.

The central crag mass and east is-

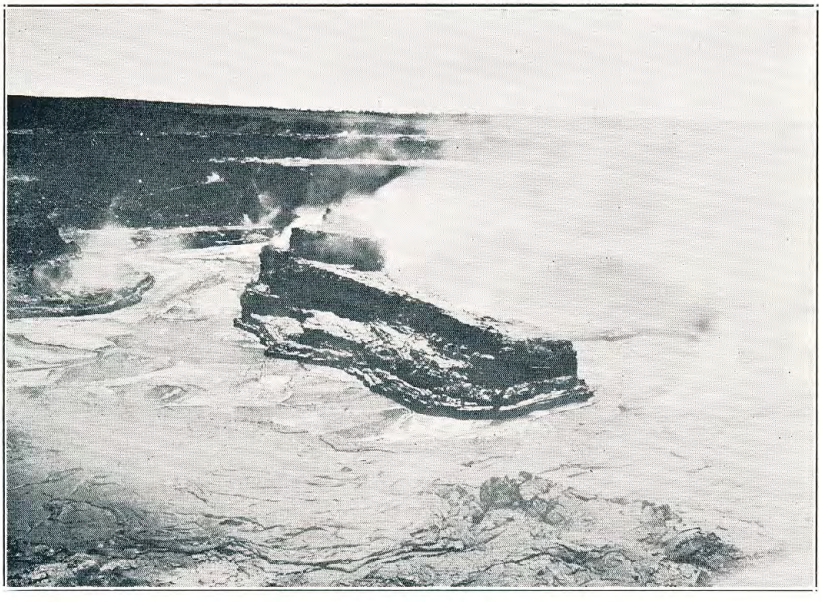


Aug. 4, 1917. Central chasm, crag and channel, east island and east cove. Photo Jaggar

Aug. 4, 1917. Southeast shelf, cove and point. Est ledge in foreground, right. Photo Jaggar



Aug. 18, 1917. Southeast arm, south and central crag masses, south grotto and central chasm. Photo Jaggar



Aug. 31, 1917. Central crag mass from the west. Southeast arm on left, southwest arm on right. Photo Jaggar

land mass had subsided considerably. Only a small tip of the central crag was now visible from Volcano House. The excessive central fuming had ceased, but smoke had increased at the high west peak of the east island. The northeast cove was increasing in size through the crumbling and subsidence of the east island mass. A curtained tunnel, active within, was visible at the east cove. The bench and rampart extending southward from the east gulch had fallen away and the remnant was 15 feet above the lake. The southeast rampart was high also, and overhanging. There was fountaining in the southeast tunnel, which was now farther south than before and opposite the end of the south pressure ridge. The east island spatter bench kept its level about five feet above the lake.

At 4:45 p. m. there was subsidence, accompanied by breaking up of crusts as usual, and heavy falls of spatter margin were seen at the north side of the central crag mass and at the north cove. Here the rampart fell with a heavy crash, starting excessive fountaining. The southeast dome was fuming heavily as though collapse were imminent. The lake as a whole was rather stagnant. The streaming was to the southeast, as usual.

General subsidence of the central area continued on Thursday, October 25, 1917, and the central crag disappeared from the Observatory view of the pit.

On October 26 the lake depression was 98 feet, and above it the new crag stood 70 feet, the central crag 85 feet and the east island crag 67 feet. The lake appeared subsiding, and there were rock falls from the summit of the east crag, from the south side of the new crag, and from the lake shore under it. A small avalanche fell from the outer wall of Halemaumau into the crevasses near the north pit, indicating that the subsidence was general. Activity was moderate, streaming and fountaining as usual, and the inner bench appeared 10 feet high. There were active grottoes under the central chasm and at the southeast tunnel. The old northwest crag mass had been breaking up and was much crevassed and tumbled across its middle region. There was glow and flame in the bench high above the east tunnel. The lake displayed subsidence, followed by rising. A great upright crack fissured the lower wall of the new crag on its south side. No hissing was heard from the west cone region, which was very smoky. The channel leading to the southwest cove had narrowed and the cove was quiet and crusted over.

For the Whitney Laboratory of Seismology I have to report no earthquakes registered during the week ending 10 a. m. Friday, October 26, 1917. Microseismic movement was moderate at first, strong October 23-24, slight thereafter. Volcanic vibration was spasmodic to moderate until October 23; on October 23-24 it was extraordinarily strong and stormy in the east-west component, but not in the north-south component. Thereafter it diminished greatly. Tilting to the east became excessive October 23-24, and tilt to the north continued very strong throughout the week, but decreased toward the end of the period. The correspondence of the seismic movements with the volcanic crisis of October 23-24 was remarkable.

Very respectfully,

T. A. JAGGAR, Jr.,
Director.

THE ANNUAL GENERAL MEETING AND TREASURER'S REPORT OF THE HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

The annual general meeting of the Hawaiian Volcano Research Association was held at the Library of Hawaii, Honolulu, T. H., on Thursday, August 23, 1917, at 2 p. m.

Present: The Board of Directors, a large number of members, and several visitors from different parts of the world.

The President, Mr. Lorrin A. Thurston, took the chair, and opened the meeting by calling for any further nominations for directorships, and appointing a committee of scrutineers of the ballots.

ADDRESS OF THE PRESIDENT.

The President then delivered his address, which was as follows:

"Ladies and Gentlemen:

"June 30th, 1917, ends not only the fiscal year of the Hawaiian Volcano Research Association, but the five-year term during which the Association has had a working agreement with the Massachusetts Institute of Technology. It seems, therefore, a proper time to give a resumé of the work of the Association since its formation, as a basis for intelligent consideration in connection with future procedure and policy.

Origin of the Association.

"The Association is the direct outgrowth of a suggestion made by Dr. T. A. Jaggar, Professor of Geology in the Massachusetts Institute of Technology, during his visit to Honolulu in 1909 while en route to Japan to investigate volcanoes there.

"Dr. Jaggar then proposed that the Institute should establish an observatory at Kilauea, the people of Hawaii to contribute thereto the sum of five thousand dollars a year for five years, the Institute to be solely responsible for additional funds and for operating the observatory.

Failure of Institute to Act.

"The people of Honolulu met Dr. Jaggar's suggestion, but, for several reasons, the Institute did not then see its way to take action.

The Perret Expedition.

"In the spring of 1911, on the initiative of Dr. Jaggar, the Massachusetts Institute arranged with Dr. F. A. Perret, a scientist who, under the auspices of the Volcano Research Association of Springfield, Mass., has made a special study of volcanoes, to spend three months at Kilauea, making detailed observations of the volcano and collaborating with Dr. Shepherd of the Carnegie Geo-Physical Laboratory of Washington, D. C., in the measurement of the temperature of the liquid lava.

"The expedition was financed by the three above named institutions.

Formation of the Hawaiian Volcano Research Association.

"On October 5th, 1911, upon the recommendation of Dr. Jaggar, an informal organization of this Association was formed, and later made formal by the adoption of a constitution, as an unincorporated association.

Objects of the Association.

"The objects of the Association are:

"(1) To encourage and promote investigation of and research concerning volcanoes and volcanic phenomena, and all matters connected therewith or incidental thereto.

"(2) To establish and maintain an observatory at the Volcano of Kilauea, with subordinate stations at other points, from which investigation and research may be conducted, and at which records may be made and kept for the information of all, subject to the rules of the Association.

"(3) To invite scientific institutions and observers to make use of the buildings, apparatus and facilities of the Association, subject to the rules of the Association, and, so far as possible, to assist such institutions and observers in carrying on their work.

"(4) To promote the publication and dissemination of knowledge concerning volcanology and allied subjects, and to accumulate literature, photographs, models, maps and specimens relating thereto, for the information of all, subject to the rules of the Association.

Agreement with Massachusetts Institute of Technology.

"As a result of the organization of the Association, Dr. Jaggar again visited Hawaii in January, 1912, resulting in a definite agreement with the Massachusetts Institute, in effect as follows:

"(1) That the Institute would give Dr. Jaggar a five-year leave of absence to act as Director of the Hawaiian Volcano Research Association and to conduct investigations, in the name of the Institute, of volcanic phenomena in Hawaii.

"(2) That the Association would guarantee $5000 a year towards the expenses of the Observatory.

"(3) That of this $5000, $4000 should be paid through the Institute to Dr. Jaggar as his salary, so that he

might maintain his connection with the Institute as a professor therein.

"(4) That the Institute would pay towards the expenses of the investigations at the volcano, the income of the so-called Whitney Fund, such fund amounting to $35,000 and the income amounting to about $1000 per annum.

"(5) That the Institute would publish the annual report of what had been accomplished at the Observatory.

Inauguration of Work at the Volcano.

"Later in the year Dr. Jaggar returned to Honolulu for the third time, and formally began work at the volcano of Kilauea as of July 1st, 1912.

Observatory Site and Buildings.

"A lease of several acres of land near the Volcano House was secured, and, through a special contribution by the people of Hilo, an observatory building was erected thereon, containing a concrete cellar built on bed-rock for earthquake-recording instruments; a general office, working and library room; room for specimens, maps and photographs; dark and other rooms for developing and printing photographs; several storage rooms and a water-storage tank.

"The building cost approximately $2100, and additions, such as enclosing the verandas, strengthening and re-roofing the same (the roof having been blown off in a storm), and an additional tank for water, have since been made at a cost of several hundred dollars.

"Small observatory buildings have also been erected in the crater, at the edge of the central pit. These are also occupied from time to time as temporary residences by observers.

Equipment of Observatory.

"The observatory has been equipped with four seismometers and other apparatus, and somewhat meagerly with tables, chairs, shelves, filing cases and other appurtenances.

Operating Force.

"The regular operating force at the observatory consists of Dr. T. A. Jaggar, Director, in special charge of volcanic investigation; Professor H. O. Wood, in special charge of seismology, and a man of all work, Alex Lancaster.

"During the first three years of the work of the Association, Howard M. Ballou, Professor of English at the College of Hawaii, acted as the secretary of the Association and editor of its Weekly Bulletin. Mr. Ballou, having left the Territory, was succeeded by Mr. L. W. de Vis-Norton, who still efficiently fills the office.

Trail to and Rest House on Mauna Loa.

"In the Fall of 1915, by special subscription in Hilo and Honolulu, the sum of $3000 was raised with which to build a rest-house and trail direct from Kilauea to Mokuaweoweo, the summit crater on Mauna Loa, a distance of 30 miles, via the rift region at the northeast corner of Mauna Loa, the scene of the most frequent and violent activity of any on the mountain.

"With the volunteer help of a company of the 25th Infantry, a horse trail was laid out and built for 20 miles through a formerly untraversed territory to Puu Ulaula, or "Red Hill," at an elevation of 10,000 feet. Here a rest-house was built and furnished with cooking apparatus, beds and other furniture, accommodating, say, ten people, with stabling for 12 horses, and water tanks. A trail was also marked and partially constructed from Red Hill to the summit, a distance of ten miles. This trail and rest-house now make easily and quickly accessible the most vital portion of Mauna Loa both from the spectacular and research standpoint. The rest-house is available to visitors at a nominal charge of one dollar per head per day.

"The whole of the property enumerated above stands in the name of the Association.

Work Accomplished by the Association.

"The work of the Association may be analyzed as follows:

"(1) Observation of the molten lava lake and crater at Kilauea, as nearly daily as practicable, detailed records being kept of the same.

"(2) Daily photographs of the crater from a fixed point at the Observa-

tory, showing smoke and steam formations and sources, and any changes that take place; also photos of pit from fixed points, showing action and changes, taken weekly and oftener if advisable; also frequent photographs of special features. Over 3000 such photographs have been taken.

"(3) Keeping a complete weather record, under Weather Bureau formula.

"(4) Keeping a continuous seismological record of local and distant earthquakes; also of local earth tilt and motion.

"(5) Observation and records and photographs of each new outbreak at Mokuaweoweo and lava flows therefrom.

"(6) Observation, study and record of other volcanic formations, both on Kilauea and Mauna Loa mountains.

"(7) Preparation and publication of a weekly bulletin with frequent photographs, setting forth the observations of the station, conditions and changes both at Kilauea and Mauna Loa. These are digested and printed weekly in the Hilo and Honolulu press, and 400 to 1000 copies are printed in full once a month.

"A copy of each number is mailed free to each member of the Association and to a selected list of scientists and scientific institutions all over the world, leaving quite a number of copies on hand for future use.

"(8) Daily Record. A compilation is made of the daily observations, weather record, photographs and sketches of changes and conditions which are not brought out by photographs, and other current data. This is made in duplicate, on letter paper, and each copy is bound in volumes. There are now ten such volumes, one set to be kept at the Observatory and one to be deposited at some central point available for consultation by all interested. In addition, there is a series of daily earthquake records, complete for the five years, with a few exceptions, due to accidents to the instruments.

"It will be a calamity if these observations and records are not consecutively continued.

"(9) Physical investigation of the molten lava lake is carried on whenever practicable, such as:

"(a) Measuring the heat of the same at the surface; in the fountains; in the caverns and at different depths in the lake, in different locations and under differing conditions;

"(b) Sounding the depth of the lake with iron pipe, at different times and at different points;

"(c) Securing unburned gases from the molten lava, both for quantitative and qualitative analysis, coöperating with the Carnegie Geo-physical Laboratory at Washington, D. C., for this purpose.

"(10) Collecting and arranging and labeling lava specimens and formations of all kinds in cabinets at the Observatory.

"(11) Collecting, filing and indexing, from all available sources, maps, photographs, records and publications relating to the volcano and kindred subjects.

"(12) Coöperation with and assisting scientists and scientific institutions in observations, studies and photographs of the volcano and kindred subjects.

"(13) Preparation and publication in scientific magazines as well as popular publications of articles on special subjects and phases connected with both local and distant volcanic and earthquake activity and phenomena.

"(14) Preparation of annual reports, summarizing conditions, activities and accomplishments at the station.

"The Massachusetts Institute of Technology was to have published these reports as a part of its contribution to the work of the station, and in connection with its original research work, receiving full credit for the work as though done entirely by the Institute. It published two reports, covering two years, but has published none since, having indicated its inability to do so owing to lack of available funds.

"(15) Preparation of lectures on subjects germane to the objects of the Association, and delivery of same several times a year, at different points in the Islands, with a view to educating the public to the importance of the

work and creating interest in and support thereof.

"(16) Trip to Japan, in 1915. Upon the occasion of the great eruption of Sakarojima, Japan, in 1915, Dr. Jaggar went to the scene, for the purpose of examining and comparing the same with other eruptions in Japan, Hawaii and elsewhere. The expenses of this trip were borne by special contributions and not by the treasury of the Association.

"(17) Trip to Washington, in 1916. In the winter of 1915-1916, Dr. Jaggar went to Washington, representing this Association, with a view to interesting the Federal Government and Congress in volcanic, earthquake and geological investigation in Hawaii. An extremely favorable recognition was given to Dr. Jaggar and his views, a measure carrying them into effect through the medium of the Weather Bureau, almost becoming law.

"Dr. Jaggar also took an active part in securing the passage of the act creating Kilauea, Mokuaweoweo and Haleakala into a National Park; it being believed that the enactment of this measure would favorably affect the first mentioned project. The expense of this trip was partly borne by special subscription and partly by the Association.

Finances of the Association.

"The report of the Treasurer will give the details of receipts and expenditures. The following summary will, however, be appropriate for statement here:

"The receipts and expenditures of the Association from January 15th, 1912, to August 31st, 1917, both inclusive, are:

Receipts	$53,767.07
Expenditures	51,667.83
Balance on hand..	$ 2,099.24

"All obligations of the Association have been paid up.

"In order that the work of the Association might not be interrupted, pending decision as to what shall be done in the future, the directors have personally pledged the payment of all operating expenses up to September 30 next, and have raised money looking toward the continuance until December 31st next. It is calculated that, by reducing expenses to a low limit, all such expenses can be met from balance in hand and from moneys pledged.

What of the Future?

"The period of agreement between the Association and the Massachusetts Institute of Technology and with Professor Jaggar, having terminated on June 30th last, and the pledges of funds for the continuance of the work of the Association in connection with such agreement having been fulfilled, this first era in the history of the Association may be said to have closed, leaving for consideration and decision what the future course and policy of the Association shall be.

"Bearing upon this question it is probably a fact that through the medium of this Association, and the scientists who have coöperated with it, more specific knowledge concerning the make-up and workings of a volcano has been secured and made available for study, during the past five years, than has been secured during the previous nineteen hundred years of the Christian era.

"Notwithstanding this, a beginning only has been made toward securing and recording the facts which must be known if volcanology is to become anything more than mere guesswork.

"While there are many spectacular events and phenomena to be observed, studied and reported upon in connection with volcanoes, these are not as important as the unspectacular and monotonous recording of what happens day by day. Full and accurate records of such observations, made by an intelligent and experienced observer, continued over a long series of years, are what must be secured before volcanology can be reduced to an exact science or even to a basis of intelligent theorizing.

"Another factor to be considered is that Kilauea and Mauna Loa constitute a ready-at-hand laboratory for the study of volcanology which, for safety and convenience of access and continuity of action, cannot be duplicated elsewhere in the world.

"A third fact to consider is that Professor Jaggar, to whose vision this Association owes its existence, and to whose enthusiasm and patience its accomplishments are due, is not only available to continue the work, but eager to do so.

"Under these circumstances it is the earnest belief of the speaker and of the present Board of Directors of the Association, that it is the duty of this organization to use every means within its power to secure the continuance of the work which has, for the past five years, been carried on under the auspices of the Association.

"The work should be undertaken in no spirit of competition with others engaged in the same or similar work, or for the enhancement of local prestige, but upon the broadest lines as seekers for the truth, welcoming the coöperation of all organizations and individuals having the same or similar objects in view, and proffering to them every assistance and encouragement in the execution of their work which lies within the power of the Association to extend.

"For the purpose of enabling the members of this Association to definitely record their opinions and desires in this respect, and by unanimous vote of the Board of Directors, I submit resolutions intended to express the sentiments hereinbefore set forth, as follows:

" 'That it is the opinion of the Hawaiian Volcano Research Association:

" '(1) That the results already secured through the medium of this Association fully justify the efforts and expenditures made in connection therewith; call for congratulations to those who have coöperated with us, and thanks to the earnest and faithful workers who have made possible the results obtained.

" '(2) That the interests of pure science and practical humanity require that investigation, observations and records be continued on substantially the same general lines heretofore followed, the scope of the same to be expanded as opportunity and financial conditions permit.

" '(3) That this Association pledges itself to use its best endeavors to support, for not less than a further term of five years, the objects set forth in its constitution; and to endeavor to secure the assistance of others in so doing, and to endeavor to secure the coöperation of other scientific institutions and individuals to that end.

" '(4) That the officers and Directors of this Association are hereby authorized and requested to take such steps as may be necessary or proper to accomplish the objects of the Association and secure the execution of the purposes above set forth.'

"It is the earnest belief of the speaker that if the foregoing resolutions are adopted and a Board of Directors elected who are imbued with the spirit therein set forth, ways and means will be found, through some medium, to accomplish, during the next five years, results greater by far than those which have been accomplished during the past five years."

The President's address, which was received with considerable applause, was followed by an address by Professor Jaggar, the Director of the Observatory.

(Note.—Professor Jaggar's address was issued as the August number of the Bulletin of the Hawaiian Volcano Observatory.)

The Scrutineers then reported upon the ballots, with the result that the whole of the retiring Board of Directors was found to have been reëlected.

The Directors having returned thanks for their reëlection, the resolutions presented by the President came up for consideration, and after several members, and some of the distinguished visitors, among them Dr. Clay Macaulay of Japan and Mrs. Young of San Diego, California, had spoken in favor of the adoption of the resolutions in toto, the question was called for, and the resolutions unanimously adopted.

The meeting closed with hearty votes of thanks to the Directors and officers of the Association.

HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

Report of the Treasurer from January 15th, 1912, to August 31st, 1917.

RECEIPTS.

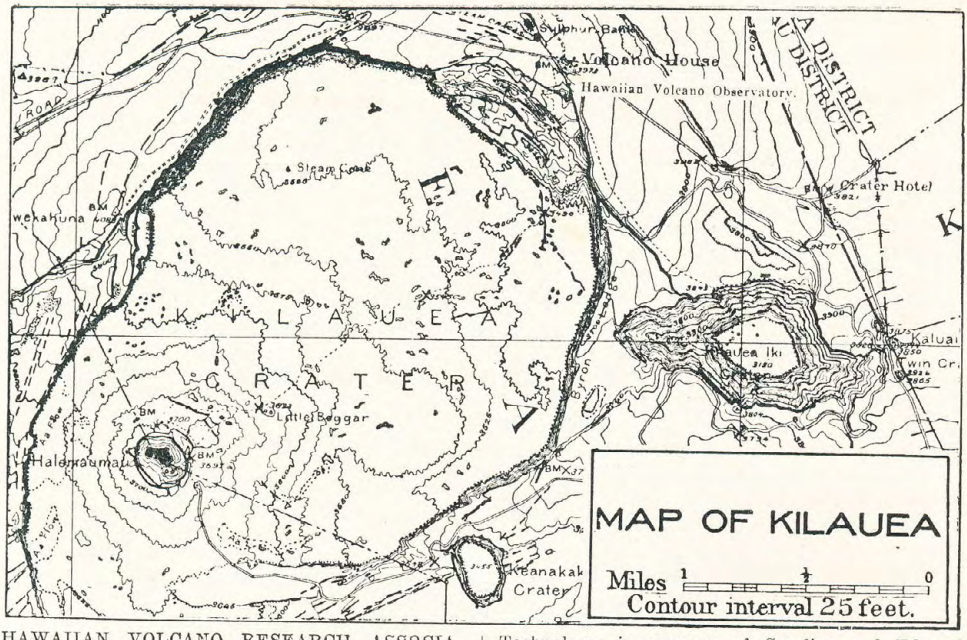
Balance turned over by Professor Jaggar	$ 1,606.50
Membership dues	1,775.00
Patrons and subscriptions	40,898.50
Repairs and Washington Fund	1,113.00
Special Fund	7,975.00
Motor Cycle Fund	100.00
Lectures	254.50
Refund	44.32

PAYMENTS.

Salaries and wages	$32,137.20	
Other expenses	19,530.63	
Balance on hand Aug. 31, '17	2,099.24	
	$53,767.07	$53,767.07

CASH ACCOUNT.

Cash at Bank of Hawaii	$ 799.84	
Cash in Treasurer's hands	1,299.40	$ 2,099.24



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, Volcano House, P. O., Hawaii. **All scientific exchanges should be sent to this address.**

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. The work was founded by the Massachusetts Institute of Technology. Publications to date have been weekly reports since the summer of 1911 now reprinted in Honolulu in monthly form. There are also special reports, printed from time to time.

The weekly bulletin as it appears in the Honolulu Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and L. T. Peck is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology, named after an endowment fund of geophysical research held by the Massachusetts Institute of Technology, in memory of Caroline and Edward Whitney of Boston, is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol a, or max. a, is given in the conventional unit, **the milligal.** The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in **milligals** by multiplying each of the numbers by 100.

WEEKLY BULLETIN

OF THE

Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, NOVEMBER, 1917. No. 11

Volcano House, T. H., Nov. 3, 1917.

At Halemaumau during the week ending Friday, November 2, 1917, the lava lake rose relative to the crags until October 31 and appeared to subside thereafter, but this effect may have been a rising of the crag lava rather than actual sinking of the lake. There has been pronounced disturbance of the crags with a crumbling down of the greater part of the east island mass with the exception of its high western block which stands in bold relief. The lake has built a new inner bench all around and the general condition suggests rising.

On October 27 at 1:45 p. m. the fume was thin and the lava rising. The southeast grotto was active. There was streaming into a grotto on the north face of the central crag mass. At 2:10 p. m. the lava was only one foot below the floor level at the central cove. At 2:20 p. m. three large central fountains were playing in the southeast arm. At 2:30 p. m. an avalanche fell noisily from the central crag mass into the chasm south of it. At 3:10 p. m. another fall took place from the southern side of the new southeast crag, the rocks falling into the lake and starting much ebullition. At 3:40 p. m. there was violent activity in the grotto under the east gulch and ten minutes later the lake was brimming level with the inner bench at the central cove.

On October 28 at 12:45 p. m. the north arm was quiet and crusted and the pit was uniformly suffused with thin blue fume. At 1:15 p. m. it became apparent that rapid rising was in progress, the lake level being about two feet below the inner bench at the central cove. At 1:30 p. m. a fragment of this bench fell in. At 4 p. m. the lake had again fallen, the inner bench at the base of the east island mass being five feet above the lake. A large fragment of this bench subsided into the lake during a sinking spell at about 4:30 p. m. The lake was rather sluggish with streaming to the southeast as usual and crusts thin and blistered. There was glow at the east tunnel and a new half-cone had been built at the southeast grotto under and against a bank ten feet high which formed a cliff where the rampart of the southeast cove had collapsed.

At 1:30 p. m. on October 29 the inner bench around the east island mass had completely collapsed and the eastern part of that body had crumbled lower than before. The roof of the east tunnel had fallen in and there was great activity of fountaining in the east cove. All the southeastern grottoes became active at the same time. At 3:30 p. m. a large block fell from the higher east island crag into the central channel starting prolonged fountaining.

On October 30 at 3:30 p. m. the older floors at the margins of the southeast and west coves appeared to stand from ten to fifteen feet above the lake, but the new inner bench stood not more than six inches above it. The western crag of the east island mass was very high and appeared to be rising as a distinct block, the remainder of that mass being low and tumbled. The southeast half-cone was puffing continually. There was no inner bench to be seen on the south side of the east island, the raw red rock and slide slopes extending directly to the lake level. At 4:15 p. m. the lake rose and flooded the floor of the central cove. Beyond in the central chasm there were new tumbles of rock, some of the fragments standing erect ten to fifteen feet high.

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L. W. de Vis-Norton.....Secretary

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On Wednesday, October 31, 1917, the lake at 2:15 p. m., seen from the northeast, was level with the inner bench at the central cove, active at the south east and quiet towards the north. At 2:30 p. m. the whole pit became very stagnant for an hour with practically no fountaining. Afterwards a few fountains broke into action in the north arm.

On November 1, at 11:30 a. m., the lake appeared much lower, but it had previously built up its inner bench to within five feet of the southeastern rampart level of October 20. The lake was now five feet below the inner bench and caverns were revealed on the west side of the southeast cove and at the central cove. There was also a shallow cavern on the north side of the new southeast crag. The inner bench showed much overhang and was twenty feet wide on the south side of the east island mass. A fuming hot rampart cone had been built opposite the central chasm and a new locality for hot blue fume was seen 50 feet to the north of the rampart at the north cove. The lake was evidently pulsating strongly through a ten-foot range and the crags appeared to have been both rising and crumbling. There was the puffing of gas pressure at the southeast cove, a new grotto half-dome had been built under the east gulch, but only a narrow ledge extended thence southward. The southeast half-dome collapsed with a crash at noon setting up intense fountaining against the bank which continued for fifteen minutes. At 4 p. m. the lake was about ten feet below the inner bench and there was rapid streaming and strong fountaining.

At noon the writer made a series of tests on the east floor bench to determine how the bench magma moves. A plummet pendulum was set up on the floor 40 feet from the edge of the cliff over the lake. The position of the plumb-line, indicated by a magnifying level, was recorded every five minutes for 70 minutes and the behavior of the lake watched at the same time. The pendulum showed vibration when fountains broke into action. The plumb-line swung in general from northwest to southeast, the movement being at a maximum of swing toward the southeast sink-holes while pronounced gas discharge and sinking was going on, and in the opposite direction while the lake was quiet and rising.

On Friday, November 2, at 2:40 p. m., the lake lava was within one foot of the inner bench and rising was in progress, the whole lake showing quiet crust. There was fountaining in the southeast grotto. At 3:40 p. m. the west central region broke up and rapid streaming into the southeast arm ensued.

For the week ending Friday, November 2, 1917, at 10 a. m., the seismographs of the Whitney Laboratory registered one small local earthquake about 8:40 p. m. October 27, and a very small local disturbance between 2 a. m. and 3 a. m. October 30. The amplitude of microseisms diminished during the week. Volcanic vibrations were rather strong until October 28; thereafter they were slight. Tilting was very strong throughout the week to the north and east, the eastward tilt diminishing only slightly after October 30.

Volcano House, T. H., Nov. 10, 1917.

During the week ending November 9, 1917, the lava column of Halemaumau has continued to rise about one foot per day. The liquid lake has shown tendency to fluctuate strongly within a vertical range of ten feet reaching pronounced overflow of the inner ledge on the evening of November 6. The central crags have risen at about the same rate so that the summit of the highest peak was on November 9 only seven feet below the rim of the pit. The lake has maintained an average level of about 98 feet below the rim for two

weeks past, but it rose six feet higher than on November 6.

It is becoming a matter of great interest to determine in what manner the stiff bench magma really moves and whether its ordinary movements are spasmodic or gradual. The liquid lake obviously rises and falls in marked spasms. Experiments have been inaugurated designed to throw some light on this question and to measure the rising and the falling of the crags every few minutes for hours at a time in the hope that some of the sudden movements, if such occur, may be caught and measured, and the rate of the more gradual motion be determined, in relation to the horizontal plane, the rim of the pit, and the lake level respectively.

On Saturday, November 3, at 10 a. m., the lake was about five feet below the inner bench, quiet in the northwestern and central regions and active at the southeast and north coves. There were occasional migratory central fountains. A new grotto has recently formed under the north side of the central steeple and this appears to be a fairly deep cavern. The northwest cove had recently been building out its shore eastward so as to make a shallow embayment, while the north cove had eaten back northward by collapse of the rampart and so increased its indentation. The northwest table was crevassed on the lake side. No change could be seen in the vicinity of the west lava flows. The old west crag mass had a number of peaks, but still preserved the islet of August, 1916, as its westernmost summit. At its base east was an active grotto. The valley extending through from the northeast cove to the east cove had widened. At 2:30 p. m. and thereafter there was subsidence, which made the inner bench about 10 feet high above the lake by 5:30 p. m. During the subsidence there was increased streaming and fountaining.

On November 4 at 2:30 p. m. the lake was about two feet below the inner bench with activity in the southeast and east coves. At 2:45 p. m. there was relatively rapid sinking of the lake surface about three feet and numerous fountains broke into action. At 3 p. m. there was a heavy fall of the inner bench at the southeast cove followed by much fountaining.

On Monday, November 6, 1917, at 11:30 a. m., the lake was only one foot below the inner bench at the central and northwest coves, and it was evident along the base of the northeast inner cliff that the lake had recently been spattering to heights of 8 feet or more. There was fountaining on the north, west, east and southeast, with streaming into the southeastern and southwestern arms. The center and northwestern region was stagnant. The southeast dome was large and glowing. Rocks were heard falling at the north cove. Central fountains occasionally developed in the southeast arm. Puffing accompanied the noise of fountaining at the north grotto. The places of densest smoke were on the north, west and southwest. The inner floor of the northwest cove was 50 feet wide, marking the outline of the October cove when the lake was at a higher level. Still higher was a half circle of overflow formed by October flooding. The southeast crag was now well above the level of the southeast shelf. A wide rock-filled gulch had been formed between the northwest table and the northwest shelf.

On November 6 at 2:15 p. m. the lava level was three feet below the inner bench and quietly rising. There was little fountaining activity of any kind. By 4:15 the rising had overflowed the floor at the central cove and this continued for 70 minutes, the gulch west of the southeastern crag being flooded. After that subsidence set in with fountaining and the lake sank five feet below the inner bench.

On November 7 at 10:15 a. m. the new inner bench was within three feet of the floor level at the southeast cove and had built over the southeast grotto dome, but flaming holes still persisted at this locality. The floor of the gulch between the southeast and south crags had been widened, but the new overflows did not extend through to the southeast cove. The central chasm was now a widened valley owing to the crumbling of the south crag in a tumbled flowing fashion making extensive talus. In the middle of this valley was a jutting rock. The spatter bench at the east gulch had been widened and

a wide inner bench built on the southeast side of the east island. Fume was rising from the east tunnel. The lake was now five feet below the inner bench with a glowing and overhanging rim. Streaming was to the southeast, fountaining was as usual, fume was moderate, there was little noise and heavy festooned crusts covered the stream through the central channel. Some blue fume rose from the pressure ridge in the south valley, and the main smoke holes were at the summit of the north inner cliff and in the western lava fields. At 10:50 a. m. there was a strong fall of the spatter bank from the north side of the central steeple. At 11:15 a. m. the wall of the southeast cove on its south side for a length of 75 feet fell into the lake, leaving a raw glowing cliff eight feet high and carrying away both the upper and inner benches. This fall made great commotion and liberated much heat in the cove.

On November 8 at 3:15 p. m. the inner bench was five feet high and there was the usual fountaining east and southeast. At 4:15 p. m. the lava had sunk two feet lower and there were migratory fountains in the middle of the southeast arm.

At 10 a. m. on Friday, November 9, measurement revealed conditions as follows:

Depression of lake, 98 feet.

Depression of central crag summit, 7 feet.

This summit thus stood 91 feet above the lake and it had risen during the week at the rate of one foot per day. The lake had risen by a similar total of six feet on the occasion of its overflows on November 6.

On this day there was little change, the lake remaining about five feet below the inner bench and general conditions indicated a stationary lake and rising crags. The bench under the east island was narrower. There was streaming to both southeast and southwest, and fountaining in northeast, southwest and southeast grottoes. Fume was dense from holes on the north, westnorthwest, west and southwest, but elsewhere it was thin. There was a flaming and puffing pot over the southeast grotto.

On this day experiments were started having in view the measurement of the movements of the central crags by taking observations every fifteen minutes for several hours and repeating this process from time to time on different days. With this work in view, a new trigonometric station was established on the northeast margin of Halemaumau and a preliminary series of readings made. It is proposed to attempt direct correlation between these measurements and the seismographic records at the Observatory.

In the Whitney Laboratory of Seismology for the week ending at 2 p. m. November 9, 1917, one very small local earthquake was registered between 7 and 8 a. m., November 3. Microseismic movement has been strong to moderate, volcanic vibrations moderate, and the pendulums have shown no recovery from the excessive tilt to the north and east which has now continued for over a month. The instruments are now in process of readjustment.

Volcano House, T. H., Nov. 17, 1917.

During the week ending Friday, November 16, 1917, the Kilauea lava column has continued to rise slowly and the summit of the great central crag has again come into view above the edge of the Halemaumau pit as seen from the Volcano House. The activity during the week has been moderate with alterations of quiet inflation of the lava lake accompanied by crusting over and more tumultuous times of breaking up with fountaining and rapid streaming. There is glow at the western conduit vent and much spatter rampart construction is going on at coves.

On Saturday, November 10, at 2:15 p. m., the lava lake was four feet below the floor of the central cove, fume was heavy in the north arm and there was active fountaining at the east grotto and in the center of the southeast arm. At 2:50 p. m. inspection from the northeast showed fountaining in the west and northeast coves, the fountain at the latter locality being noisy and throwing high jets. At 2:55 p. m. there was a heavy fall of rampart material at the north cove where the north grotto was active. At 4 p. m. from the east it was evident that the lake was slowly sinking, and by 4:30 p. m. the

central inner bench was seven feet high and there were many migratory fountains in the southeastern channel.

On November 11 at 2 p. m. the whole lake was quiet with inner bench five feet high. At 2:20 p. m. a large block of this bench about 50 feet long and 10 feet wide at the base of the southeast crag fell into the lake. Other fragments of the spatter rim around the southeast cove had been falling.

On November 12 between 4 and 7 p. m. the lake was sluggish with heavily crusted rising spells and breakings up at intervals. Surface streaming was to the southwest and southeast. There were fountaining grottoes on the east and west sides of the southeast cove, at the east gulch, in the southwest arm and on the northern and eastern sides of the west crag mass. The east cove tunnel exhibited a high flaming chimney in the bench back from the lake which occasionally ejected lava spray. The accumulated gas pressure breathed out from under border crusts on the lake and ballooned up the skin at the southeast cove. The west cone was visible from the south station and fumes in general were thin.

On November 13, at 2:15 p. m., the whole lake was very quiet, slow rising was in progress and some puffing came from the east grotto. This continued and at 2:30 p. m. the lake was about three feet below the inner bench. At 6:30 p. m. the rise had been so pronounced that the lake was brimming level with the inner bench at the east cove.

On Wednesday, November 14, it was evident that the rise observed on the previous day had taken effect in a rapid spurt of the movement of the crags, for the summit of the central crag was now once more plainly in view from the Observatory over two miles away. The fume as seen from a distance had been only a thin veil for the two days. When the pit was visited at 6 p. m. the crags of the central, southern and eastern regions all appeared higher and it was evident that the inner bench at the base of the southeast crag, eight feet above the lake, had been lifted with the crag, as the similar bench at the east gulch across the channel was only three feet high. The southeast bank had caved in and a new bench had been built there about three feet high.

The lake showed surface streaming from the bright edge of the dark crust southeastward from the middle of the southeast arm. There were central fountains in the southeast cove and north arm, and border fountains at the east and of the southwest cove and in the southwest channel. The north grotto was also active. There was no glow at the east chimney but a distinct glow was seen in the vicinity of the west cone. There was some appearance of fresh cracks at and under the south station as though the south valley were sinking to compensate the rising crags. The high western knob of the east island mass was markedly increasing in height with dense fume rising from its summit as though a chimney were developing there. The northeast cove and the gulch extending from it both appeared larger.

On November 15 at 2 p. m. the inner bench was from 8 to 10 feet high and some fifteen fountains were in action mostly away from the shores. From the southwest it appeared that much of the central crag mass had fallen to increase the debris slopes in the central valley and a long north-south crack appeared through the summit of this mass. At 2:45 p. m. the southwest arm was very quiet, but there was much fountaining in the central region. At 3:50 p. m. most of the east cove grotto dome collapsed. At 5:15 p. m. much of the inner bench around the base of the east island crag had fallen in and portions of the southeast shelf scaled away between the south and southeast stations. At 6:30 p. m. there was a heavy avalanche from the east island crag into the central channel and the inner bench was fully 12 feet high.

Measurement on Friday, November 16, 1917, at 11 a. m., made the depression of the lake 88 feet below the south rim of the pit. The summit of the central crag was three feet below the rim. These measurements would imply a rise of the lake amounting to 10 feet in seven days and of the crag 4 feet in the same time. The actual rise of the crag may have been greater as there was much scaling off.

The lake on this day was high and active, a row of dome shaped spatter

grottoes was in process of active construction along the east bench and two of these were especially large at the east gulch and the southeast cove, both showing stalactite curtains. At 10:45 a. m. there was a heavy crust over the whole southeast region and the streaming from the southwest arm and from the central region was northward. Later in the forenoon the breaking up of the crusts revealed streaming to the southeast, but the outward streaming from the southwest arm continued. A view of the northeast cove showed that that feature had now become an important indentation of the lake. Rocks were seen falling from the south side of the central crags. The easternmost pinnacle of these exhibited a flat reddish face on its south side as though the mass were moving on a fault plane of which this surface was the upward projection. A festooned flow covered the floor of the gulch west of the southeast crag. There was a large sulphur-stained patch on the site of the former northwest cones, and puffing was heard from the west cone. The inner bench was from three to five feet high, smoke was moderate, and at noon the crusts were thin and wrinkled and the lava currents were rapid, inducing much central fountaining and breaking up of crusted areas. The lake was rising in the forenoon and sinking after about 11:30 a. m.

The seismographs of the Whitney Laboratory have registered no pronounced local earthquakes during the week ending at 2 p. m., November 16, 1917. The graph of a strong distant earthquake was traced by the instruments about 5 p. m., November 15, the wave motion continuing for over an hour. The seismogram indicates an origin about 4100 miles from the Observatory and probably in a meridional direction—that is towards the north or south. Microseismic motion has been strong and volcanic vibration slight during the week. The registration of tilting has shown some recovery from the extreme inclination of the ground to the north and east which prevailed throughout October, the recovery from the east tilt being the more pronounced.

Volcano House, T. H., Nov. 24, 1917.

During the week ending Friday, November 23, 1917, there was a pronounced subsidence of the Halemaumau lava column at first, followed by recovery which has restored the lava lake to the level 90 feet below the rim so characteristic of the past few months. Slow rising has been resumed. The effects of both subsidence and recovery were shown by the crags as well as the lake, and small local earthquake shocks accompanied the disturbance.

On November 17, at 2:15 p. m., the inner bench at the southeast arm was unusually high, standing 15 feet above the lake under the east island mass, and there was much fountain activity. Thereafter subsidence became very pronounced and the inner bench began to collapse on all sides. At 2:25 p. m. a fragment of it some 50 feet long and 5 feet wide along the southern margin of the southeast cove fell into the melt beneath. At 4:45 p. m. there was a very heavy fall whereby the entire inner bench under the east island mass and under the east ledge subsided, leaving only a talus slope under the former and a sheer cliff to the live lava under the latter. At 5:40 p. m. this collapse extended southward from the east ledge so that the whole row of spatter domes from the east gulch southward went in and much turbulence was set up in the lake. Inspection of the southwest arm showed that during the hour up to 6:50 p. m. the inner bench was there falling also with much fountaining as result. By 7 p. m. the inner wall at the central and southeast coves was fully 25 feet high.

On November 18 at 3 p. m. the lava was still low and there was vigorous streaming and fountaining in the southeast arm. The southwest arm appeared wider by reason of the fall of the benches, and it was quiet and crusted over. The north arm showed two fountains, but in general the border grottoes were very quiet.

On November 19, at 11:30 a. m., the lake showed considerable change from the previous week. The inner bench, about eight feet above the liquid, still persisted at the central cove, at the east point of the southeast crag and at the inner end of the southwest cove. Around the east cove and under the southeast shelf it was entirely gone and the lake at the moment appeared to be strongly rising as the active lava lap

Sept. 21, 1917. The S.E. crag before lifting.—Photo. Jaggar.

Nov. 5, 1917. The S.E. crag after lifting.—Photo. Jaggar.

Oct. 26, 1917. The uplifted S.E. crag.

ped against the talus of the east island mass without any traces of a fresh spatter rim. The east ledge and the high western knob of the east island mass appeared to have risen, but otherwise the central group of crags had slightly subsided. The northeast part of the east island mass was certainly lower. The eastern knob of the old west crag mass was split through by a wide north-south crack. That the crags were still undergoing adjustment was shown by avalanches in motion in the east gulch and rocks sliding on the south side of the central crag. The relatively low level of the lake revealed the tunnel entrances at the central cove, the east cove and the west side of the southeast cove, where there was much activity and rapid streaming under the bank. The southwest cove was crusted over except at a puffing grotto tunnel at its eastern end. There was puffing also at the southeast. Streaming from the southwest cove was northward and there was active pounding in the north grotto.

The next day, Tuesday, November 20, at 2:45 p. m., the lake level showed no change and the surface was quiet. At 3:10 p. m. rocks were falling from the central crag mass. At 3:25 p. m. there was a fall from the south side of the southeast crag. At 5:40 p. m. a sinking spell brought about rapid northward streaming in the north arm of the lake toward spatter grottoes under the northwest table and at the rampart of the north cove.

On November 21 at 11 a. m. it was evident that the crags had generally settled and the northwest table crag was split through the middle by a wide east-west crevasse. The east side of the west crag mass showed terraces as though blocks were subsiding parallel to the lake shore. The northeast side of the east island mass was lower and more tumbled in appearance, but the western knob stood higher than ever. The floor of the central cove stood seven feet above the lake, but there was a new bench at the lake's edge some two feet high. The lake was evidently recovering as this new bench was in evidence at the east cove, at the point of the southeast crag and also under the central crag. Streaming was outward from the southwest cove, there was a puffing small area of activity on the west side of the southeast cove and much noise was heard toward the northeast. There was also occasional fountaining under the east gulch. No slides were seen in motion. At 10:30 a. m. the lake was crusted over and rising. At 11 a. m. the crusts were broken up and there was rapid streaming. At 11:30 a. m. the quiet rising was resumed.

At 2:30 p. m. on November 22 it was evident that rising continued with activity at the central cove and a spatter dome building on the west side of the southeast cove. In the evening the inner bench was being overflowed.

Measurement on Friday, November 23, 1917, at 9:30 a. m., showed the lake depression to be 91 feet below the southeast rim of the pit, three feet lower than on November 16 and seven feet higher than on October 26. The central crag stood eight feet below the rim, 83 feet above the lake, and was five feet lower than on November 16, and five feet higher than on October 26. The triangular southeast crag stood 19 feet below the rim, 72 feet above the lake and was nine feet higher than on October 26. The high knob of the east island mass, overhanging the central channel on its northern side, was now 18 feet below the rim and 73 feet above the lake. It was 13 feet higher than on October 26. In general, therefore, it will be seen that the several crags have risen during the month at different rates, and that the lake fluctuates strongly within its inner pit. In a general way both lake and crags have risen a few feet during the month.

On this day the new inner bench about three feet high had developed and become general around the lake. There were spatter domes at the east gulch and on the west side of the southeast cove. The fume was thin, streaming was to the southeast, the southwest arm was crusted over, blowing noises could be heard and there were occasional heavy central fountains in the southeast arm. A considerable point had built out southeast-ward from the southeast crag. There was no special activity at the east tunnel locality. Under the east ledge a double spatter rim appeared in steps respectively three and five feet above the lake. There

was puffing and spraying at the fountains and crunching noises in the southeast arm made by crusts overriding each other. The larger fountains would grow in size as they migrated eastward and these were followed by areas of bubble fountaining. During sinking spells there were falls of fragments of inner bench into the lake east, southeast and west, these sinking spells alternating at half-hour intervals with quiet crusting. There were active spatter grottoes northwest and north. The floor of the northwest cove had been recently much overflowed and was built out eastward.

In the Whitney Laboratory of Seismology five local earthquakes have been registered during the week ending at 2 p. m. November 23, and three of these were perceptible at the Observatory. The first was felt at about 9 p. m. November 18. On the 20th two shocks in close succession were felt about 6 a. m. and two others were recorded on the instruments at about 2 a. m. and noon.

Microseismic motion while still strong has diminished during the week and volcanic vibration has slightly increased. Tilt to the eastward has been resumed and has grown strong, while tilt to the north has increased with fluctuation.

Volcano House, T. H., Dec. 1, 1917.

During the week ending Friday, November 30, 1917, the rising tendency has been predominant in the Halemaumau lava column, culminating November 28. After that date there was slight subsidence, leaving the liquid lake about as before, 90 feet below the rim of pit, but the central crags had risen markedly, so as to be conspicuous above the edge of Halemaumau as seen from Volcano House two and a half miles away. The rising had built new ramparts and overflows at the coves and has shut off the southwest cove by building a floor across its entrance channel so as to create a separate pond there.

On Saturday, November 24, at 3 p. m., the inner bench east was five feet high, there was swift streaming from the north arm through the southeast arm to the cove at its inner end, where there was tumultuous fountaining, as also under the east gulch. At 5 p. m. the lake had risen to within one foot of the inner bench level under the east island mass. The south floor was about ten feet above the southeast cove lava.

On November 25 at 3:30 p. m. the lake at the south bench was higher, only about five feet below the floor level, and there was much fountaining east and west at the southeast cove, and at the central cove, with spraying gas pressure. At 3:50 p. m., on descending to the northeast floor, it was found that there was bombardment in progress under the north grotto dome, and a few minutes later a half of the spatter dome collapsed into the flood. An avalanche of rock fell from the north side of the east island mass into the lake starting violent ebullition. At 4:10 p. m. there was a fall of rocks from the central crag mass on its south side.

On November 26 at 3:45 p. m. the lake was high, covered with hard crust, with gas escaping from beneath this crust puffing and spraying at the border grotto southeast. Occasional heavy bursts of fountaining would break through the crust in the southeast arm, the northeast cove and elsewhere. The new inner bench was two to three feet high and there were fresh overflows across the south rampart and at the central cove, the latter flooding the gulch west of the southeast crag so as to produce a new cracked floor of smooth lava. The lake was rising and nearly overflowing the inner bench. Rocks were heard sliding in the central valley showing that the central crag-mass was in motion. About 4:30 p. m. the crust over the southwest cove was seen to break up and there was rapid inrush from the main lake to the cove and much violent fountaining. Meanwhile the general gas pressure under the crust of the lake seemed relieved by this local escape of gas and the border grottoes southeast were very sluggish while this southwest activity was in progress.

On November 27 at 2 p. m. only a few fountains were in action. The new construction by overflow at the east cove was within 15 feet of the surface of the east ledge at the east tunnel locality. At 3:30 p. m. there was subsidence by about four feet and increased fountaining. Fumes were thin and the

central crags was now plainly seen from Volcano House.

On Wednesday, November 28, 1917, at 10:45 a. m., the lake was high and the inner rampart only about two feet above it all around. The central crag was so high that both horns of its summit ridge could be plainly seen from Volcano House. There were growing spatter domes at the north, southwest and southeast coves and smaller ones at the east base of the old west crag mass and at the east cove. A new festooned overflow had poured (since November 26) from the central cove through the gulch west of the southeast crag. The central crag appeared nearly level with the pit rim. The southwest cove was now shut off by a new floor across the southwest channel as though a western submerged extension of the central crag mass had risen to make a dam athwart the narrows. The southwest pond so formed was crusted over at the moment. There were fresh overflows on the northwest floor from the northwest cove. There was no hissing at the west cone, but the southeast grotto was puffing. Central fountains were rare, streaming was outward from the southwest, and inward to the southeast arm, and there were blistered crusts. At noon a very large central fountain formed at the entrance to the north arm. The inner bench was wide opposite the east gulch, at the east cove and on the south side of the southeast crag. There were occasional longshore migrating fountains from the central region to the east cove. Fume was moderate. The lake appeared to have been rising and to be now at a high limit.

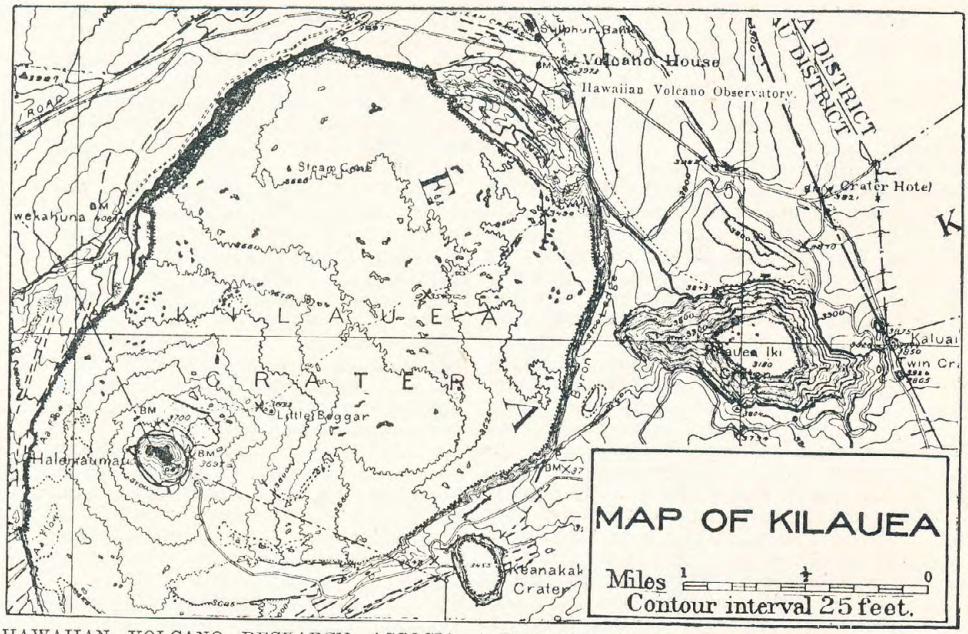
This was verified the next day, November 29, when at 2:30 p. m. the inner bench was 10 feet high all around indicating that the lake had relatively subsided. The lake was quiet except for a border fountain at the southeast grotto. Smoke was thicker.

November 30 was rainy, the fume was moderate but not thin, the crag was still moderately high, but not rising as seen at a distance. The lake was stationary and low.

In the Whitney Laboratory of Seismology for the week ending at 2 p. m. November 30, 1917, one small local earthquake was registered about 12:30 a. m. November 27. Microseismic motion has been moderate, diminishing during the week. Volcanic vibration has been normal and inconspicuous. Tilting has increased to the east and fluctuated in the north-south azimuth with a tendency southward.

Very respectfully,

T. A. JAGGAR, JR.,
Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, Volcano House, P. O., Hawaii. All scientific exchanges should be sent to this address.

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. The work was founded by the Massachusetts Institute of Technology. Publications to date have been weekly reports since the summer of 1911 now reprinted in Honolulu in monthly form. There are also special reports, printed from time to time.

The weekly bulletin as it appears in the Honolulu Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. L. A. Thurston is president of the Board of Directors of the Association, and L. T. Peck is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology, named after an endowment fund of geophysical research held by the Massachusetts Institute of Technology, in memory of Caroline and Edward Whitney of Boston, is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, the milligal. The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.

WEEKLY BULLETIN
OF THE
Hawaiian Volcano Observatory

Vol. V. HONOLULU, HAWAII, DECEMBER, 1917. No. 12

Note.—The photographs presented with this issue, if taken in order from left to right, comprise a complete panorama of the present aspect of the Halemaumau pit, the active portion of the great crater of Kilauea. The indicator lines point to the sections always alluded to in our monthly reports, and will be found of advantage in locating the sites of future developments.

L. W. DE VIS-NORTON,
Editor.

VOLCANO OBSERVATORY, Dec. 8, 1917.—During the week ending December 7, 1917, the subsidence recently reported reached its lowest limit, and this crisis was accompanied by perceptible earthquakes and a readjustment of the inner lava crags. Immediately there followed a rising of both lake magma and bench magna, which has restored the crags to their high level, above the rim of the pit, and this rising is now in rapid progress in accordance with what should be expected near the December solstice. The crags are again visible from Volcano House.

On Saturday, December 1, at 10:30 a. m., the inner bench stood 10 feet above the lake and had fallen away in part at the east cove. Until 11:30 a. m. the lake rose, then followed a breaking up of crusts with subsidence. There were occasional noisy bursts of fountaining northeast. Open tunnels at the lake edge appeared at the west side of the southeast cove and at the central and east coves. There were built up ramparts at the central and southeast coves with much smoke and a glowing wall at the last locality. Rocks freshly fallen appeared at the base of the whitened south face of the steeple on the floor adjacent to the central cove. Streaming was to the southeast and into the tunnels, there was much crunching and clinking of crusts, and the fume in general was moderate. At 2:30 p. m. the lake was much lower, crusted over and very quiet. At 4:30 p. m. there was some activity in the southeast arm, which gradually increased until at 5:30 the whole lake rent its crusts asunder and streamed swiftly to the southeast.

On December 2 at 2:15 p. m. the central floor level was 25 feet above the lake and there had been much caving in of the inner bench. Fume was thick and the lake was crusted. At 2:40 p. m. there was activity in the north arm, especially at the grotto of the northeast cove. At 2:50 p. m. six or seven fountains were in action in the southeast arm.

On December 3 at 3:30 p. m. the inner bench was about 12 feet high and showed effects of caving in at the central, southeast and east coves, and fume had greatly increased. The central crags were lower, but still visible from Volcano House. Dense smoke rose from the floors above the central, southeastern and eastern tunnels and at the curtained grottoes under the east gulch and the southeast dome. There were evidently voids acting as gas condensers under these places. The condensation of unburned sulphur vapor accumulated in chambers opened by subsidence was very striking, and the marked increase of fume during temporary subsidence is due to this process. The seismographs indicated jarring at this time and visitors reported falls of inner benches.

On December 4 at 2 p. m. it was evident that a further readjustment of the southeast crag had caused its west side to sink at the central cove and its inner bench on the other side to rise—that is, the point at the entrance to the southeast cove. Fresh overflow from the lake was flooding the depressed area at the

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L. W. de Vis-Norton.....Secretary

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central cove. There was fountaining at the southeast tunnel, the lake was elsewhere crusted over and the inner bench at the east cove was 10 feet high. At 8:30 p. m. all signs pointed to rising, the southwest arm was quiet and the north arm active, and there was much scaling away of rock from the south side of the central crag mass owing to its uplift and increased overhang there.

On Wednesday, December 5, 1917, at 11:30 a. m., the lake was rising. The eastern bench of the southeast crag showed a new lower shelf making an angle with the uplifted floor, and the east ledge also appeared as though it had been lifted. The inner bench was generally 10 feet to 12 feet above the lake level. The strong fuming of the coves had stopped as though the tunnels were filling, but there was a large sulphurous smoking patch southwest of the southwest cove. The southwest channel was again open and streaming was northward from it in a broad zone, the southeast arm being crusted over. Tunnels still showed at the central and east coves, with streaming from the lake into them. During a break-up the visible streaming southeastward was resumed. There was feeble puffing and fountaining southeast and high spatter marks were in evidence at the central cove and each gulch. At the latter locality there was glow above the lake level and a whitish flaming chimney still higher. The southeast grotto was quiet, but the southwest tunnel was noisy. There was much viscous central fountaining, bombardment was in progress along the north cove rampart, the northwest table appeared more broken, and the east island crag was cracked and stood in higher relief.

On December 6 at 11:30 a. m. the lake was higher, with new spatter margins hung with stalactites, inner bench about eight feet high, rapid streaming southeastward, smoke diminished, and crags in high relief. At 2:30 p. m. there was border fountaining at the central cove and on the north side of the central crag, but the north arm was quiet. At 3 p. m. rising was in progress and there was fountaining in the southeast arm. By 3:20 this had increased so that there was unusual gas pressure in evidence, making eight puffing border fountains and nine central fountains at the same time in this arm, the most vigorous effervescence seen here for some time. With temporary deflation of the lake and probably rising of the crags, the fresh inner bench collapsed under the east island and southeast crag masses, generating great numbers of fountains.

At this time, from the Observatory, two and a quarter miles away in a straight line, the central crag, examined with telescope, showed great increase in height above the profile of the rim of the pit, both horns and the west shoulder of the mass being plainly visible.

Measurement on Friday, December 7, 1917, at 11:30 a. m., made the depth of the lake surface 82 feet below the rim of the pit. The central crag stood 85 feet above the lake and three feet above the rim of Halemaumau. The east island stood 77 feet above the lake and five feet below the rim. As compared with November 23, two weeks previous, the lake was nine feet higher, the central crag 11 feet higher and the east island crag 13 feet higher.

At about 11:20 a. m., after a rising spell, there was general break up of crusts, swift streaming to the southeast and southwest and border fountaining. The lake stood only three feet below the inner bench. The east island, central and southeast crags all appeared higher. Heavy smoke rose from the southeast domes, the south pressure ridge, the southwest sulphurous patch, the southwest tunnel, the west floor, the old west crag mass and the north cliff. Rocks were falling from the leaning face of the central crag and a rock slide fell

from the high margin of Halemaumau under the southwest crevasse. The west crag mass was split in four great crevasses at the end nearest the lake, and rocks were sliding there. The east island crag was now in view from the Observatory.

Between 8 and 9 p. m. there was increased gas pressure, the lake was at the inner level, and many fountains were pounding on the bank at the east cove, east gulch, southeast bench and west side of southeast cove. Heavy fountains burst along the eastern base of the west crag mass and others under the north rampart, and there were occasional heavy outbursts in the center, in the southeast arm and at the southwest tunnel. Streaming was from southwest to north and from the center to southeast. The southwest cove occasionally broke up with much tumult. Blue flames were playing at the central cove and from cracks above the lake at the east gulch and at the southwest tunnel. There was a glowing and flickering vent on the floor of the central cove back from the edge of the lake. No glow was seen in the west cone region. Everything indicated pronounced rising.

The seismographs of the Whitney Laboratory, for the week ending December 7 at 2 p. m., have registered three local earthquakes, two of them felt at the volcano, respectively about 12:50 a. m. and 10 p. m., December 4, and the third very small about 8:10 p. m., December 2. There have been other small jarrings. Microseismic motion has been moderate and volcanic vibration normal except for a few spasms December 4-6. Tilting has further recovered, with swinging of the pendulums to the south and west during the week.

VOLCANO OBSERVATORY, Dec. 15, 1917.—During the week ending Friday, December 14, 1917, the central group of crags in Halemaumau has maintained its great height and has risen strongly, especially at the southeast, while the liquid lake has relatively subsided so as to appear from 15 to 20 feet below the marginal bench at the southeast cove. The most rapid uplift of the crags took place between December 8 and December 10.

On Saturday morning, December 8, the east crag and the whole summit body of the central crag were plainly in view from the Observatory, and in the afternoon the lake was very quiet and crusted.

On December 9 at 6 p. m. there was much movement in the crags, falls of rock took place, and there was strong fountaining and streaming activity. The lake appeared low and the crags high.

The next morning, December 10, it was clear that strong rising of the crags had taken place, as they protruded still farther above the edge of the pit.

On December 11 between 8 and 9:30 p. m. the fume was dense, the crusts over the lake were thin and bluish flames were abundant, especially at the southeast grotto. The inner bench appeared from 12 to 15 feet high and the spatter grottoes of the southeast cove had collapsed. The inner bench had fallen away also at the central and east coves. A very wide bench had formed at the east base of the southeast crag so as to build out a point which narrowed the channel there. Streaming in the main lake was from southwest to north, and in the southeast cove was toward the usual marginal fountains there. There was also occasional streaming in evidence towards the grotto of the central cove, and bombardment at the north rampart was frequent. Occasionally the east cove crust broke up and a fountain became active at the north base of the southeast crag. A fall of inner bench material on the east side of the southeast cove made a conspicuous wave against the point opposite. Heat from the lake was strong.

On Wednesday, December 12, 1917, at 11 a. m., the lake was heavily crusted, with inner bank almost 20 feet high. There was rapid streaming into the central cove and activity on the west side of the southeast cove. The summit regions of the southeast crag and the central steeple had been scaling off and the central cove seemed more deeply indented. The older bench under the east island crag was mostly gone and a new inner bench six or eight feet lower was forming. During a break-up several small central fountains formed.

On December 13 at 11 a. m. crusts were very thick and fume had diminished, but the margin of the southeast cove seemed higher. It was evident that rising had taken place, as a crescent-shaped spatter dome had formed on the south bank and

the southeast grotto was curtained with wide and long stalactites, while the opposite grotto was curtained with slender stalactites. Streaming was toward these grottoes around the long point of the southeast crag, which had greatly narrowed the channel leading to this cove. Another large horseshoe-shaped spatter cone had been built on the north side of the southeast crag without present activity, and the crag above showed scars of recent falling away. From the northeast a large tunnel could be seen on the north side of the central crag about 20 feet wide and 10 feet high. There was occasional activity here, but generally there was little noise and most of the activity was at the southeast. The central crag appeared to be crumbling and lifting so as to tilt up the slabs of recent overflow crust in the valley east of it, the botom of which in turn seemed to be subsiding. This would check with the supposition that the rise of the eastern point of the southeast crag indicated continued tilting over to the west of that crag block.

On December 14 at 5 p. m. the lake was again heavily crusted and low. A block of the west bank of the southeast cove had fallen in. There were occasional breakings-up at the southeastern grottoes. The bench point of the southeast crag had broken into slabs and a still lower inner bench was forming at the lake's edge. There was occasional fountaining with inrush to the bank on the north side of the southeast crag and also under the east island crag. The central channel was crusted over, but the crusts at the eastern coves occasionally broke up. Streaming from the southwest into the north arm continued incessantly, ending in bombardment at the north rampart, and occasional central fountains migrated along with this stream. At 6 p. m. there was spectacular cracking and foundering in the southeast cove, inaugurated by the bursting of blue flames through cracks in the thick crust, and there was left for a time a thin brilliant skin over the liquid. Flames were very conspicuous at the grottoes, and an almost steady flame played from a hole a few feet above the southeast grotto. The tunnel under the north side of the central crag was dark. An avalanche was heard from the northeast cove region. The southern and northeastern pressure ridges seemed higher, but the margin of the central cove was very low, only about four feet above the lake.

In the Whitney Laboratory during the week ending Friday, December 14, 1917, at 2 p. m. one local earthquake was registered about 1 a. m. December 11, which was felt at the Observatory as a short feeble shock. Microseismic motion has been moderate and volcanic vibration normal, with a few stronger spasms on the 7th, 9th and 12th. Tilting, which has been fairly strong of late to the south and moderate to the west, changed gradually to an eastward and northward tendency on December 13-14.

VOLCANO OBSERVATORY, Dec. 22, 1917.—During the week ending Friday, December 21, 1917, the Halemaumau column has reached a culmination closely according with the solstice and thereafter has subsided. Both the liquid lava of the lake and the group of central crags have taken part in the movements of rising and falling. The great crags in the pit have been plainly in view from the Observatory and very conspicuous in their relief above the rim of Halemaumau. High gas pressure with hissing, overflow and construction of many border cones reached a maximum on Monday, December 17.

On December 16 at 2:45 p. m. the inner bench at the central cove was only two feet high and the lake was crusted and very quiet, with much fume. It was evident that the central crag mass had risen and was well above the level of the edge of the pit,. but the southeast crag had been tilting farther to the north and falling away on that side so as to destroy its summit peaks and lower it. It was evident that the floors bordering the lake were rising, especially on the northeast and south.

On December 17 at 4 p. m. the lake was in the midst of a spasm of violent rising, and during that day overflows of the lake margin had taken place at the eastern, central and northwestern coves. The latter had overflowed a large area. There were twelve border cones of crescent form in different parts of the lake, all in process of construction by border fountaining and overspatter. At the southeast cove the lake was within two

feet of overbrimming the rampart. In the north central region there was a large fountain continuously active, and the streaming was there northward, while in the southeast arm it was southward. The northwest and west cone localities on the stained and smoky floor west of the old crag mass, were both glowing under blow-pipe action from beneath, the west cone evidencing this by puffing, the other by continuous hissing. The northwest table crag showed collapse of its southern half and farther uptilting of its northern half. The east ledge at the lake margin was distinctly higher. A curtain of stalactites hung across the central grotto.

On Tuesday, December 18, at 2 p. m., the maximum activity appeared to have been passed, fumes were thicker, there was little fountaining and the southeast arm was stagnant. At 2:15 there were three active border grottoes east and southeast, but otherwise the lake was heavily crusted. The southeast dome grotto was curtained and quiet, with much smoke rising from its summit. From 8:30 to 10:30 p. m. there were open grottoes at the central and southeastern coves and on the west side of the main lake. Subsidence had produced long stalactites hanging from glowing margins where the lake lapped against the crags. The stalactites were dragged with the flow of the currents which streamed into the several coves. Fourteen fountains were in action with the usual fluctuations of grotto fountaining. The east ledge was rising strongly, and the channel leading to the southeast cove had widened.

On December 19 at 4 p. m. the lake appeared relatively low and smoky. The northwest cone area still showed glow, but not the west cone, and puffing at these places had ceased. At the west cone there was noise of collapse heard as though rocks were falling into crevasses. The southeast bench appeared nine feet high and the central cove bench six feet high above the lake, while the lowest inner bench of the point of the southeast crag was three feet high. The lake was mostly crusted over. There were occasional fountains in the north arm and middle region, and there was grotto activity east and southeast and against the south side of the east island crag. Streaming was as usual to the southeast and north, and there was bombardment at the north rampart. Dense smoke rose from the south edge of the southwest cove. The northwest cove was narrow, and the fresh overflow floor stood six feet above the lake. All the spatter crescents of December 17 stood high above the lake as rampart humps at the edge of the inner bench deserted by the subsided live lava. There was some hissing from the southeast grotto curtained with stalactites across its face.

On Thursday, December 20, the high central crag mass, by measurement from the Observatory at 9 a. m., showed fully 25 feet of its turreted upper portion above the near edge of the pit as seen from a distance. This was the maximum lift of these crags for this period of rising, and the maximum had been held for the preceding twelve hours. In the afternoon of December 20 the crags were subsiding, and for the next two days they sank over four feet a day. The following were the measured vertical amounts of crag showing on successive days:

Dec. 19, 12:30 p. m.—24½ ft. showing.
Dec. 20, 9:00 a. m.—25 ft. showing.
Dec. 20, 4:30 p. m.—23 ft. showing.
Dec. 21, 9:00 a. m.—18 ft. showing.
Dec. 22, 9:00 a. m.—14 ft. showing.

On December 20 at Halemaumau the lake was still sluggish and falls of rock were seen at the southeast crag and the east island mass.

On Friday, December 21, 1917, at 4:20 p. m., measurement made the depression of the lake 92 feet below the southeast rim of Halemaumau. The position of the crags' summits was as follows: Central crag, 7 feet above edge and 8 feet lower than on the previous day; east island crag level with edge; southeast crag 27 feet below edge; east ledge 38 feet below edge. The overflow floor of the central cove was 15 feet above the lake, making the maximum level attained by the lake on December 17 approximately 77 feet down. On that date the lake had risen five feet above the level of December 7. On the morning of December 20, when the crags attained their maximum, the central and east island crags had both risen about 12 feet since December 7—averaging a little less than one foot per day. The movement, how-

ever, was by no means uniform. The accordance of the maximum with the solstice was striking.

On December 21 the lake appeared low, but much gas had accumulated beneath the thick crust and occasionally broke through it with a rush. The crust cracked with clanging noises. There were caverns revealed at the central cove and at the west side of the southeast cove. At the southeast grotto the crust was heaving and the confined gas occasionally broke out with flames. Border fountains played against the north base of the southeast crag and the south base of the east island crag. Streaming was north in the north arm. Five fountains were in action at 5:20 p. m., three in the southeast region and one each at the north and southwest. About 9 p. m. a heavy fall of the whole south margin of the southeast cove took place, and during the evening the lake was subsiding and other falls of rock were heard. Strong uplift was evident at the east ledge, the south crag and pressure ridge, the northern smoke cliff and at the remnant of the northwest table. The inner bench had fallen away at the east cove and at the east gulch, the latter now indented as a considerable cove. Rocks were falling there and from the north side of the southeast crag, and one small slide was seen in motion at the east end of the higher 1894 ledge. The long point making out southeastward from the southeast crag now exhibited four distinct benches produced by the gradual overturning of the crag to the north. The lowest of these was only four feet above the lake. The northward rotation of the mass had caused a falling off of the whole summit region on the north side so as to make that side a flat broken surface. The east ledge was now nearly as high as the southeast shelf.

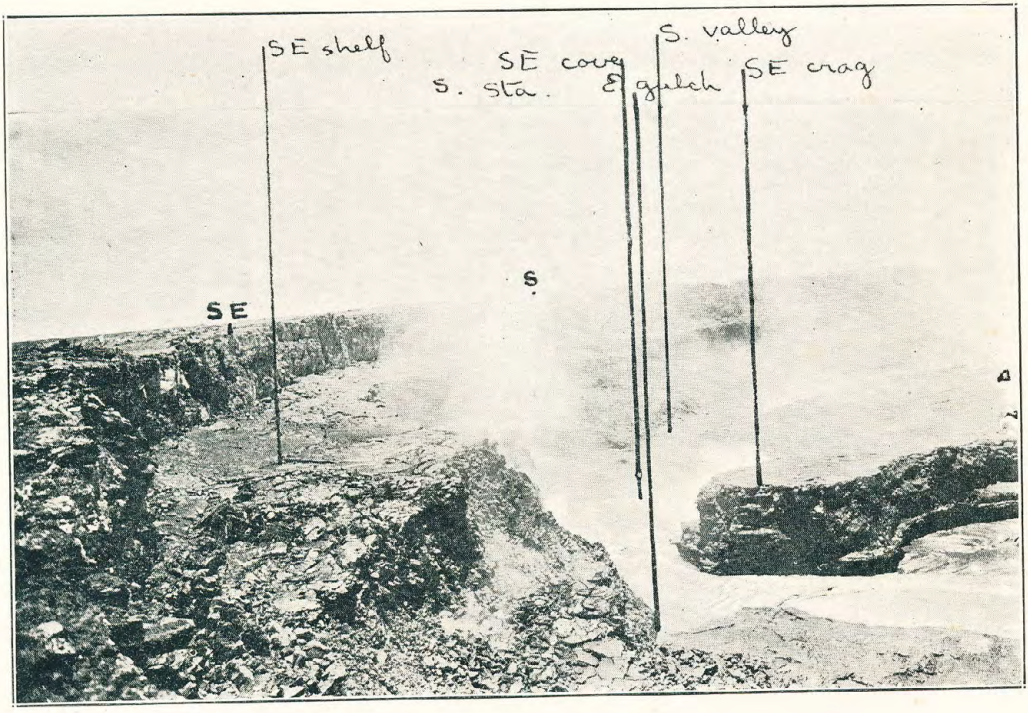
For the week ending at 2 p. m. December 21, 1917, no local earthquakes have been registered on the seismograms from the Whitney Laboratory, but one powerful distant earthquake of the "world-shaking" class was registered about 7:40 a. m. December 21, Hawaiian time. The preliminary phase of this record developed gradually and its duration was somewhat doubtful, but an approximate estimate would make the center of the disturbance only 1300 miles away—about the distance of Fanning Island or Laysan Island. Microseismic motion and volcanic vibration have both increased moderately during the week. The tilting has progressed westward and northward, but not strongly.

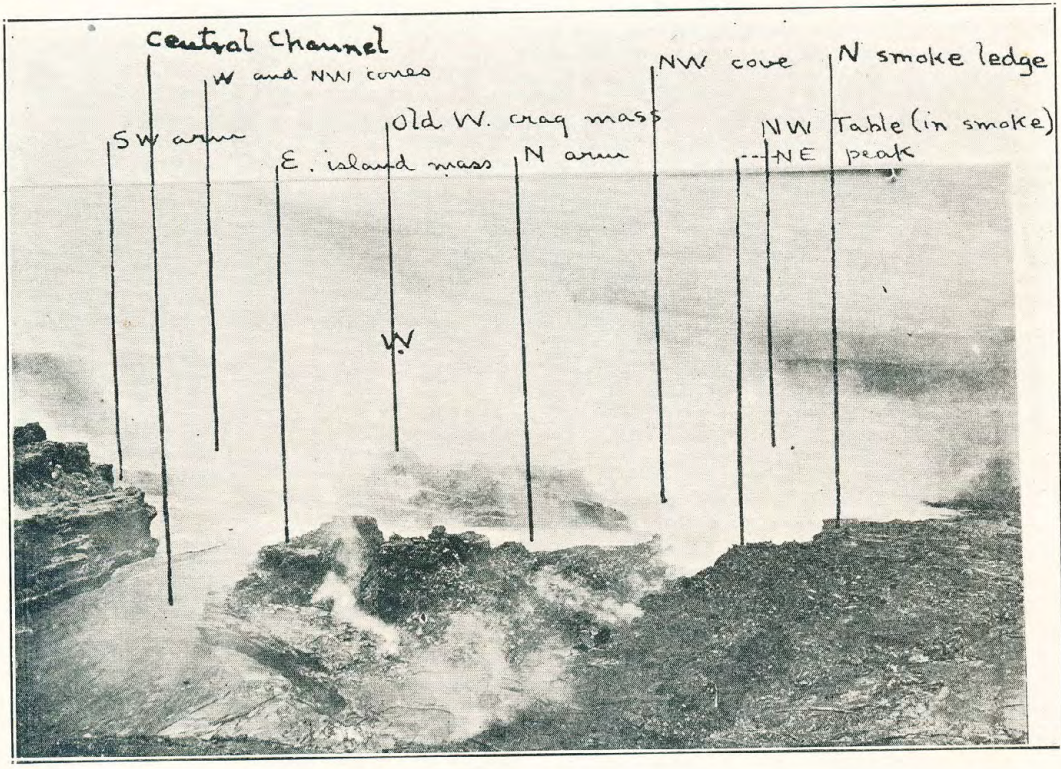
VOLCANO OBSERVATORY, Dec. 29, 1917.—During the week ending Friday, December 28, 1917, the lava column of Halemaumau continued its subsidence for a time, but on December 24 it resumed rising very much as before the solstice, so that at the end of the week the depression of the liquid lake was only 75 or 80 feet and the central and east island crags were again well above the level of the edge of the pit. The solstice period has been marked by several heavy earthquakes registered on the seismographs from origins a long distance away.

On Saturday, December 22, in the morning, the lava lake was lower, rocks were falling from the north side of the southeast crag, and there were cavernous openings on the west side of the southeast cove and at the central cove. There was a new inner bench two to three feet above the lake. Smoke was increased and the rampart was cracked on the west side of the southeast cove. The crag summits as seen from the Observatory were much lower. A very heavy localized rainfall about noon over Uwekahuna bluff on the west side of Kilauea sink produced a remarkable double waterfall down the face of the cliffs under Uwekahuna, draining out from the wash valley back of the southern bench of the cliff. The waterfall continued some thirty minutes, more or less.

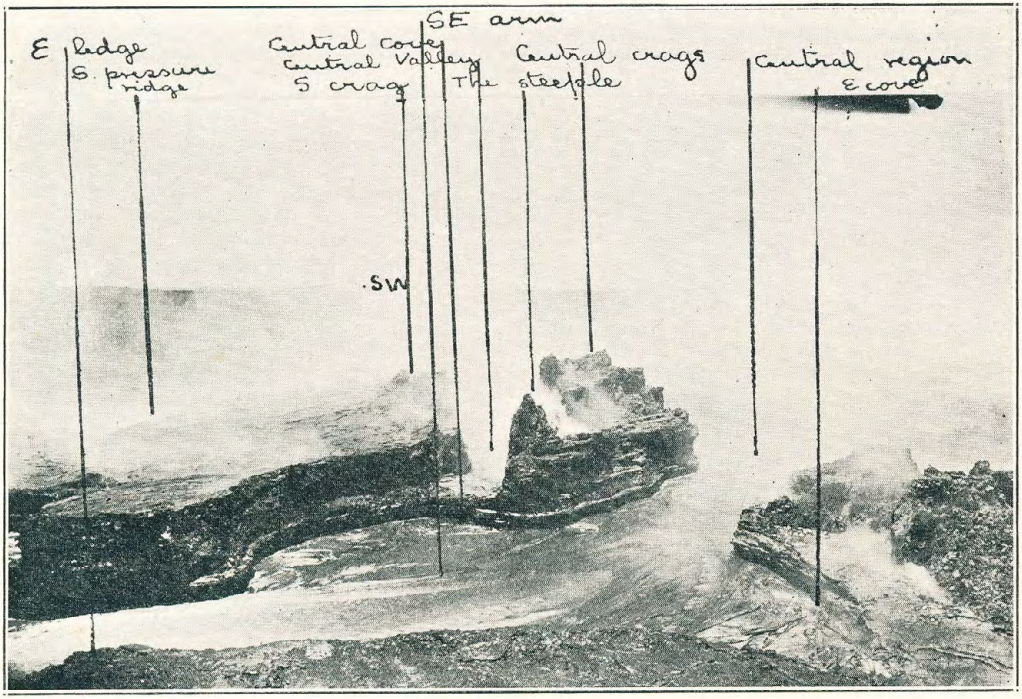
On December 23 the crags were stationary and the fume somewhat thinner, as though the subsidence were arrested or the lake were rising.

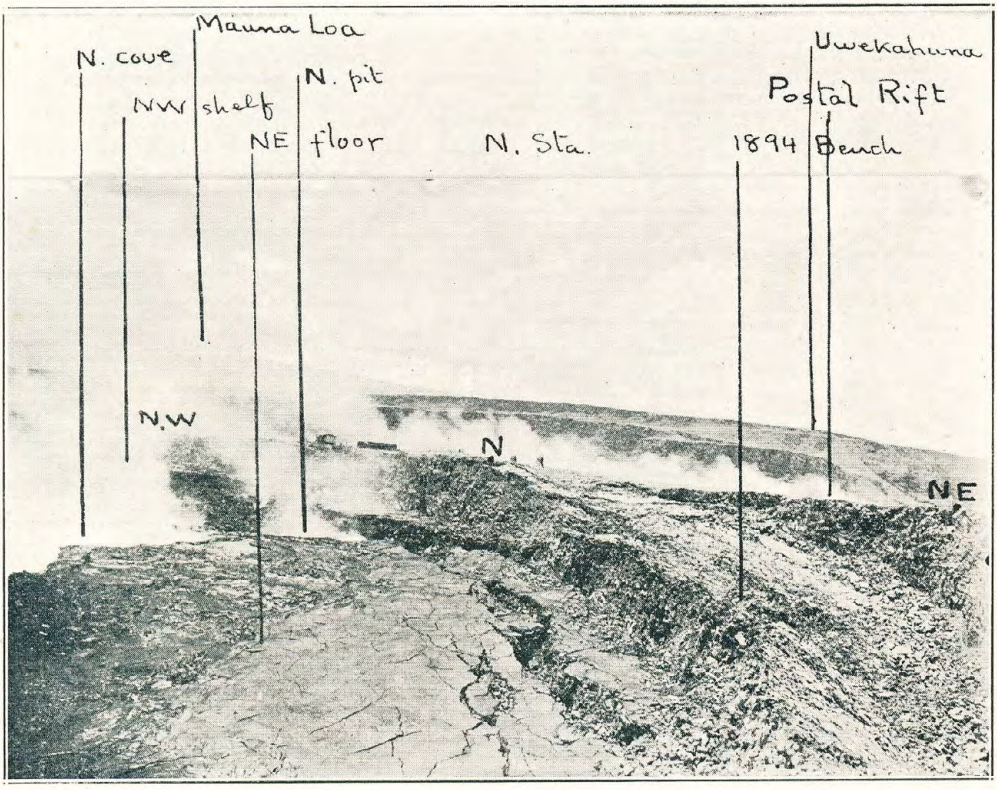
On December 24 at 5 p. m. the crags were much lower. The western summit of the central crag had fallen away and the east peak was now the higher and its tendency to overhang towards the south appeared increased. From the southeast station the lake appeared tumultuous, some 20 feet below the floor above the southeast cove, and general cracking and foundering and easterly streaming were in progress, with twenty or more fountains, open tunnels in the





Sept. 10th, 1917. Index Panorama.





Halemaumau from East.—Photo Jaggar.

coves and stalactites hanging around the lake shores. The tunnels were at the east cove, with quietly glowing interior, on the west side of the southeast cove, rumbling and active within, and at the east gulch. Five uptilted benches were now discernible from top to bottom on the southeast crag, the lowest one being only five feet above the lake.

From the southwest edge of the pit a quiet glowing cavern was seen at the northeast corner of the southwest cove leading under the central valley. Part of the roof was seen to fall into the lava below, and there were several small falls of rock from the south face of the central crag mass. Streaming was northward out of the southwest cove through a very narrow channel some 25 feet deep, with an active grotto in its outer bend. There were places densely smoking in the southwest floor and the south pressure ridge. Hissing was heard occasionally from the direction of the southwest tunnel. There was a stained area emitting blue fames at the eastern end of the pressure ridge, suggesting the presence of a cavity below. Out in the northern, western and central parts of the lake nine fountains were counted, some of them continuous in groups on the west side of the east island mass. This was a new feature distinctive of a definite subsidence. The noise was that of a continuous plashing, and the fountains threw up much spray and high flings of melt. Both the north arm and southwest cove regions were crusted most of the time. No glow could be seen near the western cones. The benches around the middle region of the lake were irregular, 15, 20 and 30 feet high.

At 5:30 p. m., looking from the southeast, four fountains were in action in the central region and one each in the grottoes of the central and southeastern coves and on the south side of the east island. In the central cavern there was continuous fountaining, inward streaming, high incandescence and much bubbling. There was outward streaming from under the high east island crag and along the shore to the east cove tunnel. Occasionally prolonged hissing was heard in the southeast cove where the gas forced its way from under the edge of the crust which covered the greater part of the southeast arm. At 5:30 p.m. there was bombardment against the north rampart and the lake was noisy with puffing, plashing, hissing, rumbling in the caverns, and cracking crusts. A glimpse of the distant northwest table summit suggested that it had risen. From the east station no activity was seen in the cavern on the north side of the central crag. Puffing was heard at the northeast cove and from the cavern of the central cove. Several falls of rock took place from the face of the east ledge and from the north face of the southeast crag.

On December 25 at 11:30 a. m. conditions were changed and the signs of rising were unmistakable. The fume was thinner and the crags were higher. The southeast arm was crusted over and a new inner bench had been formed entirely submerging the lower bench of the previous day at the point beneath the southeast crag. The new bench stood three feet above the lake. The caverns were quite submerged and were replaced by spatter grottoes at the east gulch, the central cove, the east cove, and the northeastern and western sides of the southwest cove. Both the latter and the southeast cove were crusted over. There was an active grotto with short stalactites on the west side of the southeast cove. Four or five continuous fountains played in the central region and in the north arm. Puffing could be heard from the grottoes. The western cones were hot and fuming. There had been a fresh fall from the second bench on the south side of the southeast crag since the previous day.

It should be noted that there has been much falling lately of rock from the high edge of Halemaumau about where the great crevasses on the southwest emerge into the pit. The tumble of broken rocks is scattered on the broken and cracked floor beneath.

On Thursday, December 27, 1917, at 3 p. m., it was rainy and foggy, but, nevertheless, it was evident that both lake and crags were higher. The lake was heavily crusted, the only open place being a small area on the west side of the southeast cove where the fiery lava streamed into the southeast tunnel. There was also cracking and foundering at the margin of the east cove and occasionally some activity broke out at the east gulch.

A new inner bench had formed about one foot high above the lake, and this was a wide platform at the east cove and at the point of the southeast crag. The lake was gaining on this crag, which showed now only three inches in its profile instead of five. Again the northwest table crag appeared very high as though rising.

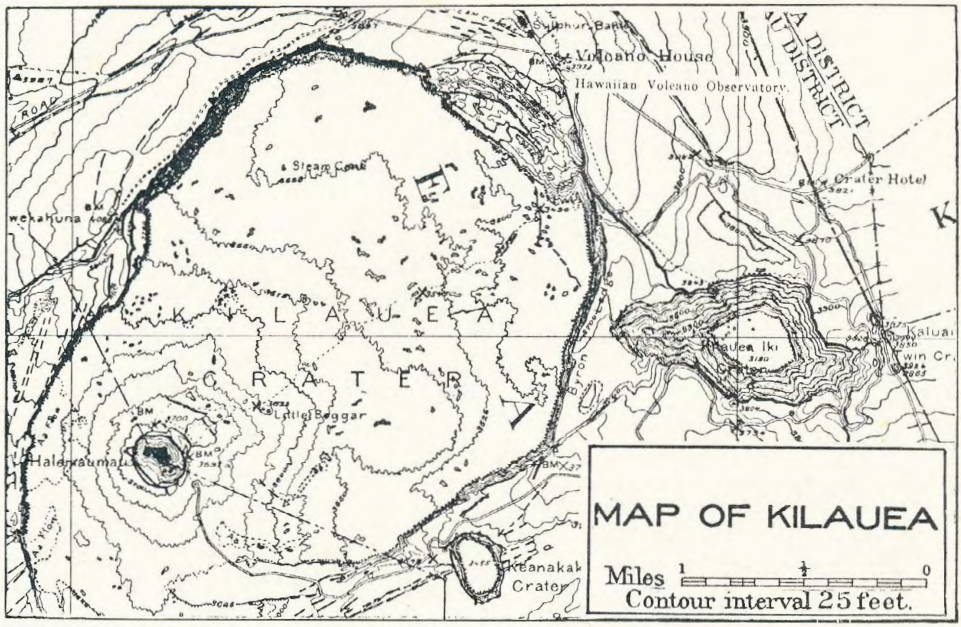
On December 28 the crags were distinctly higher. At 2:30 p. m. the inner bench stood two feet above the lake, which was rising, with activity at the central cove. At 2:45 there was fountaining in the north arm, and at 3 p. m. the southwest arm was seen to be broken up, with a few fountains in action there.

During the week ending at 2 p. m. December 28, 1917, the instruments of the Whitney Laboratory have registered one small local earthquake about 3 p. m., December 21, and a pronounced distant earthquake at 11 a. m., Hawaiian time, on December 28. The forephase of this seismogram is indefinite owing to heavy microseisms, so that the distance of origin is not clearly determined. Microseisms became very strong after the 24th. Volcanic vibration and movement of tilting have been moderate. The distant earthquake of December 28 may have been one of the Guatemala shocks recently reported.

Very respectfully,

T. A. JAGGAR, Jr.,

Director.



HAWAIIAN VOLCANO RESEARCH ASSOCIATION.

This society is a voluntary one, made up of subscribers to scientific work which is being executed by Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, Volcano House, P. O., Hawaii. **All scientific exchanges should be sent to this address.**

In 1917 there are about 150 subscribers in Hawaii and elsewhere, firms and individuals. A group of firms and persons in Hilo built the main observatory building in the spring of 1912. The work was founded by the Massachusetts Institute of Technology. Publications to date have been weekly reports since the summer of 1911 now reprinted in Honolulu in monthly form. There are also special reports, printed from time to time.

The weekly bulletin as it appears in the Honolulu Advertiser is reprinted as a leaflet and sent to regular annual subscribers to the work of the Association. **L. A. Thurston is president of the** Board of Directors of the Association, and L. T. Peck is treasurer. New subscribers who are interested in volcanoes will be welcomed in the Association. The Association aims: (1) To record volcanic activity and earthquakes in Hawaii; (2) to attract scientific men hither for special studies; (3) to promote the establishment of volcano observatories all over the world. The annual dues of regular members are $5; patrons of the Association subscribe larger amounts.

WHITNEY LABORATORY OF SEISMOLOGY.

The Whitney Laboratory of Seismology, named after an endowment fund of geophysical research held by the Massachusetts Institute of Technology, in memory of Caroline and Edward Whitney of Boston, is equipped with two Bosch-Omori 100 kg tromometers registering N-S and E-W motion, a heavy Omori tromometer registering E-W motion, and an Omori "ordinary Seismograph" designed for registering strong earthquakes in all three components of motion. These are seated on concrete piers in a closed basement room having practically constant temperature, beneath the chief Observatory building near the hotel. Time is referred to a rated chronometer, checked at intervals by solar observations with a transit. Both instruments are loaned by the College of Hawaii. Hawaiian standard time (H. S. T.) is 10 hrs. 30 min. slower than Greenwich time.

CANCANI SCALE OF SEISMIC INTENSITY.

Expressed by accelerations measured in millimeters per second per second.

I.	Instrumental	0.0	2.5
II.	Very slight	2.5	5.0
III.	Slight	5.0	10.0
IV.	Sensible, mediocre	10.0	25.0
V.	Rather strong	25.0	50.0
VI.	Strong	50.0	100.0
VII.	Very strong	100.0	250.0
VIII.	Ruinous	250.0	500.0
IX.	Disastrous	500.0	1000.0
X.	Very disastrous	1000.0	2500.0
XI.	Catastrophic	2500.0	5000.0
XII.	Great catastrophe	5000.0	10000.0

Grade IV. is ordinarily the minimum perceived by the senses; and in grade XII. the acceleration, or rate of change of motion (jerk) reaches that of terrestrial gravitation.

In the standard form of report the maximum intensity or acceleration, designated by the symbol α, or max. α, is given in the conventional unit, **the milligal.** The milligal is a measure of acceleration, such that 1 milligal = 1/100 mm. per sec. per sec. = 10 μ per sec. per sec. The Cancani scale, here defined in terms of millimeters per sec. per sec., can therefore be expressed in milligals by multiplying each of the numbers by 100.