PREFACE

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

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

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

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

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

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

The Volcano Letter publications are also available in print:

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

April 2023

THE VOLCANO LETTER

A Weekly news leaflet of the Hawaiian Volcano Research Association

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TITLE PAGE AND INDEX FOR 1928

(Nos. 158 to 209)

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TITLE PAGE AND INDEX FOR 1928

Sheet 2

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No. 158 RELEASED WITHOUT COPYRIGHT RESTRICTION January 5, 1928

KILAUEA REPORT No 832

WEEK ENDING JANUARY 4, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

The week following the storm of the solstice season has been characterized at Halemaumau pit by many avalanches, tremors, and strong WSW tilting. Recorded avalanches were at 8:15 and 10 a. m. December 29, 10:02 a. m. December 31, and just after 9 p. m. January 2 and preceded by felt jarring. Dust rising over the pit was repeatedly seen, and several people reported avalanche roaring.

Measurements about 3 p. m. December 29, at 15 places along large cracks close to the east edge of the pit, showed that the cracks had widened two to four inches during December. All the talus slopes show fresh debris, and the falls of rock are particularly conspicuous along two vertical solfataric zones at the east and west ends of the big northeast sill. These appear to be ancient wall cracks where the pit wall shows a U-shaped cross-section of an ancient pit. The lava floor shows no changes other than fresh overlapping of extending talus debris, notably at the northwest.

There were 84 earthquakes registered during the week. One at 9:56 p. m. on December 30 was feeble; it has not been reported as felt. All the others were very feeble. On January 1 at 8:04 a. m. a tremor almost large enough to be classed as feeble was recorded, and at the same time a heavy avalanche was noted in the pit. Another heavy avalanche followed a few minutes later, but its recorded tremor was not nearly so pronounced.

Microseisms continue moderately strong.

NEW ZEALAND-TONGA VOLCANOES

A suboceanic ridge connects New Zealand and Tonga, and east of this is a narrow, almost linear, trough in the ocean bottom over 4,000 fathoms deep in two places (Volcanoes of the New Zealand-Tonga Volcanic Zone, by J. Allan Thomson, New Zealand Journal of Science and Technology, December, 1926, p. 354-371). West of the Kermadec Islands the submerged region descends gradually to depths of over 2,000 fathoms. The Tongan Plateau bears the inhabited islands of Tonga on its eastern higher side, composed of submarine tuffs and coral limestone. On its westward lower side there are small volcanic islets and submarine volcanoes. Similarly in New Zealand there are sedimentary rocks in the northeastern part of the country forming a raised mountain axis, while in a relatively depressed belt, next to the west, lie the volcanoes. In the Kermadecs the volcanoes lie close to the edge of the ocean trough, but there are granite fragments in the tuffs there of continental origin.

The volcanoes from Ruapehu in New Zealand to Fanua Lai in Tonga lie in a northeastward-trending straight line parallel to the ocean deep east of them. Farther north the lines of botb plateau and trough swing to the northwest toward the discontinuous platforms which support the Ellice, Gilbert, and Marshall groups of islands. The active volcano line also bends, ending with Niuafou.

Andesitic lavas and ashes dominate throughout the entire chain of old and new volcanoes, only the Kermadec Islands and Niuafou showing basalt in addition. This andesitic composition and the linear arrangement make the whole system one volcanic group.

To the east of this group all the Pacific islands consist only of basalts and their derivatives characteristic of the Pacific basin proper, while to the westward, as the active volcanoes are mainly andesitic, the New Zealand-Tonga line is believed to be marginal to the Pacific, particularly as many of the islands are partly composed of continental plutonic, and sedimentary rocks.

"There are at present two competing theories as to the origin of andesitic magmas. Daly, who believes that a universal layer of basaltic composition everywhere underlies other rocks, considers that andesite is best regarded as a direct derivative of common basalt by the removal through sinking of the heavier constituents in a column of slowly cooling liquid basalt. Hobbs, on the other hand, considers that andesites are formed by the simple melting of shales under up-folding arcs of the crust owing to the relief of pressure caused by the arching." After pointing out some objections to both these theories, Thomson concludes: "Probably a combination of Hobb's theory with Daly's theory of a universal underlying layer of basalt comes nearer the truth. Under the up-rising arcs there is a melting both of shales and other continental rocks and of basalt and an admixture, resulting in an andesitic magma. Within the Pacific basin proper, where the basalt layer forms the surface of the crust, a remelting forms only a basalt magma, from which trachytes and alkaline rocks are formed in small amounts by differentiation."

Dr. Thomson's paper is in the main a record of eruptions of this whole line of active volcanoes Forty explosive outbreaks are recorded since the beginning of the 19th century, the only records of lava flows being those of Ngauruhoe of 1869 and 1881, both of which are disputed. However, all the larger cones show lava flows in section. "Either flows are relatively so infrequent that nearly a century can pass without one, or there has been latterly a change in the mode of eruption by which the lava has become more explosive." This all sounds very much like the eruptive history of Lassen Volcano and the Aleutian and Japanese cones ,and as the list of Tongan outbreaks is admittedly incomplete, it is probable here as elsewhere that many of the lava flows are from the lowest vents and consequently submarine.

This accents the importance of what has become increasingly evident at the Hawaiian Volcano Observatory, namely, to devise geophysical methods for studying movements of magma underground. This means investigation of tilt, tremor, magnetism,gravity, horizontal and vertical shift of benchmarks, and changes of solfataric chemistry. A combination of these processes, rapidly at times of explosive crisis, and slowly at other times, is what must form the basis for diagnostic measurement in volcanology. Intrusion is the greatest volcanologic process; it is in action today, and this fact is insufficiently realized by geologists. There is no field more hopeful for development of precise methods along these lines than the volcanic districts of New Zealand, where a new volcanologic service has been inaugurated. T.A.J.

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No. 159 RELEASED WITHOUT COPYRIGHT RESTRICTION January 12, 1928

KILAUEA REPORT No. 833

WEEK ENDING JANUARY 11, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

This week has ended with a small gush of lava in the bottom of Halemaumau, but it is very doubtful whether this is anything more than a squeezing-up by pressure of remnant liquid lava from the July eruption of 1927.

The week has been fine, ending with strong northeast wind. At the end of last week there was almost continuous uneasy sliding of small rocks from the west, northwest, and north walls of Halemaumau. This is usually started by a big rock falling from high up the wall. The July floor has been greatly overlapped with debris, especially under the northwest talus cone, the top of which has been incessantly added to so as to bury the niche formerly seen there.

A traverse of the south and west edges of the pit the afternoon of January 7 showed that the flag at the west-northwest rim was in a precarious position, and new cracks were giving up hot steam for 50 feet back of this flag. So fresh were the cracks that fern and grass sods watered by the recent rains were torn asunder, and some of the fissures were more than three feet wide. Numerous small slides were falling under this place.

On January 9 new measurements along the cracks back of the east rim showed progressive widening of the principal crack northward to a maximum of five inches increase of width over the measurements of December 29. Leveling across Kilauea Crater floor from the south gravel ridge to the vicinity of the pit revealed a lowering in eight months of the Halemaumau rim region of 0.4 foot. Six notable slides occurred just after noon.

On January 10 avalanches increased all day at the northwest, and from 4:30 to 5 p. m. big slides indicated that the WNW wall was undermined and in process of falling. A large wet scar in the high wall lay over wet new-fallen fragments below. There was some sliding on all sides of the pit, as though the bottom plug were lowering under the debris slopes.

At 12:26 a. m. January 11 there was a prolonged avalanche roar heard, and then a moderate rosy glow appeared over Halemaumau. When the pit was reached about 1 a. m. there were three glowing areas of fresh incandescent lava on the floor, a long curved western band, a small central pudding, and a smaller fiery pot at the site of the north floor cone of July, 1927.

It was evident that new lava had spouted up, but in addition a light-colored landslide area covered the whole northwest floor. The rosy glow above the pit as seen from a distance had entirely disappeared in 20 minutes; the new lava was no longer bright, but consisted of a filigree of cooling flows with a suggestion of blue flame at the northern cone. There was little observed motion, no hissing or fountaining anywhere, but sliding continued from all sides, particularly northwest. The high, dark, avalanche scar in the WNW wall was now extended up to the top, and steam was seen on the face of the wall next to the north.

A circuit of the pit during the forenoon showed that the main new flow was not visibly incandescent by daylight, and consisted of black "sharkskin" lava in a crescent around the south side of the northwest pool of 1927. It lay just outside of the sunken crust of that circular pool, which had been surrounded by a raised bank separted by cracks from the subsided inner shell. The new lava had come up these cracks in three places, the flows merging outside of the bank to make the crescent, which was about 500 feet long. At its northeast end, near the center of the pit, was a small, ragged, lava patch, which had flowed from another crack eastward.

All of this appeared to have been occasioned by the landslip of the northwest debris slope. The tumble of rocks had ridden over and weighted down the whole of the crusted pool, breaking up the crust, as shown about the edges, and apparently squeezing up live lava from below, which emerged at the border cracks. Apparently this "lava floor," seemingly dead since last July, was really a stagnant lava puddle, still liquid below. It had been about 70 feet deep.

The northwest floor area was all covered with lobate heaps of red bowlders, the lobes convexed to the southeast. The northwest talus was completely stripped, revealing a rock slope lying at a flat angle. An immense avalanche from the edge of the pit had carried away the WNW flag, made a new notch in the pit edge just where the opening cracks had predicted collapse, and the crash had precipitated the landslide at the bottom.

The fire pot at the north cone had merely sent out a little trickle of black lava, stimulated by the same landslide pressure on the crust as at the other places. During the day the slides seemed to subside.

All this history pointed to a collapse rather than a rising, as shown by the slides and inward tilt of the past week. The load of tumbled rock revealed and squeezed up a little remnant lava. There was no harmonic tremor and no hissing was heard, both of these being characters of gas-charged lava when it is vigorously tumescing and ready to make fountains.

There were 58 local earthquakes recorded during the week. All were very feeble with the exception of one, at 1:07 p. m. January 4, which was a moderate shock felt in Hilo, South Kau, and other places, as well as locally. The distance to its origin from the Observatory is indicated as 21 miles. A number of the very feeble local tremors occurred coincidently with avalanches in the pit. For many avalanches the time was not noted. It is probable that if more avalanche times had been noted, there would have been a greater number of the recorded tremors matched with coincident avalanches. During the night of January 10-11 a very heavy avalanche occurred, probably at 12:26 a. m., if the tremor recorded on the seismographs at that time can be regarded as the resultant disturbance. This tremor was more strongly recorded on the Uwekahuna seismograph than at the Observatory, which is to be expected; the distances of the two stations from the pit being 0.9 and 2.2 miles, respectively. The tremor as recorded at the Observatory was almost strong enough to be graded above the very feeble class, being nearly large enough to be perceptible. It was preceded by four more feeble preliminary tremors, the first of which was recorded at 12:19 a. m.

Microseisms were slightly stronger than usual during the middle part of the weekly period. Tilt accumulated moderately toward the WSW during the week.

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No. 160 RELEASED WITHOUT COPYRIGHT RESTRICTION January 19, 1928

KILAUEA REPORT No. 834

WEEK ENDING JANUARY 18, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Succeeding events confirm the belief that the lava gush of January 11 was only a squeeze by landslip on remnant liquid lava under crust. There has been no more flowing, and all the seismic, avalanche and tilt disturbances of the first of the year have ceased. There is nothing new at Halemaumau.

The number of earthquakes recorded on the Observatory seismographs during the week is only 15. They were all very feeble. Of this number, nine came on the first two days, leaving only six for the rest of the week. Microseisms were moderately strong on the 13th and 14th. Slight east tilt has accumulated during the week.

LAVA AND ASH OF KILAUEA

In 1925 Dr. John B. Stone, Bishop Museum Fellow of Yale University, made a geological investigation of the rock materials and structural relations of Kilauea Volcano, which he presented as his dissertation for the doctorate. (Products and Structure of Kilauea, Bishop Museum Bulletin 33, Honolulu, 1926; 59 pp., 2 pl., 7 fig., and bibliography.) This essay is an admirable introduction to the discussion of the difficult interpretation of field facts concerning the relation of Kilauea to Mauna Loa. Dr. Stone examines without prejudice the specimens he collected himself, giving full credit to all earlier workers. He makes use of block diagrams to exhibit the structure and topography of Kilauea Crater and Kilauea mountain. He gives special attention to the boundary line between Kilauea flows and Mauna Loa flows, and concludes that a volcano in the general vicinity of Mauna Loa was older than Kilauea. On the basis of the evidence presented, this conclusion appears to the reviewer to be still in doubt, as it seems to him not unlikely that the ancestral volcano under the Mauna Loa-Kilauea complex was a ridge connecting the present Kilauea sink with the Waiohinu district by way of Wood Valley and Mohokea, all of these places being engulfment remnants of ancient craters.

Stone makes the following wise comment: "It is generally assumed in discussions of Hawaii that the island has been built by the five recognized volcanoes, but this is by no means certain. An old land mass underlies Kilauea and at least part of Mauna Loa. That this land was built by the present Mauna Loa is quite possible. but not proven. The evidence of extensive faulting along the southern coast and probably also along the northern side of Kohala suggests that there may have been older volcanic centers of which nothing is known, now sunk beneath the ocean or buried by the later volcanoes." It seems to the reviewer that Wood Valley and Mohokea are physiographically much too important as probable old volcanic centers to justify the statement that "nothing is known" about them.

The petrography of Kilauea indicates that all specimens are basalts, with labradorite basalts most abundant and containing only one per cent of olivine. There are some olivine basalts, and from the deeper mountain gabbroid explosion blocks have been thrown up which are picrite basalts containing 15 to 40 per cent of olivine. The minerals are olivine, pale brownish augite, rare hypersthene, calcic plagioclase feldspar, magnetite, ilmenite, and brown glass containing apatite. Cristobalite was found in vesicles of some of the coarser rocks. Sulphur and sulphates have been formed by fumarolic action. The textures of the rocks range from intersertal to diabasic when they are crystalized, porphyritic crystals are olivine, feldspar, and pyroxene, and the tops of the flows have a black, glassy ground mass.

Typical feldspar basalts of Kilauea Crater contain weight percentages of minerals as follows: Olivine, 1; augite, 54; labradorite, 31; iron ores, 13; glass, 1; and the specific gravity is about 3. Dikes are rare, and when found have chemical composition like the flows. Gabbroid intrusions are common in the bottom walls of the innermost craters, showing percentage compositions as follows: Olivine, 40; augite, 31; laboradorite, 37; iron ores, 2; apatite, 0.3; and specific gravity, 3.

The ash beds make up less than five per cent of the section of ancient lavas exposed on the fault cliffs near the sea southeast of Kilauea. There are interbedded with the lavas five layers, 15 to 20 feet thick, of reddish yellow stratified ash here, which are quite fresh. On top of these older lavas and underneath the veneer of recent flows which have cascaded over the Kilauea slopes, there is a bed from 20 to 60 feet thick of alternating yellow and gray ash containing lapilli. This occurs at the top of the pre-Kilauea series in the big fault cliffs, and is correlated by Stone with the so-called "yellow ash," from 28 to 95 feet thick, in the Pahala and Kapapala districts. Stone states that the yellow ash of Kapapala contains bands of lapilli and is pisolitic. He classifies as a single stratum marking an episode in the geological history of the country the red and yellow clays of Glenwood and the Bird Park, the beds of the southeast fault cliffs, and the ocher soils of Pahala.

There are ash beds at the base of the Uwekahuna cliff west of Kilauea Crater, and others forming the surface soils around Kilauea. These last range in thickness from one to 30 feet, and contours drawn by the reviewer on Dr. Stone's map of thicknesses show that the surface ash is at its maximum just south of the crater and is distributed northeast and southwest from there in belts of decreasing thickness.

The thread-lace scoria, or basaltic pumice, which lies at the base of these ash beds, ranges in thickness from one to 18 inches, the thickest exposures adjoining the north side of Kilauea Crater. The contours indicate a symmetrical development around this part of the crater with widest belts at the north, as though a south wind were blowing when lava fountains in the northern part of the crater ejected this material.

Four intervals between ash eruptions are indicated by fossil sod layers in the beds above the thread-lace scoria, and Stone considers only the coarse upper layer to be the product of the eruption of 1790. The ash beds contain mineral and glass fragments, sometimes the one and sometimes the other being dominant. The 1924 ash consists almost entirely of mineral fragments. T.A.J.

SAMPLE COPY

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No. 161 RELEASED WITHOUT COPYRIGHT RESTRICTION January 26, 1928

KILAUEA REPORT No. 835

WEEK ENDING JANUARY 25, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Nothing has happened during the week to change Halemaumau pit. A little dust from slides was seen rising January 24. The seismographs at the Observatory recorded 25 very feeble local earthquakes. On the 24th, beginning intermittently at 5:12 p. m. and becoming continuous at 5:18 p. m., there was a very feeble protracted tremor, very much resembling harmonic tremor in appearance on the record. It waxed and waned, so that there were five distinct times of maximum amplitude, which have been included in the above count for the weekly total. The greatest of these maxima occurred at 5:37 p. m., and the tremor itself continued until 5:46 p. m. before the last trace died out.

Microseisms have been normal during the week, and tilt has accumulated very slightly toward the ENE.

LASSEN REPORT No. 14

Mineral, California, January 15, 1928

R. H. Finch, Associate Volcanologist

There have been several reports recently concerning activity of Glass Mountain, a peak about 7,850 feet high and about 75 miles north of Lassen Peak, in the Modoc lava beds. Rather new lava flows are to be found nearly all the way between Glass Mountain and Lassen Peak. Forest Service officials report about half an acre of land covered with pumice which is very hot. By digging but a little way into the pumice, much higher temperatures can be reached. Near this pumice bed there is a deep fissure from which steam issues.

According to George W. Courtright, a rancher and trapper residing about 12 miles east of Glass Mountain, the heat of the mountain has been known for years. The local Indians, ever since the country was settled, have been known to say, "Glass Mountain no good place." Mr. Courtright reports that numerous earthquakes occurred in January and February, 1910, and that during the shaking flames were observed over the mountain. In the spring of the same year he reports finding "blue mud" on vegetation on the mountain slope. Earthquakes originating in the mountain and accompanied by rattling noises have been noted by Forest Service officials for at least 15 years. Similar noises and shakes have been observed by Mr. Courtright for a much longer period. Near the northern end of the lava beds to the north of the mountain, a fissure about one-half mile long opened up during a very pronounced shake in 1910.

The writer and Mr. George L. Collins of the National Park Service endeavored to make temperature measurements and to take photographs on the mountain January 13, 1928, but were driven back by a heavy snow storm. It is planned to conduct further explorations in the spring.

VOLCANO-GLACIER FLOODS

The effect of volcanic heating on glaciers in Iceland is of great interest in comparison with what may happen on the glacier-covered volcanoes of Alaska. This melting was supposed to happen on the snow-covered Lassen Volcano of California. It may even have happened some thousands of years ago in Hawaii, when glaciers lay on top of Mauna Loa and Mauna Kea. This may account for some Hawaiian tuff deposits. The heat of the eruption melts the snow and ice masses, and the warmed water melts out gorges in the glaciers, increases in volume, and mixes with volcanic and glacial debris so as to make collossal torrents carrying icebergs out over the lowlands. These glacial floods are common in Iceland, where they are known as "Jokulhlaup" or glacier rushes. (Vulkankunde, by Karl Sapper, with petrographical introduction by A. Bergeat; 32 text figures, 30 plates, and 4 colored maps; 1927, Engelhorn, Stuttgart.)

At Katla, Iceland, in 1918, several openings trending SW-NE, about 1,000 meters above sea level, went into action along this crater which had become buried under ice since 1823, when it was last active. At 2 o'clock in the afternoon of October 12, 1918, after a swarm of weak earthquakes, steam clouds shot up, and for three nights thereafter these were full of electric fireworks. Human electrical operations, such as telegraph and telephone, were interupted. There was much rumbling, and heavy ash-fall occurred and shrouded much of the land in darkness. This continued off and on for 20 days, with maxima about the 10th and 21st day. In a radius of one kilometer 698,220,000 cubic meters of ash fell.

The warm water streams from the melting of ice reached a depth of from 60 to 70 meters, and the masses of sand and mud which the glacier rush carried with it were so extensive as to build out the coast line.

The first glacier rush happened an hour and a half after the eruption began, and flooded a sandy waste at the foot of Katla. Spectators saw the flood, overhung by steam and dust clouds, laden with gigantic icebergs, rushing down a valley, and in a short time the sea nearby was covered with large and small bergs. At 5:30 that afternoon, a new glacier rush started in farther to the east, and continued most of the night, as shown by the roaring of the waters and the crashing and rumbling of colliding icebergs. This torrent spread out over a flat area of about 125 square kilometers, carrying thousands of ice slabs, the larger ones becoming stranded on the sandy waste. At one place the torrent rushed against a cliff 60 meters high, so that ice fragments and water shot into the air like a gigantic surf on a sea shore. By the next morning most of the flood was finished, but there were several smaller out-breaks on later dates. Farming lands were damaged, and many animals were killed. A visit to the crater after the eruption revealed heaped-up ash and great clefts 500 to 800 meters long, 40 meters wide, and 25 meters deep. Two great gorges had been eroded out of the glaciers by the floods.

This review will be continued. T.A.J.

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No. 162 RELEASED WITHOUT COPYRIGHT RESTRICTION February 2, 1928

KILAUEA REPORT No. 836

WEEK ENDING FEBRUARY 1, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

There has been nothing new observed at Halemaumau pit. The week has been stormy with northeasterly wind and rain. A little sliding from the walls was observed January 28, and sulphur is reappearing at the bottom of the talus E and SE. Today there is increased avalanching on the north walls of the pit. Thirty very feeble local earthquakes have been registered at Kilauea for the week. Microseisms have been normal.

LASSEN REPORT No. 15

Mineral, California, January 16, 1928

R .H. Finch, Associate Volcanologist

On December 21, 1927, the temperatures of Morgan's main hot springs varied but slightly from previous measurements of October. Some of the smaller springs near Mill Creek channel show increase of temperature and decrease of outflow. In one of these in October, some larvae of presumably a large fly were living in water at a temperature of 168 degrees F. In December there were still more larvae, and the temperature was 195 degrees F. On each occasion the larvae appeared very much alive.

At 8 a. m. December 30, R. H. Finch and O. H. Emerson left Mineral to try for an ascent of Lassen Peak. The cabin at Supan's solfatara was reached at 2 p. m. While the snow was not as deep as last year at a corresponding date, snowshoes were needed all the way. At Supan's (the 'Sulphur Works"), the snow was about four feet deep as compared with about six feet last year. All small streams showed less volume than a year ago. Owing to high wind and dense steam clouds, a satisfactory temperature reading of the largest steam vent at Supan's was not obtained, but indications were that it was as hot as when measured in October, 1927 (240° F.). Owing to heavy snow storm, no attempt was made to complete the ascent, and Mineral was reached on the return December 31 at 2 p. m.

AGE OF LASSEN CINDER CONE LAVAS

By AUSTIN E. JONES

The following preliminary notes on rough field application of the Chevallier method (Volcano Letter No. 45; Nature, October 3, 1925, p. 515) to Lassen lavas are of interest. The method assumes the magnetic declination of the outcrop to preserve the declination of the year of solidification. Mr. Finch writes that Mr. Austin E. Jones, assistant at the Lassen station, and he had found evidence of a source fissure in this flow marked by a NW-SE line of cones. Mr. Jones writes:

"August 30, 1927, I made rough experiments with a Forest Service surveying compass by Keuffel and Esser. (Lat. 40° 32′ N., Long. 121° 15′ W. Magnetic declination 19° E.). Loose lava blocks showed magnetic declinations varying up to 20° from the earth's field here. A traverse was run, checked by backsighting, to a large reddish outcrop on the east side of the lava beds between Butte Lake and Snag Lake. The magnetic field of this outcrop was found to have a declination of 14° 9′ east of north. This was close to a small red cinder cone on this edge of the lava beds.

"Traversing across the beds, a black rock was found giving declination 16° 7′ east of north. This had smooth surfaces and was part of a fissure eruption frozen in place. The ridge had precipitous sides 20 to 40 feet high, was 50 feet thick, and indicated a former fissure for more than 100 yards.

"Assuming equivalence to Redding, California, the nearest magnetic station, and extrapolating for the declinations at ten-year intervals 1810 to 1920 (Smithsonian Physical Tables), the older rock cooled between 1794 and 1797. Interpolating for the newer rock, it cooled in 1832. The probable error is within 10 years.

"If the lava underlying the Cinder Cone ash were examined, it should prove much older than either of the other two flows, and should help date Cinder Cone itself."

ALASKAN NOTES

Associated Press notices of December 7, 1927 (Seismological Dispatches of Georgetown University) say that many square miles of land are rising in upper Cook Inlet. Small boats here have gone aground in waters formerly deeper, and places formerly covered by several feet of water at low tide are now only reached by the highest tide, which has a range of 34 feet at Anchorage. (The same thing has been observed in eastern Japan.)

A notice of December 8 states that two volcanoes on Unimak had been smoking for ten days, after a season of unusual activity in the Aleutians. The smoke and vapor is stated to be "in comparatively small quantities."

Lake Kenai, 20 miles northwest of Seward, is reported to have been severely shaken by three earthquakes December 9. Cabins swayed, but no damage was done. Juneau experienced a rattling earthquake for 30 seconds at 10:02 a. m. December 31. T.A.J.

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No. 163 RELEASED WITHOUT COPYRIGHT RESTRICTION February 9, 1928

KILAUEA REPORT No. 837

WEEK ENDING FEBRUARY 8, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Halemaumau pit remains the same, no noticeable changes having occurred since the "activity" of January 11. There are occasional slides from the walls, sometimes large enough to send a little dust above the rim, but no large avalanches have been observed. A visit at 5 p. m. February 8 showed a few wall scars north, northeast, and east. There was very little steaming, but the wet steaming areas on the taluses were very conspicuous. The crack at the southeast trail, about 75 feet back from the rim, has widened.

Twenty-five earthquakes were counted on the seismograph records, of which 21 were very feeble and four were feeble. One of the later group, at 2:24 a. m. February 6, had an indicated distance to origin of 20 miles.

VOLCANO LORE

A very important book on geographical volcanology has just been published by Professor Karl Sapper, in charge of the Department of Geography at the University of Wurzburg. (Vulkankunde, von Karl Sapper, with petrographical introduction by A. Bergeat; 32 text leaves, 30 plates, and 4 colored maps; 1927, Engelhorn, Stuttgart.) Dr. Sapper is well known for his extensive studies of the statistics of eruptions and the distribution of volcanoes on the earth, and he has made extended journeys, especially among volcanoes of Central America and Iceland. This book is a readable text on the geographical distribution, significance, and forms of volcanoes on the one hand, and on the mechanism of volcanic eruption in its relation to mineralogy, physics, and chemistry on the other. No attempt is made to expound the mathematical aspects of the subject in relation to geophysical processes, but a very complete chapter on the history of volcanologic investigations is presented from the time of Aristotle to the days of such modern theorists as Daly and Joly.

The petrographical introduction by Dr. Bergeat presents current notions concerning the minerals in volcanic rocks, the classification of such rocks, and the distinction between the intrusives and the effusives. This chapter hardly goes beyond 19th century petrography.

Chapter II, on the gas-content of magma, is very modern, and contains a full discussion of the recent work on collection and analysis of gases and the studies of lava temperature which have been made by American investigators, especially in Hawaii, California, and Alaska.

Chapter III deals with the meaning of "magma" and a discussion of basaltic substratum in its relation to such conceptions of the motion of the crust of the earth as have been expounded by Daly, Wegener, and von Wolff. With reference to von Wolff's book on "Vulkanismus," Dr. Sapper expressly states that he does not attempt to double on the geophysical data set forth in von Wolff's book, but wishes rather to supplement it with a text which is expressly geographical.

The fourth chapter, on the "Nature of Volcanic Activity," is illustrated by descriptions and pictures of the wonderful eruptions of Santa Maria Volcano in Guatemala, which have come under the direct observation of the author, and also such recent happenings as the eruption of San Borin in 1926, the explosive eruption of Kilauea in 1924, and the remarkable Icelandic eruption of Katla in 1918. This chapter is necessarily one of the most important in the book, 90 pages long, and deals with the forewarnings and accompaniments of what are called eruptions, and then discusses these phenomena under the headings "Subaerial Eruptions, Subiacustrine, and Submarine Eruptions; and finally pure effusive outbreaks, which are treated somewhat more completely than other phases of the subjects because of the fact that they are less well known than explosive eruptions.

The history of Masaya is traced from the sixteenth century on, this Nicaraguan volcano having exhibited a lava lake, lava flows, gas outbursts, and many moderate explosive eruptions with ejection of ash, sand, lapilli, and scoria. Some of these were disastrous.

Sapper next describes Kilauea, treating in order the visit of Ellis in 1823, Daly's work in 1909, the work of Brun, in 1910, who obtained the impression of a continuous lava stream or spring passing under the pit, only a part of which was revealed by the opening. It should be said that Tempest Anderson, in 1909, had a similar notion about both Halemaumau and the volcano on Savaii, and it is interesting to note that Shepherd's recent suggestion of heat by lava circulation (Volcano Letter No. 157, December 29, 1927) contains the elements of a similar conception. Perret's work is given much attention by Sapper, who has evidently studied exhaustively his description of observations made in the summer of 1911, which were the beginning of what has since developed into the Hawaiian Volcano Observatory. Sapper points out that whereas W. L. Green considered the lava process a hydrostatic one, Daly added the conception of gas frothing to establish a convectional circulation, and then Perret added the notion of a continuous gas combustion, which has been carried still farther by Jaggar.

The next purely effusive volcano to be discussed is Matavanu, on Savaii, in the Samoan group, which developed a lava lake and sent a flood of basalt over several villages into the ocean for six years—1905 to 1911. The condition in successive years is reviewed largely from the data published by German observers, making the most complete condensed statement of the succession of events in that remarkable Samoan eruption which has yet appeared.

This review of Dr. Sapper's book, the first article of which appeared under "Volcano-Glacier Floods" in Volcano Letter No. 161, January 26, 1928, will be concluded next week. T.A.J.

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No. 161 RELEASED WITHOUT COPYRIGHT RESTRICTION February 16, 1928

KILAUEA REPORT No. 838

WEEK ENDING FEBRUARY 15, 1928

Sectior of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Conditions at Halemaumau show no change over last week. A slide from the east wall at 9:30 a. m. February 12 was reported. A visit at 11:30 a. m. on the 13th showed new fine material at the bottoms of the NE, N, NW, and SW walls. Measurements show pronuonced widening of the east rim crack from the 14-ton bowlder to the edge of the pit.

The number of earthquakes recorded on the Observatory seismographs during the week ending February 15 shows a very considerable increase over the numbers for the last few weekly periods. The records show 61 local earthquakes, all very feeble with one exception. The earthquake recorded at 10:06 a. m. on February 11 is graded as feeble, and may have been perceptible to some people in the vicinity of the volcano. The indicated distance to the origin of this shock is 28 miles. It has been reported as felt in Hilo. A few minutes after this earthquake there was a prolonged tremor lasting about four minutes. Aside from the fact that this perceptible earthquake and prolonged tremor occurred on the 11th, this day also had more than its share of the very feeble earthquakes, 16 being recorded during the 24 hours.

Microseismic motion was somewhat stronger than usual on the 9th and 10th. There has been practically no accumulation of tilt during the week.

VOLCANO LORE

(Conclusion)

It is pointed out that lava volcanoes occasionally produce intense explosive phenomena, and in this connection the explosive eruption of Kilauea in 1924 is carefully reviewed. Masaya is quoted as having behaved like Kilauea in ejecting pumice and breadcrust bombs at the end of a lava flow period.

The classification of eruption types is considered, as for instance in the four categories of Lacroix; namely, the Hawaiian, Strombolian, Vulkanian, and Pele types. The Hawaiian type has great fluidity of magma, seldom exhibits explosive paroxysms, and characteristically produces glassy black slags and fibrous spun glass. The Strombolian type exhibits basaltic magma, more viscous, resisting the explosion of gas, so as to make heavy explosions common, with ejection of magma bombs. The Vulkanian type has very stiff magma, which becomes fully solidified between explosions, so that when an explosion occurs cauliflower clouds are the rule, with ejection of angular stones and breadcrust bombs. In the Pele type, glowing clouds of dust are ejected explosively, with extreme restriction in the orifices, viscosity of the underground magma is at a maximum, and down-rushing torrents of debris are common.

Finally, the subject of phreatic or water-made explosions is treated, and in this connection there is cited an explosion that took place in the lava fields of Matavanu in May, 1908. A great opening was made in the lava field of 50 meters diameter, great quantities of mud were thrown out a hundred feet into the air. At first it was thought that a new crater had formed. The place was in the midst of the former town Saleaula, where there had been a stream of water. Similar explosions have been described in Mexico, in the Aegean Sea, and elswhere.

The aftermath of volcanic activity is next considered, as shown in the activity of solfataras, geysers, mud streams, gas craters, and the like. Next comes the genetic morphology of the volcanic edifices, and the destruction of the same through atmospheric erosion, chemical action, the work of the winds, and other processes.

The geography of active volcanoes is Dr. Sapper's specialty, and this book presents more fully than any of its predecessors the facts known concerning the distribution of volcanoes, the amount of materials ejected, the frequency of eruptions, and the geographical significance of these facts with reference to the activities of men and in relation to the other geophysical processes of the crust of the earth. There follows a condensed list of active volcanoes, and their several histories are treated by means of formulae, such as were instituted first by de Ballore. This treatment promises much for volcanologic science as it makes possible the condensation of a vast amount of information in a single letter. Thus Kilauea is described for the year 1822 "a2", which means lava flows of greatest magnitude exceeding two cubic kilometers in bulk. So the letter "b" stands for ejection of ash, sand, lapilli, and scoria; "c" stands for ejection of deep magma, and "d" for explosive ash eruptions involving chiefly surface material.

The review of volcanology at the end of the book is eclectic, and covers with the same thoroughness and brevity that appears in all the other chapters the progress of volcano theory during the growth of civilization, and ends with the statement: "The most important goal for the future of volcanology is to obtain new collections of fact and make them available, for only by such procedure can a substantial basis be made for more satisfactory theories than have hitherto been evoked." T.A.J.

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No. 165 RELEASED WITHOUT COPYRIGHT RESTRICTION February 23, 1928

KILAUEA REPORT No. 839

WEEK ENDING FEBRUARY 22, 1928

Sectior of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

It has been a week of avalanching at Halemaumau pit, with the accompanying tremors recorded on seismographs. On February 17 at 8:30 a. m. and at 10:15 a. m. light avalanche dust clouds were seen NE and NW respectively. All the forenoon of the 18th the north wall was working, and dust clouds went up at intervals. At 1:30 p. m. there was a big dust cloud at the north, but when the pit was visited all was peaceful both that afternoon and the next day.

February 20 at 8 a. m. a large dust cloud rose at the north corner of the pit and hung in the air for 20 minutes. Other avalanche clouds followed, and a climax of sliding sent up such a cauliflower that the column of dust rose several thousand feet and was visible from Hilo, starting rumors of an eruption. Between 9:30 and 11 a. m. only minor avalanches occurred N and NW, and there were others in the afternoon. The pit floor was covered with red dust on its north side, and the big cloud had stained the outside Kilauea floor there also. On February 22 the roar of an avalanche was heard about 3 a. m., small slides were seen NE at 8:30 a. m., and on visiting the pit at 2 p. m. I found little motion. The bench at the west end of the big north sill is gone, and there is a break in the wall west of there. The northeast corner had been sliding, as shown by fresh avalanche debris.

During the past week there have been recorded on the Observatory seismographs 52 very feeble local earthquakes and one very feeble teleseism. The avalanching at the pit is probably responsible for many of the small tremors recorded on the seismographs. Avalanching began during the early hours of the 20th, apparently working to a climax at 8:57 a. m., when an avalanche occurred that made a definite record on the instruments. At 3:05 a. m. February 22 there was heard a roar of an avalanche, and a corresponding tremor appears on the seismogram.

The teleseism was very feebly recorded, a phase that may be the beginning of either the secondary or long wave is shown at 9:42 a. m. February 21. No estimate of distance could be made.

An earthquake reported felt in Hilo at 6:55 p. m. Febraury 15, is represented only by a very feeble tremor shown on the Observatory seismogram.

Tilt during the week has accumulaied modrately towards the SSW.

EXPLORATION OF WEST COAST OF HAWAII

The wheeled boat "Ohiki," described in Volcano Letter No. 156 December 22, 1927, traveled 30 miles to the beach at Ninole lagoon December 21, and successfully propelled itself in the water and landed itself on two beaches. It went forward and backward as required, taking up motor-car propulsion when the wheels touched bottom. The freeboard was raised, the paddle-wheels enlarged, an extension of the boat aft and water fenders were built, a winch and cable were mounted in the bow, and tests on Hilo beaches were made with increasing success January 17 and 20, and Febraury 4. A large outboard motor was added to the paddle-wheel propulsion, and a speed in water of four miles per hour was attained. The machine weighs 3,800 pounds, and is 22 feet long, with 5 feet beam, and overall width of 7 feet at the paddle boxes.

Thus equipped, an expedition was conducted to the west coast of Hawaii. The scientific party consisted of L. A. Thurston, President of the Hawaiian Volcano Research Association; T. A. Jaggar, R. M. Wilson, and T. Dranga, the personnel varying during the fortnight. The machine in the guise of an automobile truck left Kilauea Observatory February 8, the party of six camped at Waiohinu Homesteads that night, proceeded overland to Hookena, remaining there one day making beach and sea tests. We then went overland to Keauhou February 11, and camped there four nights, making sea trips south to Kaawaloa and Napoopoo, and north to Kailua, returning in each case overland. The boat was run with outboard propeller alone, paddles alone, and both together, and landings were made on rocks, pebble beaches, and sand.

Crew and load were reduced to four men, Thurston, Jaggar, Dranga, and Tahara, and a minimum of equipment, extra washboards were built amidships, and a voyage off the wild shoreline of northwest Hawaii was undertaken from Kailua to Kawaihae, a distance of about 40 miles. Camps on beaches were made at Makalawena, Kiholo, and Puako, and landings on other beaches at Kukio and Kalahuipuaa. Kawaihae was reached without accident at 11:30 a. m. February 19, the boat again became a truck for the steep hill road of 2,600 feet rise to Waimea, where the night was spent; and the next afternoon a land journey of 69 miles brought the party to Hilo via Hamakua and eastern Hawaii. February 21 completed the circuit of the island to Kilauea, making the whole journey by amphibian 208 miles by land and 58 miles by sea. Boat, engines, and running gear were all strong and in running order. The runs overland all made elevations of from 1,000 to 3,900 feet.

Geological features of interest observed on this journey were the lava cascades of Hookena, what appear to be fault cliffs at Hookena, Kaawaloa, and Keauhou, the 1801 flow north of Kaupulehu, mostly aa at its sea-front, the 1859 flow at Kiholo, where it is black pahoehoe of very fresh aspect, and the Kaniku flow in South Kohala, mostly aa lava equally new in appearance but of unknown date. At Puako are brown soils more than 10 feet deep, which appear to be freshet deposits, and a flat of this material heavily forested with algeroba extends more than three miles southwest of Puako, suggesting the yellow tuffs, of southern Kau, the glacial outwash of Mauna Kea near Humuula, and the North Kohala soils. The thickness of such deposits, remote from the volcanoes, more and more appears to suggest a glacial outwash origin rather than ashfall. (See Bull. Hawn. Volc. Obs'y October, 1925, p. 76.) T.A.J.

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No. 166 RELEASED WITHOUT COPYRIGHT RESTRICTION March 1, 1928

KILAUEA REPORT No. 840

WEEK ENDING FEBRUARY 29, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

The notable avalanching described last week at Halemaumau pit came to an end, and during the current week very little has occurred in Kilauea Crater with the exception of a seismic flurry of felt earthquakes on February 26.

A visit to the pit at 2 p. m. February 25 revealed no motion of sliding from the walls, nothing new in the bottom, and more yellowish green sulphur stain near the base of the talus slopes east and southeast at spots which have exhibited such solfataric action for a long time past.

On February 26, after the two felt earthquakes of the night and morning hours hereinafter recorded, along with the southerly tilt which might have presaged subsidence in Kilauea, there was no conspicuous rock sliding to justify such a conclusion. Only one small fall of rocks that made dust occurred between 11:30 a. m. and 1:15 p. m. At 1:40 p. m. there was a slide at the north corner of the pit, and the niches in the wall northwest and north were working a little. On February 29 in the afternoon there was no change in the pit, but the eastern sulphur patches, after a spell of dry weather, appeared a little brighter colored.

There were 29 local earthquakes recorded by the Observatory seismographs during the week. Two of these were perceptible; the others were all very feeble. The two perceptible shocks occurred during the morning hours of February 26, the first one at 1:41 a. m. is classed as slight, and the second one, which came at 7:16 a. m., is classified as of moderate intensity. The first awakened a number of people from sleep, and is reported by some as accompanied by an earth noise. The second was of greater intensity than the first, and was felt as a single jolt by nearly everyone in the vicinity of the volcano, even though some were on their feet and walking at the time. A single bursting noise came with it. This second shock in its first movement dismantled both seismographs, so that after the first movement nothing was recorded till the last small dying out tremors, which show on the record after the instruments were set to rights three minutes later. When the pen was again set on paper, there was a definite tilt of about two seconds of arc disclosed, probably representing an actual tipping of the ground remaining from the disturbance of which the earthquake was the indication. The preliminary movement of both of these shocks was toward the southwest, in the direction of Halemaumau, and owing to the total lack of preliminary phases, both shocks were apparently strictly local.

Microseisms were somewhat stronger than normal on the 26th. Accumulated tilt during the week is strong toward the south, being due almost entirely to the sudden occurrence of south tilt during the second perceptible shock, as noted above.

LASSEN REPORT No. 16

Mineral, California, February 8, 1928
R. H. Finch, Associate Volcanologist

On Saturday, January 21, 1928, a rather sharp earthquake shock was plainly felt at Mineral. Within a few minutes two more smaller shocks occurred. All appear to be Lassen earthquakes. Sixteen inches of snow fell January 22-23, making it necessary to plow out the road.

In the library of the California Academy of Science an account of the last lava flow at Cinder Cone, Lassen Park, dates the flow during the winter of 1850-51. Other notes say January, 1851. According to the field evidence, there is nothing to refute the date 1850-51.

Newspapers have reported a new geyser at Calistoga. Examination showed in a new drilling, when the steam-producing depth of adjacent wells was reached, a temperature of 230° F. was measured. Before drilling was resumed, the well blew off and steam rushed up around the casing and eroded a crater before the well was cooled off with cold water so that the casing could be cemented in. Now the well is capped, and the steam supply is used in one of the bath establishments. The old, much advertised geyser well has been drilled deeper, and now it spouts about every minute instead of every four minutes.

On February 8 at 7:55 a. m. at Mineral there was a perceptible earthquake accompanied by loud roaring.

EAST INDIAN VOLCANO BULLETIN

A new monthly publication in English, the Bulletin of the Netherlands East Indies Volcanological Survey, was begun in November, 1927. It will be sent to those interested by the Survey in question, Bandoeng, Java.

There 58 volcanoes in the East Indies which have been in eruption since 1600 A. D., and 45 others in fumarolic activity. Sixteen volcanoes have erupted in Java. Observatories are in operation on seven Javanese volcanoes. The research carried on concerns seismologic, meteorologic, temperature, and chemical measurement, and depth soundings in crater lakes. Each Bulletin reviews the volcanic phenomena of the month, lists publications, and No. 2 contains an interesting table and map summarizing all the volcanic activity of the East Indies. T.A.J.

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No. 167 RELEASED WITHOUT COPYRIGHT RESTRICTION March 8, 1928

KILAUEA REPORT No. 841

WEEK ENDING MARCH 7, 1928

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

On March 4 at 3:10 p. m. there was a slide in the lower northeast corner of Halemaumau. On March 6 at 11:25 a. m. and again at noon thin dust from slides rose from the north corner. On March 7 at noon the pit was without change, rocks dribbled occasionally from the north wall, and a slide at 12:20 p. m. fell at the south.

The Observatory seismographs have recorded only nine very feeble local earthquakes during the week ending March 7. In addition to these there were two pronounced spells of continuous tremors, 3:04 to 3:14 p. m. on March 1, and 4:10 to 4:23 p. m. on March 2.

Microseisms have been slight. Tilt during the week shows only a slight accumulation towards the SW.

NEW KRAKATOA ERUPTION

Just after the December solstice Krakatoa, in the Straits of Sunda, between Java and Sumatra, broke into activity. Krakatoa is the volcano which in 1883 started activity in May and reached one of the greatest explosive climaxes in history in August, blowing away the side of the island, and making a flood wave in the sea which drowned some 35,000 people on the neighboring shores of the strait.

A Reuter dispatch of January 5, 1928, states that Dr. Stehn, head of the Java volcanological service, had led an expedition to Krakatoa and reported the active crater to be under water, ejecting columns of water, steam, lava, and ashes 250 to 650 feet high. The activity on that date had greatly increased within the preceding 24 hours. A press dispatch of January 26 stated that an eruptive outburst occurred that afternoon, that the volcano was almost submerged in the sea, and that its activity had been increasing during the preceding few weeks. A message of January 28 stated that the eruption had been violent in recent days, but was apparently dying out, with submarine rumblings still persisting, and only the exhalation of fumes and gas for the preceding 12 hours.

Details reported in the Paris "Times" of January 24 are that the refugees from the southwestern coast of Java were coming into Batavia, that the government had sent a naval vessel for rescue and investigation, and that an enormous column of steam and fire was rising 200 to 300 yards above the top of the crater. Terrifying rumblings were heard under Sunda Strait on all sides of the Krakatoa island-ring. Natives were said to be standing in terrified awe, assembled in groups along the coast of Java and Sumatra, panic had caused the inhabitants of Coneet Bantam in southern Sumatra to flee into the high regions inland, the men venturing back to the coast only during daylight, and local insurance companies have increased their rates for volcanic insurance.

On January 25 it was reported that the government was broadcasting warnings to the population and that the main crater had been building itself up to the surface of the sea for the past five days.

"For the past five days 300 eruptions a day have taken place between 8 o'clock in the morning and noon. A tenth of these are more than 300 meters high. The highest column of burning ashes on January 21 reached 1,200 meters into the air."

Then follows an obscure statement to the effect that if the three active craters became closed, or if the crater became built up above the ocean, an explosive disaster might occur. T.A.J.

LONDON EARTHQUAKES

A curious note in the "Evening News" of London, England, March 9, 1927 ("When London Quakes," by Mary Morrissey), states that an earthquake occurred in London in April, 1580, which knocked pieces off St. Paul's Cathedral, set the church bells ringing, caused people to rush out of the theaters and taverns, and led Queen Elizabeth to order a special prayer against earthquakes to be used nightly by every household.

In 1692 an earthquake in London filled the streets with terrified crowds. On February 8, 1750, there was a sharp shock, accompanied by a roar, thought to be the blowing-up of powder mills. Just a month later another earthquake broke crockery, caused bells to ring, made the dogs howl, and fish were said to jump clean out of the water.

Then as now quackery in seismological forecasting was rampant, and a weak-minded soldier foretold a third and worse earthquake to occur the night of April 5. On the evening of that day there was a fashionable exodus, the roads out of London were thronged with vehicles, some contenting themselves with spending the night in their coaches in Hyde Park, with cards and candles to pass the time, while others went "to an inn 10 miles out of town," says Horace Walpole sarcastically, "where they are to play brag until 4 o'clock in the morniing and then come back, I suppose, to look for the bones of their husbands and families under the rubbish."

But the earthquake never came, and the soldier was shut up in a mad-house. T.A.J.

AN EARTHQUAKE IN PARLIAMENT

A curious interlude in the New Zealand Parliament (N. Z. Herald, 12th October, 1927) occasioned by an earthquake, occurred October 12, 1927, when a seismic spell began, leading to a violent shock October 15 at New Plymouth and a number of shocks November 8 and 9 in northern New Zealand. At an evening session of the Parliament at Wellington, a sharp earthquake shook the building, produced a buzz of murmuring that almost drowned the voice of the Member speaking, and caused an immediate evacuation of the galleries. Later a debate was just starting when the electric lights failed. Pending the arrival of candles there were vain attempts to relieve the gloom with song. With candles business was resumed, then the lights flashed on again. Members had hardly settled down to business, however, when the lights failed a second time, and the leader of the opposition suggested adjournment. Discussion of this was arrested when the lights once again appeared with their usual brilliance. T.A.J.

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No. 168 RELEASED WITHOUT COPYRIGHT RESTRICTION March 15, 1928

KILAUEA REPORT No. 842

WEEK ENDING MARCH 14, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

On March 10 at 11:30 a. m., dust arose from slides at Halemaumau on the northeast corner of the pit. At 3 p. m., and again between 4:25 and 5 p. m., several slides occurred, those during the last period being observed at the edge of the pit. The falls of rock were from places halfway up the cliff on the northeastern and northwestern walls, sometimes occurring simultaneously at two distinct places, and obscuring the pit with thin dust clouds.

On March 13 there were avalanches during the forenoon which sent up dust clouds chiefly at the northeast corner of the pit, and about 1:50 p. m. a prolonged roar of an avalanche was heard at the Observatory, a thick cloud of dust rose at the northeast so as to cut off the view of the pit, and this gradually thinned and disappeared in the course of a half-hour. At 3 p. m. there was more dust from the same place.

On March 14 thin dust clouds rose occasionally from the pit, and a new scar was observed from Uwekahuna Bluff on the southeast wall of Halemaumau not far below the upper edge of the pit.

The seismographs at the Observatory recorded 17 very feeble earthquakes during the week ending March 14. There were two that had the indicated distances 23 and 9 miles. On March 13 the big avalanche in the pit caused a decided tremor to be recorded at 1:53 p. m.

Moderate NE. tilt has accumulated during the week.

WORK OF THE SECTION OF VOLCANOLOGY 1927

In 1926 various phenomena in Halemaumau indicated the probability of the return of quiet lava through the bottom talus, and this happened July 7, 1927. The end of 1927 showed no reaction of subsidence, and hence it was expected that at decreasing intervals lava would return. That eruptible lava was close to the bottom of the pit was verified January 11, 1928, when a landslip forced liquid melt to come up through cracks.

The routine of the Hawaiian staff involved new features as follows: Compiling of Lassen and Kodiak reports, measuring seismograms from Kodiak, study of tide gauge records, supervision of a machine shop, and increased precision in measurement of horizontal and vertical movements at Kilauea Crater. The staff operated the Uwekahuna Museum until December, when it was turned over to the National Park Service. Field work has included exploration of Mauna Loa trails, continuation of drilling for temperature measurement, tests of a special motor boat for shore exploration, establishment of the Kodiak Station, and exploration of the Aleutian Islands.

Additions to the plant in Hawaii were a new seismograph and its cellar in Hilo, motor car radio receiving sets for time signals, and various machines. The Uwekahuna Observatory and Museum was finished in April and opened to the public, and this establishment forms an addition to the scientific equipment in that a high-class Japanese three-component seismograph has been added to the recording mechanism of the Observatory at a point nearer to the pit than ever before.

Collaboration in Hawaii has been largely through the Research Association, as will be detailed next week. The Alaskan Branch of the Geological Survey has cataloged and stored the collection of Aleutian specimens, and has furnished valuable cooperation in Alaskan volcanology. The topographic maps of Hawaii, now nearly finished by Captain Burkland's topographers, are invaluable as a basis for extending geologic and volcanologic surveys. The Bishop Museum has published an excellent bulletin on the geology of Kilauea by Dr. Stone. The National Park Service has given every assistance, and is now relieving the Observatory of labor and expense in operating for the public service the Uwekahuna Museum. The Coast Survey is doing work closely linked to volcanology in precise triangulation, leveling, magnetism, gravity measurement, hydrography, and computations of theoretical isostasy. The Observatory has furnished the Coast Survey with an Hawaiian seismograph for use at Sitka, Alaska. The National Geographic Society has authorized Dr. Jaggar to explore the Pavlof Volcano group on the Alaskan Peninsula in 1928, and will finance the expedition. The motor boat amphibian, subject of construction experiments and field tests in Hawaii under the Research Association, is a collaborative effort coordinate with the National Geographic project. The Coast Guard furnished invaluable service in transporting the Volcanologist to Attu Island and back to King Cove, and in offering every facility for exploration and for developing a collaborative Government project for Dutch Harbor. The United States Army, through Major General E. M. Lewis, in command of the Hawaiian Department, has assisted the Observatory with the loan of important equipment, and both the Army and Navy have taken great interest in the possibilities of assisting volcanology with airplanes.

It is hoped that in the future several scientific bureaus of the Government will make a united effort, from Dutch Harbor as a base, to map the Aleutian Islands, explore their natural resources, and conduct geophysical work in that land of abundant earthquakes, remarkable weather phenomena, unusual tides, and superb transitions in geological process.

Outstanding events of the year, in addition to the volcanic activity above noticed, were the opening of the Uwekahuna Observatory by the Honorable Hubert Work, Secretary of the Interior, on April 19; and the exhibition by the Observatory with the assistance of the Hilo Chamber of Commerce of a working seismograph, motion pictures, and photographs of active eruptions, at the Hawaiian Territorial Fair in Honolulu in September.

Associate Volcanologist R. H. Finch discovered spells of seismic activity at Lassen Park, explored the steam district northwest of Calistoga, measured temperatures of hot vents, mapped recent lava flows and faults, and investigated earth movements at Supan's Springs by installing a line of stakes at the sulphur bank there. The Kodiak seismograph station has been operated efficiently by Mrs. E. M. Floyd. An eruption of Mageik Volcano, in the Katmai group, occurred in August, and a heavy Alaskan earthquake in October.

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No. 169 RELEASED WITHOUT COPYRIGHT RESTRICTION No. 168

KILAUEA REPORT No. 843

WEEK ENDING MARCH 21, 1928

Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Two visits to Halemaumau this week disclose no important changes. Exceedingly dry weather has been prevalent, and there has been a minimum of slides in the pit. At 4:15 p. m. March 18 a few stones were heard falling, and the south cone was steaming freely. Considerable debris had fallen on the east floor from slides of the preceding week. The southeast sulphur spot was entirely obliterated, and the east sulphur spot was dimmed. Large new scars showed on the face of the northeast wall, and there were streaks made by slides north-northeast. The rim has receded very noticeably at the 14-ton bowlder. During 15 minutes just before 10 a. m. today not a sound was heard, and steaming was very slight at all vents. The whole pit interior appeared very dry, dusty, and peaceful.

During the week ending March 21 there were 20 very feeble local earthquakes and one teleseism recorded on the instruments of the Observatory.

The record of the teleseism showed fairly definite phases, the preliminary being at 6:40:26 p. m. on March 15, the secondary coming at 6:47:59 p. m., and the long wave beginning at 6:56:03 p. m. The beginning of the preliminary wave was of the gradually emergent type, so that the distance indicated by these times of arrival, 3,685 miles, is probably slightly too small. This earthquake was also well recorded on the seismograph in Hilo. At this station the preliminary wave showed a more definite beginning, and the somewhat greater indicated distance of 3,720 miles is probably more nearly correct.

The accumulation of tilt during the week has been slight toward the SW.

WORK OF THE RESEARCH ASSOCIATION 1927

In the course of 1927, the Hawaiian Volcano Research Association has accomplished through the Hawaiian Volcano Observatory the following:

(1) Construction and opening of the Uwekahuna Observatory and Museum, now serving the public through the National Park Service.

(2) Establishment, manning, and maintenance of the useful instrument shop.

(3) Manufacture and output of three seismographs, two now in operation at Kodiak and Hilo, and one shipped to the U. S. Coast and Geodetic Survey for use at Sitka, Alaska.

(4) Continuation of boring experiments on the floor of Kilauea Crater, so that in all 34 holes for measurement of temperature have been drilled.

(5) Continuation of seismometric recording at Hilo and at Kealakekua in West Hawaii, and establishment of a new station, equipped with a three-component instrument of Japanese manufacture, at the Uwekahuna Observatory on the high bluff west of Kilauea Crater.

(6) Continuation of publication of the Monthly Bulletin of the Observatory and of the Volcano Letter.

(7) Building and testing a wheeled boat.

The Uwekahuna Observatory is a success, and travelers find in the motion pictures, the exhibits, the explanations, and the splendid view a compensation for what is missing when the lava pit is inactive.

For the winter of 1927-28 the drilling apparatus is laid up, and the work connected with temperature measurements on the holes and points located and on the cracks adjacent to the 132 surveyed stations of the Kilauea floor.

The seismological registration done by the stations under the Research Association is incessantly improving as to quality of instruments and time service, and it will not be long before all stations have instruments of the same quality as those at the Observatory.

Under the Research Association, F. Y. Boyrie has worked continuously from March 1 to December 31 as machinist in the shop equipped here by the Association. He has constructed seismographs, repaired instruments, set up the electric plant for projection apparatus at the Uwekahuna Observatory, installed all the machinery in the shop itself, kept the drilling apparatus in order, and assisted by F. F. Fischer and S. Oda, has built the wheeled-boat. Professor Paul Kirkpatrick was employed by the Association from July 1 to August 14 to act as lecturer, in cooperation with the National Park Service, at the Uwekahuna Observatory, and to carry on seismological research. He devised special projection for the motion pictures at the Territorial Fair, and had charge of the Observatory's exhibit at the Fair. Captain R. V. Woods and J. B. Albert continued to do good work as seismograph operators in Kealakekua and Hilo, respectively. The station at Hilea, under A. D. Williams, was temporarily discontinued on May 15 until such time as a better istrument is available.

The Hawaiian Volcano Research Association has added to the plant complete tool equipment of a power machine shop, including gasoline engine, automatic hack-saw, large and small machine drills, a machine grinder, a circular-saw table, and a forge. A large lathe was obtained and added to our shop. New parts for this lathe were obtained through the Government in October, and this tool, supplementing the small Barnes lathe and the still smaller jeweler's lathe already on hand in the Observatory, equips the establishment with turning tools sufficient for all present need. T.A.J.

STATION NOTES

On March 15 Dr. T. A. Jaggar left this station, beginning his trip to Washingtoon, D. C. In Washington on April 5 he will deliver a lecture before the National Geographic Society, and will then start for Alaska as leader of the National Geographic Pavlof Volcano Expedition.

Mr. F. Y. Boyrie terminated his services as machinist for the Observatory on March 15. In his place Mr. Tai On Au has been engaged to continue the construction of other units of the Hawaiian type seismograph and to carry on the miscellaneous machine work of the station. Mr. Au is a resident of Hilo, and comes to the Observatory after three years training in the machine shop of the Smith-Hugh Vocational Training School. R.M.W.

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No. 170 RELEASED WITHOUT COPYRIGHT RESTRICTION March 29, 1928

KILAUEA REPORT No. 844

WEEK ENDING MARCH 28, 1928

Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Conditions at Halemaumau remain practically the same as last week, except a slight increase of steaming due to recent light rains. There were three floor vents emitting steam this morning, two of which mark the sites of two of the lava fountains of last July. The vent of the small twin fountain, at the center of the pit floor, had the densest vapor. There has been no avalanching and very little sliding. Two or three small slides were observed March 24 and 28.

Crack measurements taken on the 24th show varying differences over measurements of February 13 of from seven-eighths of an inch to three and three-quarters inches. Four of the original 15 marked measuring points along the east rim have become unavailable through caving or becoming too wide to be reached.

During the week ending March 28 the Observatory seismographs have recorded 12 very feeble local earthquakes and one teleseism. The teleseism is recorded on March 21, its preliminary wave beginning at 5:56:50 p. m., the secondary wave at 6:04:39 p. m., and the long wave at about 6:14 p. m. The indicated distance is 3,875 miles. A notice from Lieutenant J. H. Peters, in charge of the field station of the U. S. Coast and Geodetic Survey in Honolulu, gives as the preliminary determination of the epicenter Lat. 28° N., Long. 96° W. By the same authority, the teleseism mentioned in the Kilauea Report last week, which occurred on March 15, was in Lat. 23° S. and Long. 170° E. These preliminary notices are obtained from the records of different observatories, assembled and computed through the cooperation of Science Service, the Jesuit Seismological Association, and the U. S. Coast and Geodetic Survey.

Tilt has accumulated only very slightly to the south during the week.

REVIEW OF HAWAIIAN EARTHQUAKES OF 1927

The total number of seismic disturbances recorded on the seismographs of the Hawaiian Volcano Observatory during the year 1927 is 1,168. This number includes 19 teleseisms, of which seven were decipherable as to distance.

The remaining local earthquakes number 1,149. These grouped by their intensity are as follows: 1,121 were very feeble, 16 were feeble, 9 were slight, and 3 were moderate. All of the slight and moderate shocks and five of the feeble shocks were reported as perceptible, being 17 in all for the number of earthquakes felt here during the year.

The following table gives the number per month of the local shocks for 1925, 1926, and 1927. The numbers for 1925 and 1926 have been included here for the sake of comparison, and were copied directly from Volcano Letters Nos. 54 and 112, respectively, in which the earthquakes for these years were reviewed.

Month	1925	1926	1927
January	94	54	85
February	94	32	46
March	79	68	63
April	70	761	68
May	83	43	82
June	51	56	45
July	109	101	72
August	94	254	75
September	102	240	103
October	50	62	76
November	48	46	191
December	48	61	243

The number in April, 1926, is swelled due to the shocks accompanying the eruption of Mauna Loa. The very feeble earthquakes here counted are probably not all true earthquakes. Many of the records are too faint to distinguish the character of the shocks. While most of them are real earthquakes, some are caused by avalanches in the pit, some are the waxing to maximum amplitudes of a more continuous tremor of the harmonic type which may be present, but for the most part may be too feeble to record, some are volcanic spasmodic tremors, and a few during February and March, 1927, were probably caused by blasting in the vicinity.

There are certain features of interest that stand out during the year 1927. The regular recurrence of times of increased local seismic activity cannot be set aside as accidental. These crests of activity come at intervals of about two weeks, near the times of the first and last quarter phases of the moon. This feature has been mentioned in Volcano Letter No. 143, September 22, 1927. The records for October, November, and December continued to show the same effect.

On March 20 the heaviest earthquake of the year duplicated the one of March 19, 1926. It is a coincidence perhaps that these two big earthquakes should fall almost on the same day of the two years, though the proximity of the equinox may have been the inspiration in each case. The outbreak of lava in July was oddly enough almost wholly unaccompanied by seismic activity. There was one perceptible earthquake just after the appearance of lava differing in no way from other shocks that occurred during the year. The only definite seismic accompaniment was the presence of harmonic tremor during the first day of the eruption of lava.

A group of seven perceptible earthquakes, with two more almost strong enough to be felt, occurred in the period between July 24 and August 3. This is a large share of the heavier shocks for the year, and their grouping within these few days undoubtedly has some significance. On December 3 and 4 there occurred an extraordinary series of spasmodic tremors clearly volcanic in origin. In this series there were about 75 individual tremors which have all been counted in the total number of earthquakes for the month, swelling that total considerably above its normal amount.

R.M.W.

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No. 171 RELEASED WITHOUT COPYRIGHT RESTRICTION April 5, 1928

KILAUEA REPORT No. 845

WEEK ENDING APRIL 4, 1928
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Scars on the Halemaumau walls indicate that slides have occurred at various places. The largest of these is at the southwest, and extends the full height of the wall. Appearances seem to indicate that great rim blocks have tumbled down the face of the wall, gathering material to such extent as partly to bury the southwest cone. Just as the cone of July, 1924, was buried by debris of the southwest talus, it now appears that the big cone of July, 1927, is to share the same fate.

During the week ending April 4 the Observatory seismographs have registered 20 very feeble local earthquakes and one teleseism. Two of the local earthquakes were of the protracted tremor type, one beginning at 10:26 a. m. on the 29th being 12 minutes long, and the other beginning at 9:29 p. m. on the 31st being three minutes long. One earthquake at 5:38 p. m. on the 28th was registered here as very feeble, but was perceptible in Hilo. The teleseism is very faintly recorded, the preliminary wave beginning at 6:45:38 p. m. without other distinguishable phases.

Tilt has accumulated during the week moderately toward the ENE.

EARTH MOVEMENTS IN JAPAN

The great Kwanto earthquake of September 1, 1923, is well known as a classic among the great earthquakes of the present age. Accurate surveys existing before its occurrence have fortunately made possible the discovery and study of earth movements of a most surprising magnitude resulting from it. In 1925 a report published by the Imperial Earthquake Investigation Committee showed that the floor of Sagami Bay had suffered serious deformations. Depressions of the bottom of the bay amounting to as much as 400 meters, and elevations as great as 250 meters, were shown to have occurred. In a very general way the depressions and elevations exist in alternate parallel belts as if caused by a wrinkling of the original surface.

There has recently been published (Proceedings of the Imperial Academy, Tokyo, February, 1928, Vol. IV, No. 2) three papers of considerable interest dealing with additional information on the effects of this great earthquake. The elevations and depressions above mentioned seemed so great and out of reason that a careful study was made of the data used in obtaining them. Possible errors in making the soundings were discussed, and while it is admitted that some of the values showing extreme change may be improbable, yet for the most part the differences originally obtained seem unassailable.

By re-triangulation a study has been made of the horizontal movements in connection with this earthquake. An analysis has been made to show where the greatest horizontal stresses existed in the earth's crust. This analysis tends to show that the maximum horizontal compressional stress accumulated some distance to the northeast of Sagami Bay; yet the maximum effects appear to have occurred in the bay itself.

The suggestion is made that the land areas are more rigid than the area of the earth's crust underlying Sagami Bay. Thus under the horizontal pressure shown by the triangulation, it is perhaps possible that the entire land block in the region of the greatest stress moved forward, the force expending itself in crumpling the more plastic crust under the bay. This idea is supported by the fact that no visible faults were made on the land area, indicating that whatever motion in which the land block took part, it moved as a whole. The relatively small horizontal displacements shown by the triangulation may have easily occasioned the much larger vertical displacements in the wrinkling of the bottom of the bay. This may be easily illustrated by noting the height to which a piece of paper will buckle up from a flat surface if its ends are forced only slightly nearer to each other.

It therefore seems that the area beneath Sagami Bay is a weak spot in the earth's crust which was compressed and deformed by the earth stresses accumulated in the more rigid surrounding regions.

There are also two other papers in the same publication dealing with certain interesting cases of land elevation and depression due to other earthquakes, detected by re-running spirit level lines. A tabulation is given showing the results of re-leveling over or near the epicenters of eight different earthquakes where changes of elevation were clearly shown. The Kwanto earthquake above discussed produced changes of elevation on land amounting to as much as two meters, which is the greatest amount shown in the list.

Much of this re-leveling over old lines was done several years after the original leveling was completed. The results may be questioned, therefore, in that the changes disclosed may not all be due to the single greatest earthquake occurring in that interval of time. Slow tiltings are known to exist, and the changes may be due in part to these slow motions instead of to the one earthquake suspected. There is one interesting case quoted, however, wherein the vertical changes discovered can be definitely attributed to a given earthquake. The running of a spirit level line was in progress when a sharp local earthquake occurred back on part of the line only three months completed. The portion of the line passing over the epicenter was immediately re-run. It was discovered that over the epicenter the earth's crust had bulged up an amount of over 2 cm. in a distance of only 4 km.

That motions of the ground are not all sudden and accompanied by earthquakes is shown by the last paper, dealing with a spirit level line run over older work after an interval of 35 years. In the region covered during this period of time there were no major local earthquakes. The line crossed several land blocks surrounded by known fault lines, and it was found that the blocks had suffered a general depression. In each case the west side of the block had fallen more than the east side. In one block the west side was depressed 9.4 cm., while the east side showed a depression of only 3.8 cm. In the adjoining block the west side was down 9.6 cm., while the east side had been elevated 0.4 cm. These two land blocks are being independently tilted towards the west.

The study of such earthmovements gives information that is valuable in the prediction of earthquakes. For the most part the cases above are movements that took place at the time of occurrence of earthquakes. But if slow movements can be detected, and their mechanics correctly interpreted, it may be possible with increased knowledge along these lines to tell where earth stresses are accumulating, and to so predict an earthquake before the actual fracture takes place. Work is being done along these lines in California and Japan, so that in the future it may be possible to detect the development of potential earthquakes.

R.M.W.

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No. 172 RELEASED WITHOUT COPYRIGHT RESTRICTION April 12, 1928

KILAUEA REPORT No. 846

WEEK ENDING APRIL 11, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Halemaumau on April 6 at 9 a. m. was comparatively quiet, although the southwest wall was still dusty from slides of the preceding week, and the south and center cones and other vapor vents were steaming profusely. On April 7 the pit began a spell of active avalanching, when at 7:07 a. m. a very prolonged roar of falling debris was heard by occupants of cottages in the vicinity of the Observatory. Reference to the seismogram showed that this avalanche set up strong tremors lasting two minutes. About five minutes later a thin cloud of dust arose and rolled along the crater floor and up the north ledge. At 7:14 a. m. there was another avalanche roar, and thick dust ascended. Other large slides followed from time to time, also evidenced by rising dust clouds. The slides appeared to come from the north and northwest walls.

On April 8 there were slides NE. at noon, and at 3:15 p. m. the southwest wall was still dust-coated. Rock falls were heard N., NW., and SW. On April 10 thin white dust was seen at intervals over the north corner of the pit. On April 11 the pit was free of steam and quiet, except for a dustless slide of rocks in the north corner at 8:50 a. m., a few invisible falls of stones from different walls, and a slide at 11:25 a. m. at the NW. New debris lay on the NW. talus.

A visit on April 1 to Mauna Iki, the Kau Desert flow of 1920 from Kilauea, showed that there are still several spots hot enough to ignite dry sticks.

The number of local earthquakes recorded during the week ending April 11 was 24. All of these were very feeble with the exception of one at 7:13 a. m. on April 7. This one was still a feeble shock, but larger than the others and almost strong enough to be perceptible. It followed by six minutes the heavy avalanche above described, and more rocks were heard to fall at about the time of the shock.

The acumulation of tilt during the week was moderate toward the WSW.

On April 2 Messrs. G. E. Josephson and W. E. Bonsey, of the faculty of Kamehameha Schools, Honolulu, walked to the Rest House on Mauna Loa, the following day going to the Crater of Mokuaweoweo and returning to Kilauea. This trip to the top and back within two days is somewhat of an accomplishment. They reported steaming in the southwest end of the crater, with a suggestion of yellow sulphur stain and fume. Conditions in Mokuaweoweo, however, are probably normal.

SUN SPOTS AND VOLCANIC ACTIVITY

Various correlations have been attempted between recurrences of volcanic activity and other phases of earth condition. In Volcano Letters No. 94, Octoper 14, 1926; and 129, June 16, 1927, it was suggested that there is a definite connection between fluctuations in the rate of rotation of the earth and latitude variations with changes of volcanic activity. The effect of lunar phases and solar season has been many times discussed. These causes have their effects on volcanic and seismic activity through possible stresses set up in the earth's crust due to earth tides or to slight periodic expansion and contraction of the earth as a whole.

In "Technology Review" of January, 1928, Dr. Charles G. Abbot gives an interesting description of his experiences and general results in the study of the sun. The sun's control of the earth is manifest in several ways, and it may easily have a periodic effect on volcanic activity through its radiations as well as through its gravitational attraction. Of particular interest is the 11-year cycle in the waxing and waning of sun-spot numbers. Perhaps there is a correlation between this sun-spot cycle and the 11-year cycle of volcanic activity that has been suggested as existing at Kilauea. The volcanic cycle still needs some years of observation before the fact of its existence is made certain and its phase and period fully determined. Yet a rough histrocial review detects years of high activity about 1896, 1908, and 1919. High sunspot years came about 1918 and will again be due about 1929.

The variation of solar radiation also shows a shorter cycle of a little over 25 months in period, which probably produces response in conditions on the earth. These changes in solar condition have already been found to affect climate and weather, and their study is proving useful to meteorology. Volcanology may perhaps also derive benefit from the investigation of these changes in the sun's radiation .

Such far reaching problems as earth rotation, latitude variation, earth tides, sun-spot variations, isostatic adjustment of erosion, long-period climatic changes of the earth's atmosphere, and periodic phases of volcanic activity, are delicately inter-related, so that the study of each involves consideration of the others.

NOTICE TO NON-SUBSCRIBERS

The Volcano Letter mailing list is being revised to effect as much economy in mailing as possible. We are very glad to send the Volcano Letter free to libraries of educational institutions, professors of geology, etc., but we suspect that there are recipients of this publication that may no longer be interested in it. We shall be deeply appreciative if those no longer desiring it will please send notice to the Hawaiian Volcano Obseravtory, Volcano House, Hawaii.

TITLE PAGE AND INDEX

Those who have saved their copies of the Volcano Letter for binding will be interested to know that the Hawaiian Volcano Observatory is preparing three annual title pages and indexes of the articles appearing in the issues of 1925, 1926, and 1927. These will be printed and mailed in the near future.

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No. 173 RELEASED WITHOUT COPYRIGHT RESTRICTION April 19, 1928

KILAUEA REPORT No. 847

WEEK ENDING APRIL 18, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

The volcano continues inactive and without phases to indicate the possibility of reappearance of live lava in the near future. Visits to Halemaumau were made on the mornings of April 13, 16, and 18. On the 13th the pit was quiet and dry, and there was very little steam. Stones were heard rolling occasionally on the north wall, and there were one or two small dusty slides atop the west end of the northeast sill. The most noticeable fumarole was at the center of the southwest talus. On the 16th the wind was too strong to hear sounds within the pit. There were indications of ground cracking in the vicinity of the south station. On the 18th no changes were noted, except a quantity of dark-colored bowlders scattered down the south talus. The two 1927 cones were steaming. The yellow stain at the base of the east talus seemed deeper, but the south and southeast sulphur spots have not yet reappeared.

During the week ending April 18 the Observatory seismographs registered 11 local earthquakes. All were very feeble with the exception of one which occurred at 1:43 a. m. on April 16. This one was slight, but was felt by many people in the vicinity of the volcano. Its origin is shown to be five miles from the Observatory, the direction suggested being SE.

Slight ENE. tilt has accumulated during the week.

THE CHAIN CRATERS ROAD

The Hawaii National Park on April 15 opened its new road along the chain of craters southeast and east of Kilauea. Work on this road was commenced in April, 1927, and its cost as now given to the public is $158,083. It starts from the Volcano House-Halemaumau road at a point one-half mile east of the Summer Camp, and follows in general the route of the old Cocktail Trail, crosses the old Keauhou Road, and continues on through the general region traversed by the Kalapana Trail, ending at the southwest side of Makaopuhi Crater. Its length is 6.95 miles. It is throughout a first-class, modern, gravel surfaced, automobile highway.

The craters from which the road takes its name are in a sweeping curve along the Puna Rift line, and give evidence of both ancient and recent volcanic activity along that crack in the mountain structure. Out-pourings from this same rift line where it curves still farther east and northeast beyond Makaopuhi, have built the ridge of Puna, marked by its line of cones. The Puna ridge probably continues even beyond the easternmost point of the island, though it there disappears into the sea. The road may some day be continued down into Puna to make another most interesting route between Hilo and the volcano.

Starting at the point of departure from the older Volcano House-Halemaumau road, the new road passes at 0.5 mile, 1.0 mile, and 1.6 miles the three craters Lua Manu, Puhimau, and Kokoolau. At 2.3 miles is the Devil's Throat, and at 2.4 miles the cinder cone. Two more craters, Heake and Pauahi, are next passed, the first at 2.7 miles, and the highway follows the rim of the second between 3.4 and 3.6 miles from the beginning of the road. At 3.8 miles the old Keauhou road is crossed, and then comes Aloi Crater at 4.6, where is the steaming area and the road's nearest approach to Puu Huluhulu. Between 5.5 and 5.7 miles the road follows the edge of Alealea Crater. At 6.0 miles is the entrance south to the very interesting 1923 miniature lava flow. The end of the road is reached at Makaopuhi Crater, 6.95 miles.

Justice cannot be done in describing these points of interest in so small a space; a brief review must suffice. The craters are members of the same family which includes the Crater of Kilauea, Kilauea Iki, and Keanakakoi. They are the stand-pipes where in times past the lava rose and fell as it was forced into or allowed to drain from the great crack called the Puna Rift. The benches and mezzanine floors in some of the craters represent lava lake levels that were maintained long enough for the lava beneath parts of them to harden. Those parts of a cooling lake where lava still remained soft enough to drain away when the release of pressure came, would then collapse, leaving these benches high and dry.

The Devil's Throat is like the Pit Craters in the Kau Desert. These deep well-like holes are the cavings-in of the roofs of lava tubes or chambers, weakened by heat or earthquake cracks; the falling debris perhaps being removed by the flow or heat of lava beneath to make room for more and still more caving-in till finally the very top surface falls in. Near the Devil's Throat is an interesting cinder cone, of which the inner construction has been exposed by the cutting for the road. The road throughout its length exposes by its cuttings interesting shallow sections showing the thickness and composition of the region's surface layers.

The steaming area at Aloi Crater gives evidence of rock beneath the surface still hot enough to turn back as steam the ground water that comes in contact with it. In the steaming area is an interesting ridge of hard, dense, bluish rock very different from the usual vesicular and frothy types of lava.

Of special interest are the miniature lava flows of 1922 and 1923. The little flows in Makaopuhi Crater of May 28, 1922, and on the brink of Napau Crater which oozed out the next day, are the clues that indicated how the lava was draining from Halemaumau during its great collapse of that month. Halemaumau refilled its lava reservoir during the next 15 months, but again movement along the Puna Rift occurred, as evidenced by earthquakes, opening the way for the lava to drain again from the pit during August, 1923. In this case the clue was the small flow of August 25, 1923, just south of the new road, at the 6.0 miles point. Here can be seen how lava issued from a long crack in the ground, spattering up into the trees and flowing down through the forest for a few hundred feet, making interesting tree moulds. Halemaumau partly recovered from this second collapse, then in April of 1924 came the earthquakes and subsidence in Puna, at the lower part of the rift line, followed by the great explosive collapse of Halemaumau in May. This time no lava appeared along the rift, but evidence seemed ample without it that once more the same crack was responsible for the wasting of Kilauea's fire.

Thus the Puna Rift is easily seen to be an important part of the volcano. The new road now makes it more accessible for study, so increasing the knowledge of the volcano as well as making available to the pubilc a region of great interest and scenic beauty. R.M.W.

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No. 174 RELEASED WITHOUT COPYRIGHT RESTRICTION April 26, 1928

KILAUEA REPORT No. 848

WEEK ENDING APRIL 25, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Halemaumau is quiet, and there has been very little working of the walls and little change in steaming. The coatings of white salts have increased on the north and southwest walls. Two noisy slides from the ledge at the middle of the south wall were observed at 8:50 a. m. April 25, and the quantity of debris on the talus below indicated that there has been other slides. There is no new surface cracking about the south rim.

The east rim cracks were measured on April 21, but little difference was found over the measurements of March 24.

The Observatory seismographs have recorded 12 very feeble local earthquakes for the week ended April 25. Tilt has accumulated slightly WNW. during the same period.

ECHO SOUNDING

In Volcano Letter No. 122 of April 28, 1927, mention was made of sonic or echo sounding for ocean depths. The U. S. Coast and Geodetic Survey S. S. Guide has for the past few weeks been operating along the Kona coast of the Island of Hawaii, making standard charts in the region of Kealakekua and Kailua bays. The writer was given opportunity to go aboard and witness the sounding operations, seeing the fathometer in operation.

This device is simple in principle and most efficient in operation. The hydrophone, a part of the apparatus, is placed in contact with the water on the ship's bottom. This is a metal diaphragm, which is caused to vibrate by means of a powerful electro-magnet, like a giant telephone receiver. The sound thus transmitted to the water travels to the ocean's bottom, and is reflected back again as an echo. This faint echo is then received by a microphone and is electrically amplified by vacuum tubes to such strength that it will operate a magnetic relay. The speed of sound in sea water is known. The timing of the sound's journey from the ship to the ocean's bottom and return is therefore a measure of the depth. The whole operation is made automatic. A disk revolving behind a fixed scale carries upon it a contact device and a neon tube. When the neon tube passes the zero point of the fixed scale, contact is made causing the hydrophone to start the sound waves on their downward journey through the water. The return echo is signaled by the operation of the relay, which causes the flash of a spark through the neon tube; but during the journey of the sound to the ocean's bottom and return, the neon tube on its revolving disk has traveled along the scale from the zero point where operations were started, so that the flash of the spark occurs at a distance from the zero point of the scale corresponding to the time elapsed. The flash of the spark is instantaneous, but due to the persistence of the image in the retina of the eye, it appears to remain stationery for a fraction of a second at some part of the scale where its position may be read. The scale is graduated to read directly to fathoms, so that one needs but to glance at the instrument, noting where the spark flashes occur on the dial scale, to be immediately informed of the depth of water beneath the ship.

The work of the vessel includes the taking of other data of all sorts. Direct wire soundings are frequently made with a lead which brings back samples of the bottom. Water samples are taken from near the bottom at the same time. Thermometers are lowered which record temperatures.

In order that the positions of the soundings may be plotted upon a chart, the ship's position is known at will by three-point locations read upon shore objects, when the work is within sight of land, as is usually the case. The position of the ship is thus determined for each sounding made. The frequency with which these soundings are made and plotted is dependent upon the distance out from shore, the regularity of the bottom, or the importance of the area being covered and the amount of detail desired in the chart. In contrast to the older method of lead and line soundings, the use of which demands that the ship be nearly stopped each time a sounding is taken, this sonic method allows soundings to be taken at any speed the ship may be making. In chart making the only reason for diminishing speed is to allow the observers time to record the depth and position data. In the shoal water near land where the ship cannot be taken, small motor boats are used, with ordinary lead and line, to fill in the shore details of hydrography. Topographic parties on shore add other information for the chart.

The interest of volcanology in this work can be understood when it is realized that the volcano is not all above sea level. One too easily thinks of the base of this island volcano as being at sea level. As a matter of fact its base is where its slopes first start upwards from the great general plains of the sea bottom. The average sea bottom of the Pacific about Hawaii is easily as much below the sea surface level as the summit of Mauna Loa is above it. Thus in height the whole lower half of our volcano is under water and not available to direct observation. On the slopes of Mauna Loa that are above sea level, which we are able to study directly, we find many points of interest to volcanology. There are lava flows, cones and volcanic vents, rift lines, and fault scarps. These features obviously must exist on those parts of the mountain's slopes covered by sea water, though perhaps in changed form. This speedier and easier method of taking soundings that has been developed in the last few years should teach us much about these inaccessible lower slopes of the mountain. It may be that further developments in echo sounding will enable those operating the apparatus to tell by the quality of the returned echo what the character of the sea bottom is. We may thus be led to discover and be enabled to chart submarine areas freshly covered by lava. Increased detail of shape of the ocean's bottom discovered by greater numbers of soundings will perhaps disclose cones or volcanic topography of other sorts. In last week's Volcano Letter mention was made of the possibility that the great Puna rift extends on to the northeast after it dips into the water. The few scattered soudings taken for the older charts confirm this idea, showing a ridge extending on down the submerged flank of the island. Detailed soundings here might easily show interesting features which would reveal the history of this ridge.

R.M.W.

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No. 175 RELEASED WITHOUT COPYRIGHT RESTRICTION May 3, 1928

KILAUEA REPORT No. 849

WEEK ENDING MAY 2, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Halemaumau remains unchanged except that steaming has increased in the pit due to the rains of the past two days. Most conspicuous is a wet steaming area on the north-northwest wall.

There were evidences on April 28 and May 2 that the north wall had had slides. Dust from a slide at the north corner was observed at 11:30 a. m. on the latter date. For some time there has been a slight accumulation of yellow stain at the site of the southeast sulphur patch, which has long been buried under debris, and on April 28 this stain was so plainly perceptible that it was thought that sulphur crystals were forming. Today, however, no yellow stain or crystals were to be seen.

The Observatory seismographs have recorded 20 earthquakes during the week. All of these were very feeble with the possible exception of one at 5:01 p. m. April 27. This one, while still feeble, might perhaps have been felt. Several of the others were large enough to show themselves plainly as true earthquakes rather than as small and distinctly local spasdomic tremors.

Tilt accumulated slightly to the south during the week.

THE THREE-YEAR CRUISE OF THE "CARNEGIE"

On May 1 the yacht "Carnegie" was scheduled to start upon its seventh cruise. This vessel of the Carnegie Institution of Washington is in charge of Captain J. P. Ault, and during the next three years is to engage in investigations of terrestrial magnetism and electricity, marine, biology, meteorology, and oceanography.

Work in magnetic observations at sea was first begun systematically by Halley in 1698. Other observations were made casually by various ships until in 1905 the "Galilee" was started out specifically for magnetic observations. The "Galilee" had iron in its hull that was found to be disturbing to the observations, but it was used until 1909, when the present vessel, the "Carnegie," was completed. The "Carnegie" started its first cruise in August of 1909, and has now traveled about 290,000 miles. This seventh cruise, which is starting, will add about 110,000 miles to its record. The proposed route for the present cruise is to start with a circuit in the North Atlantic Ocean, after which the vessel will go through the Panama Canal to the South pacific, then into the North Pacific, and will be near Hawaii about August, 1929. The route then goes through the South Pacific, and eastward once and a half around the world in the south latitudes, then up through the Atlantic and back to Washington, reaching the starting point about July, 1931. (See Journal of the Washington Academy of Sciences, Vol. 18, No. 5; or Scientific Monthly, February, 1928.)

With the experience furnished by the "Galilee," the "Carnegie" was built with as little iron and steel in its construction as possible. It is a two-masted sailing ship with an auxiliary engine of 100 horsepower capable of driving it without sail at the rate of six knots. The engine is constructed for the most part of non-magnetic metals, only a few essential parts being of steel. There is practically no other iron or steel on board. The vessel's anchors are of bronze, with manila cables. There are seven men on the scientific staff, and 17 in the crew.

The study of terrestrial magnetism has been and still is the major aim of the vessel's journeys. Observations for compass declination or deviation are systematically made ,and the secular or annual variation is determined for the different parts of the oceans. Seasonal and daily changes are also observed. From this information accurate isogonic charts are made enabling navigators to correct for compass errors. It is interesting to note that here again the eleven-year cycle of sun-spot activity has an effect. It has been found that there are changes in terrestrial magnetism that correspond to these changes in solar radiation.

On this cruise the vessel will undertake new work, the study of terrestrial electricity. This includes the measurement of atmospheric charges and potential, and leads to better understanding of conditions affecting radio transmission and of the Heaviside layer. Marine microbiology and chemistry will be studied, and other branches of marine life will be observed. Tow nets have provided for the collection of samples of ocean living organisms, and a laboratory on the ship provides the means for analysing or preserving the samples brought in. Another new laboratory has been added to accommodate the radio apparatus and the electrical depth sounding equipment. Marine meteorology is given attention. At sea, meterological observations and investigations of terrestrial magnetism and electricity are free from the many disturbing influences that exist on land.

Oceanography receives its share of study. Deep sea soundings are made, deep and shallow water temperatures are observed, bottom samples are collected, by a line run out to depths as great as 20,000 feet. In order that the line may go straight down and not be slanted in the water by the ship's motion, the vessel is stopped every other afternoon, or about every 150 or 200 miles, for the purpose of making these observations. The vessel is equipped with echo sounding appartus, as described in last week's Volcano Letter. Captain Ault remarks that the topographic features of the bed of the ocean must be as interesting to the geodesist and seismologist as are the features on dry land.

Results of some of the observations will be computed on the vessel and transmitted for publication when various ports are touched. The information is disseminated to all nations, and for this reason the vessel is a welcome visitor to ports all over the world. R.M.W.

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No. 176 RELEASED WITHOUT COPYRIGHT RESTRICTION May 10, 1928

KILAUEA REPORT No. 850

WEEK ENDING MAY 9, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

A few changes have taken place in Halemaumau. The wet steaming area of the north-northwest wall has become less conspicuous. The coating of white salts on the north wall has entirely peeled away. Dust was seen there on May 5 and 6, and stones were heard rolling at that side on other visits.

A survey of locations of various steam vents was made on May 7. They are as follows: Back of N., NW., and W. rims; below edge of E. rim; middle of NNW, wall; both side edges of NW. talus; center and south top of SW. talus; three places on SE. talus; below east end of NE. sill; middle of NNE. talus; two floor fumaroles at foot of N. talus; the south and center cones.

The southwest talus, by far the greatest debris slope in the pit, has some interesting phases. Slides rarely occur from the wall above it, and it is the only talus that has not overlapped the lava floor formed last July. This indicates that the talus has remained stationary and without change for about a year. For some time, however, a crack just below the upper edge and parallel to the wall has been developing, and may mean that the talus as a whole is slipping, perhaps to slide down onto the lava floor as did the northwest talus, which by this mechanism caused the squeezing up of liquid lava in Halemaumau on January 11 last.

During the week ending May 9 there have been recorded on the Observatory seismographs 35 earthquakes. One of these was a very feeble teleseism of which the preliminary phase began at 6:24:39 p. m. May 7. The record was so feeble that other phases could not be distinguished, and no estimate of distance could be made. Of the local earthquakes all were very feeble with the exception of one at 4:41 p. m. on May 5. While this shock was still feeble it may have been strong enough to be perceptible. The distance to its origin is indicated as 19 miles from the Observatory. On May 2, at 2:45 p. m., there was a protracted tremor which lasted for four minutes apparently of volcanic origin.

It was stated last week that there had been several earthquakes somewhat larger than the usual run of very feeble tremors. Most of them were not large enough to rise above the "very feeble" class, but were strong enough to indicate distance. This series of earthquakes has continued through this week also, so that the fortnight shows a very definite feature of seismic activity. An attempt to determine the epicenters of some of these earthquakes has shown them to have been rather scattered and without indication that any particular locality is responsible for the disturbances.

Tilt has accumulated during the week slightly to the south.

EARTHQUAKE BELTS

There is published in the "Scientific American" for April, 1928, a decidedly interesting and easily understood article on the world distribution of earthquakes. This article is by Professor Bailey Willis, and therefore carries with it the weight that can be expected from an authority on the subject.

The necessity for earthquake-proof building is emphasized. Here again is pointed out the fact that very few parts of the earth are absolutely free from earthquakes. The limited areas that we consider as liable to earthquakes are merely those in which earthquakes are relatively frequent. Those which are usually considered free from earthquakes are the spots on the earth where earthquakes are less frequent, but where shocks are by no means impossible.

The risk of earthquake damage increases as density of population increases. A great earthquake may occur under the ocean and pass completely unnoticed by mankind, except by seismographic records: yet a smaller earthquake taking place at a great center of population sometimes brings with it tremendous damage.

Professor Willis calls attention to the fact that buildings may be made more earthquake-proof at very little additional original cost. Great buildings are erected with careful consideration paid to the various forces that may affect them. Their design is calculated to make them strong against wind pressures, to enable them to carry loads of snow, and to make them proof against the disintegrating effect of weather. Much attention is paid toward making them fireproof. But in many places earthquakes happen so seldom that risk of damage from that cause is ignored completely, and in the design of buildings no features are included to guard against the earthquakes which the place must some time expect.

The article gives a table headed "Annual Frequency of Earthquakes in the More Seismic Regions." Some readers here in Hawaii have noticed and commented on the fact that Hawaii is omitted from this table. There are here great numbers of volcanic earthquakes, particularly on the Island of Hawaii. These are for the most part the accompaniment of movements in the mechanism of the volcanoes. They are not deep-seated nor far-reaching in their effects. The type of earthquake with which Professor Willis deals is the more far-reaching tectonic kind. Tectonic earthquakes are slippings in the earth's crust when it yields suddenly to stresses which have accumulated through ages, and do not necessarily occur in volcanic regions only. Such shocks are so heavy and deep-seated, involving the sudden shifting of such large volumes of the earth's crust, that they are recorded sometimes by seismograph stations throughout the world. Here in Hawaii our seismographs frequently record such distant earthquakes, which we call teleseisms. But it is very seldom that we transmit answers to these messages from distant parts of the earth. Tectonic earthquakes of sufficient depth and power to be recorded away from Hawaii seldom occur here. Practically all of our earthquakes are so purely local that they pass unnoticed by seismographs in other parts of the world.

R. M. W.

NOTES

A radio message from Dr. Jaggar, at Squaw Harbor, Alaska, has just been received. He states that he has arrived there safely with his outfit, and that the tests of his new amphibian automobile-boat have proved satisfactory. When Dr. Jaggar was in Washington, the National Geographic Society, under whose auspices this expedition is being made, saw the necessity of and made appropriations for a topographer to accompany the party. With tests completed, the expedition will start in actual work of reconnaissance within a week.

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No. 177 RELEASED WITHOUT COPYRIGHT RESTRICTION May 17, 1928

KILAUEA REPORT No. 851

WEEK ENDING MAY 16, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

The north and northwest walls of Halemaumau have been sliding, and several clouds of dust, made by avalanches, were seen rising from time to time. One from the north wall at 6:13 p. m. May 11 made vibrations which were recorded by the seismographs. There have been no changes in the pit except the difference in the amount of steaming under varying weather conditions.

During the week ended May 16 the seismographs at the Hawaiian Volcano Observatory recorded 32 very feeble local earthquakes. A teleseism was also recorded, the preliminary wave arriving at 11:57:01 a. m. on May 14; the secondary showing itself 10 minutes and 16 seconds later. The estimated distance to the epicenter is 5,580 miles.

Microseismic motion, which has been unusually feeble for some weeks past, increased to moderate amplitude during this week. Tilt has accumulated slightly WSW.

THE CRUST OF THE EARTH

Mau's burrowings into the crust of the earth by means of shafts and tunnels barely scratch its surface when the depths so reached are considered in terms of the dimensions of the crust itself. Information as to composition, consistency, and temperature at greater depths must be obtained by indirect observation. In 1914 Michelson conducted experiments to measure the periodic tiltings of the earth's surface which he translated into earth tides. These tides, similar to ocean tides but of smaller amplitude, resulting from the attractions of the sun and moon, gave a measure of the rigidity of the earth by showing how much the earth's structure yields to these deforming forces. His experiments showed that the earth is a whole is somewhat more rigid than solid steel.

Geology, by the study of strata that have been laid bare by ages of crust folding, up-thrust and erosion, by analyses of volcanic ejecta and extrusives, has arrived at certain conceptions of the construction of the earth's crust. Seismology has yielded up most important evidences since the path and rate of travel of earthquake waves are dependent upon the density and elasticity encountered along their routes. These earthquake wave paths penetrate most parts of the earth, and serve to probe its inner condition. Thus it has been found that at a depth of some 50 or 60 km. there is a level of change of condition; earthquake waves are reflected from this level of discontinuity, or if they penetrate it are found to travel at much greater speeds below it than in the upper levels. Geophysicists have been making tests of the compressibilities of various rocks. Isostasy gives data as to the relative distribution of density with depth.

Geologists, seismologists, isostasists, experimental geophysicists, each have their particular ideas of exactly what is beneath us in the earth's crust, based on their individual lines of observation. How do successive layers vary in composition, density, temperature, conditions of rigidity and elasticity? Professor Reginald A. Daly, in an article published in the American Journal of Science, February, 1928 has assembled these various data and ideas with the aim of producing harmony among them.

Professor Daly shows that while the paths and velocities of earthquake waves are dependent upon conditions of density and elasticity, yet it is dangerous with information at present available to assume that the rocks which we believe to have those conditions of density and elasticity are thereby identified as those actually traversed. The preliminary earthquake waves travel at speeds of from 5.4 to 6.0 km. per second in the upper layers of the earth's crust, and the secondary waves travel from 3.2 to 3.5 km. per second; but below the layer of discontinuity the preliminary waves attain a speed of about 7.9 km. per second.

To try to determine what particular rocks these earthquake wave speeds represent, geophysicists have made compressibility tests of various constituents of the earth's crust. Specimens have been subjected to careful measurement under great pressures. But these samples are generally tested at our ordinary living temperature, and are tested in small pieces only. Daly's article points out that the results of these tests for a given material may not accurately apply to the higher temperatures and greater bulks of the same material at the depths in question. Also it is known that constants of rigidity and elasticity of many materials are not the same for great stresses as they are for small stresses, nor are they the same for stresses applied and released quickly as they are for stresses held through long periods of time. The vibrations of an earthquake wave are rapid, and their stresses are slight. In response to these vibrations perhaps different constants of rigidity and elasticity apply than those secured in making the tests or in computing from the static conditions of great pressure within the earth's crust. It therefore seems doubtful that it is yet possible to take the constants derived by timing earthquake waves to identify any particular rock or mineral.

Taken without these reservations ,the compressibility tests seem to preclude the possibility of a basaltic layer underlying the earth's crust. The idea of its presence there, however, is desirable to geologists and isostasists. The article here reviewed suggests that if basalt could be tested under the conditions existing at that great depth, that it might be found to have constants which would make it the proper medium to carry earthquake waves at their observed speeds.

R. M. W.

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No. 178 RELEASED WITHOUT COPYRIGHT RESTRICTION May 24, 1928

KILAUEA REPORT No. 852

WEEK ENDING MAY 23, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

On May 19 yellow stain was strongly noticed at the site of the southeast sulphur patch, and on May 21 the area of stain, as seen from the opposite side of the pit, appeared to have increased. Apparently sulphur crystals are again forming at this place.

A circuit of the pit on the 21st showed considerable change in the rim contour due to avalanches. On May 22 several slides occurred, one from the south corner about 9 a. m. making considerable noise. Dust was seen rising from the north and northeast corners during the day.

The east rim cracks were measured on May 23, but very little difference was found over the measurements of May 7 .

The seismographs at the Observatory recorded 13 local earthquakes during the week ended May 23. One at 7:43 p. m. May 18 was feeble, but may have been perceptible; all the others were very feeble.

Microseismic motion diminished during the week to an amplitude somewhat less than normal. Tilt accumulated slightly to the SSW.

The teleseism of May 14 mentioned in last week's report is given a tentative origin in Lat. 8 degrees S., Long. 80 degrees W. (north coast of Peru). This position results from a preliminary combination of reports from several stations, assembled and computed by the U. S. Coast and Geodetic Survey, the Jesuit Seismological Association, and Science Service in cooperation.

Thousands of sailors from United States battle squadrons now in Hawaiian waters are visiting the volcano.

ANCIENT PHILIPPINE EARTHQUAKES

A recently published catalog of historic earthquakes in the Philippine Islands (Seismologiacl Bulletin of the Weather Bureau, Manila, for 1926) gives 32 pages of very interesting descriptions of some of the greater ancient earthquakes and volcanic eruptions there. The time included is from 1585, when the first shock was recorded after the discovery of the Philippine Islands, to 1865 when the establishment of a government bureau began the more systematic collection of data. The descriptions of earthquakes are for the most part from writings of the priests, and frequently mention the damage to churches and parish houses. More damage occurred to such buildings because of their masonry construction than to the native buildings of loosely built wood, bamboo, and thatch.

It is suggested in the preface that the seismicity was probably about the same then as now; the number of earthquakes chronicled being then about as great as the numbers noted in recent years.

The descriptions are very graphic and interesting, and are set forth as the personal experiences of the various authors. About all the different effects that earthquakes produce are mentioned. Landslides and mud flows, shaken and broken buildings, earth cracks large enough to engulf human beings, changed river courses, ejections of mud, sand and water, darkness caused by dust of destroyed buildings or by clouds of volcanic ash, general destruction of towns, subsidence and flooding of land by sea water, tidal waves, and many other things are mentioned in the descriptions.

Many references are made to improved building construction with the aim to minimize the amount of earthquake damage. One writer says: "In spite of all these (experiences) the vanity and forgetfulness of men left them unconvinced that high houses are more subject to a great ruin. After the said earthquakes numerous houses were again built in the city, most of them of cut stone, as if all had forgotten the former disasters. Against all good architectural rules, walls fourteen to twenty meters high and less than a meter thick with a foundation about two meters deep were raised. Moreover these high and thin constructions had not any buttress as support or reinforcement; the mortar was of very poor quality made of little and weak lime and sand carelessly applied by unscrupulous Chinese, but yet our citizens pretended to have lasting buildings." Can it be said that even now in modern times with all this experience available to us that enough consideration is given to earthquake-proof building construction? Their experiences in those earlier years led finally to the building of wooden columns into masonry walls to prevent the falling-in of roofs should the masonry be shaken down. They also took such precautions as adding buttresses to building design, and building thicker wails and wider foundations. There is occasional note that damage was greater near a river than distant from it, perhaps having to do with the known increase of earthquake effects on buildings situated upon beds of alluvium.

The terror and grief among the people during these great earthquakes, and the ensuing pestilences and famines, are listed among the most serious effects of the shocks. Thus was Manila visited by disaster in the great earthquake of November 30, 1645: "The horrifying spectacle of that night was made more terrible by the distracted and precipitous wandering of the people through the darkness, blackened by the dense cloud of dust covering the city, the yells of the terrified multitude and the cries for help of the victims crushed and buried in the ruins."

The question of "earthquake weather" is mentioned by one writer as follows: "On the date of the main earthquake the weather was calm, the sky cloudy and dull, the air hot and heavy with puffs of wind and drizzling at intervals." These are indications, that author remarks, of impending earthquakes. There seems to be persistent belief throughout history that so-called "earthquake weather" exists as a forerunner of great seismic disturbances. This question is still open for science either to prove or disprove.

R. M. W.

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No. 197 RELEASED WITHOUT COPYRIGHT RESTRICTION May 31, 1928

KILAUEA REPORT No. 853

WEEK ENDING MAY 30, 1928

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Halemaumau continues quiet. A few small slides have occurred. On May 26 the north wall was streaked from slides. The southwest sulphur patch has again been obliterated by fallen debris.

Rumors of recent widening of cracks at the 14-ton bowlder proved false, although this place presents a dangerous appearance.

An extraordinarily strong northeast wind on May 25 made dense dust clouds on the south Kilauea floor and over the Kau Desert.

Eleven very feeble local earthquakes were recorded on the Observatory seismographs during the week ending May 30. There was also a very feeble record of a teleseism on May 26, of which the secondary and long waves are doubtfully identified at 11:37:50 and 11:46:24 p. m.

During the first part of the week there was a sharp spurt of tilt toward the NE., with an equally definite recovery, so that the net tilt accumulated for the week is but very slight toward the N.

GEODETIC WORK ON THE NORTHWEST HAWAIIAN ISLANDS

The U. S. Coast and Geodetic Survey S. S. "Guide," after completing the work of charting on the Kona coast of the Island of Hawaii (Volcano Letter No. 174, April 26, 1928), proceeded to the northwest islands of the Hawaiian group. The work there is the beginning of an extended program of latitude and longitude observations, determinations of gravity, measurements of magnetic declination and intensity, charting and topographic mapping. These small islands have needed such observations in order that they may be accurately charted. Their positions have heretofore been located for the most part by sextant observations only.

The geological aspect of these islands has been considered by Professor Harold S. Palmer in Bulletin 35 of the Bishop Museum. They are uninhabited, and have been given but little attention in the way of scientific investigations and surveys. It is believed that these are the older islands of the Hawaiian group and that they were at one time high volcanic cones, now reduced by erosion to projecting fragments and shoals.

The "Guide" has just completed the first trip of three weeks to Nihoa and Necker islands and to French Frigates Shoal. On Nihoa an astronomic station was occupied, where latitude, longitude, and azimuth were determined. Observations were also made for gravity and for magnetic declination. A topographic map of the island was made on the scale of 1:2,500. Some difficulty due to heavy seas attended the first attempt to go ashore on the island. The boat carrying the scientific party with instruments and supplies was capsized during the landing, but the instruments were for the most part recovered and there were no casualties.

Observations were to have been made on Necker Island, but rough weather made landing there impracticable. The ship therefore proceeded to French Frigates Shoal, where on East Island the same observations were made as on Nihoa. Triangulation was also started, and more complete magnetic observations were made at this place.

The ship returned to Honolulu for supplies and fuel, and has just started on a second trip to these islands. Another attempt will be made to occupy Necker to make there the same observations that have been completed at Nihoa and French Frigates Shoal, and to continue the triangulation work at the latter place.

The program contemplates continuing these observations on through the islands to the northwest as far as Ocean Island, if conditions permit, perhaps representing several seasons' work. For the longitude and gravity observations radio time signals are received direct from the Arlington station near Washington, D. C. Lieutenants Brown, Bainbridge, and Simmons, who did geodetic work on the Island of Hawaii about a year and a half ago, are the observers in this present work. R.M.W.

THE BALKAN EARTHQUAKES

The destructive earthquakes which occurred last month in Bulgaria and Greece filled the columns of the press at the time with descriptions of death and destruction. A series of pictures appeared in the "Illustrated London News" of May 5, 1928, giving very graphic evidence of the damage which the earthquakes accomplished.

Reports from the scientific investigations by seismologists and geologists as to just what occurred will be some time getting into print, due to the time that the necessary observations must take. A short preliminary discussion by Dr. Charles Davison of this group of earthquakes and their aftershocks has already appeared in "Nature" of May 5. That there will be many points of interest to scientists is evident from the number of observed geological effects mentioned in the press. The migration of focus during the series of earthquakes has attracted attention. The great area disturbed in the Bulgarian earthquakes and the lesser area disturbed by the Grecian shocks has already suggested that the former had a greater depth of focus. Changes of land elevation, tidal waves, the opening of great cracks in the earth, altered volume of flow in mineral springs with changes in the temperature of the water, are all things which will supply a wealth of material for scientific study. There is mention made of electrical displays noted before the occurrence of the first shock, suggesting forewarning phenomena, though science still doubts the existence of such effects. Mention is also made of investigations immediately started to discover the effects upon buildings, thus to learn more about details of design which will minimize damage by future earthquakes.

The scientific discussion of such calamities must be made the most of to increase knowledge toward lessening the loss of life and property in the future. R.M.W.

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No. 180 RELEASED WITHOUT COPYRIGHT RESTRICTION June 7, 1928

KILAUEA REPORT No. 854

WEEK ENDING JUNE 9, 1928
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Practically no changes have taken place at Halemaumau in the past week. On June 2 and 5 there were avalanches, dust from one of them at 1:45 p. m. on the former date rising in a peculiar compact cloud. The odor of free sulphur was noticed very slightly at the southeast rim at 11:30 a. m. June 6.

During the week there were 14 very feeble local tremors recorded on the Observatory seismographs. One of these, an earthquake slightly larger than the others, exhibited phases indicating a distance of nine miles to its origin. On June 5 there were two periods of continuous tremor, the first one beginning at 7:53 a. m. and lasting six minutes, and the second one beginning at 8:03 a. m. and lasting four minutes. These two spells of tremor perhaps represent the same disturbance, as they were separated by only a four-minute quiet interval.

During the first part of the week microseisms were somewhat more feeble than normal. On June 2 and 3 there seemed to be evidences of a vibration of longer period than the normal microseisms. Their period was about 7.2 seconds, and they could be detected in the records at intervals during the greater part of these two days. Microseismic motion again became normal by the end of the week.

Tilt has accumulated slightly to the southwest.

AERIAL PHOTOGRAPHS

In the current issue of "The Military Engineer" there is another article describing the campaign of aerial photography in southeastern Alaska. This project was described some time ago in the "Scientific American," and was mentioned in Volcano Letter No. 127, June 2, 1927. The recent article gives reproductions of some of the excellent photographs secured and briefly describes the field program and the subsequent compilation of the pictures into maps. Some of the country covered is so inaccessible to people on foot that it has not been thoroughly explored, and some lakes that were heretofore unknown were discovered in the photographs. Much valuable information was thus obtained in the matter of possible power sites and water supplies. Sets of these photographs are on file in the Geological Survey offices in Washington and in the office of the Forest Service at Juneau, Alaska.

During the 1926 outbreak of Mauna Loa in Hawaii, aerial photographs were for the first time used here to record progress of lava flows. The value of their use in this connection cannot be over estimated, both for the collection of scientific data and as a safety measure for the protection of human lives and property. At times of Mauna Loa eruptions, with the consequent lava flows down the slopes of the mountain, automobiles carrying sightseers in great numbers have crowded in to the flanks of the flow from both directions on the belt road running around the island. The traffic congestion resulting has usually been considerable, although during the last outbreak police organization kept everything well in hand. But with such congestion on this road there is grave danger that a lava flow coming down from above may split and isolate some of these sight-seers in a dangerous predicament. Some of the regions on the mountain slopes above the road are almost impenetrable, and it is difficult in the extreme for men on horseback or on foot to keep close watch on all the developments of the flow that might prove dangerous to those below. Periodic flights of an airplane over the flow, with the photographs that might be taken on such flights, would easily show the development of any dangerous aspects of the outbreak. A series of such pictures would constitute a most valuable scientific record of the flow. R.M.W.

THE FAILURE OF THE SAINT FRANCIS DAM

There has just been issued the report of the commission appointed by the Governor of California to investigate the failure of the Saint Francis dam, which occurred shortly after midnight on March 13, 1928. Defective foundations is the cause given for the collapse of the structure. Part of its length was built on a geologic formation which appears like solid rock when dry, but was found to lose much of its strength when water-soaked.

The body of the dam crossed a geologic fault which has been termed "dead." Motion along this fault line might easily have caused the failure of the dam. Careful investigation showed no sign of movement, however, and the nearest seismographs showed no earthquakes anywhere near the time of the calamity. In Volcano Letter No. 99, November 18, 1926, an article by Dr. G. Agamennone is reviewed in which he laid emphasis upon the necessity of an installation of seismographic instruments as a safety measure at all large dams. Stresses to the point of failure in these great dams probably do not accumulate suddenly. The softening of the foundation may have allowed this dam to settle or yield a little, perhaps with slight internal fractures, even some days before it actually collapsed. A seismograph installed upon the dam might have detected these slight preliminary motions, recording them either as tremors or as slight tiltings.

The failure of the dam in this case is not ascribed to actual earthquakes, but the use of seismographic instruments might nevertheless have given warning of the coming collapse, possibly several days in advance. The cost of installation of these instruments would seem to be a very slight amount to pay for the possibility of detecting the danger of such a calamity. R.M.W.

ERRATUM

The number of the preceding issue of "The Volcano Letter" was transposed. The correct number is 179, not 197. Recipients are urged to make the correction on their copies to avoid confusion in filing.

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No. 181 RELEASED WITHOUT COPYRIGHT RESTRICTION June 14, 1928

KILAUEA REPORT No. 854

WEEK ENDING JUNE 13, 1928
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

The volcano is quiet. There have been a few light slides, mostly from the south wall, but none has been noticed that was large enough to cause clouds of dust to rise. The weather is extremely dry, resulting in diminished steaming activity. There are no phases apparent which may indicate a change in volcanic conditions, but with the approach of the summer solstice close watch must be kept for anything that may be significant.

Twenty-three very feeble volcanic tremors were registered at the Observatory. One of these lasted for four minutes beginning 12:26 p. m. June 6. Microseismic motion is slight. Tilt accumulated slightly to the WSW.

MAKAOPUHI CRATER

The new Chain Craters Road in the Kilauea Section of Hawaii National Park, which at present ends at Makaopuhi Crater, has brought this interesting piece of scenery more under public observation than before. In Volcano Letter No. 47, November 19, 1925, there are notes of a visit to the bottom of this crater by Dr. John B. Stone, and Mr. R. H. Finch of the Observatory. Dr. Stone remarks that the eastern part of the crater was originally inclosed by a complete oval wall, the western part of which was destroyed when the collapse making the western pit occurred. This exposed a section down through the lava fill of the original eastern crater, which now forms a mezzanine floor to the western pit. The small spot of green salt part way up on the cliff on the east side of the deeper pit, and other small spots of the same salt appearing on bowlders in the talus slide below. Dr. Stone identifies as the basic copper sulphate, brochantite. The green spot upon the wall of the crater has been called the "eel's eye," whence comes the Hawaiian name of the crater, Makaopuhi.

On June 6, 1928, another trip was made to the bottom of the crater by Messrs. W. O. Clark, G. W. Russ, R. M. Wilson, and others. Some additional interesting features were noted. The ridge-like block above the north end of the cliff of the mezzanine floor appears to be part of the original northwest wall of the crater, which at some time has tilted forward and down. This is shown by the fact that the strata exposed in the surface of this block are tilted down at a considerable angle, while those in the undisturbed wall are nearly horizontal. The steep gully filled with talus just to the west of this tilted block is the crack formed when the block separated from the main wall. This apparently occurred some time during the life of the crater before the formation of the western pit.

The present bottom of the crater is a fill of ordinary aa lava which flowed down the western talus from the fissure vent of 1922. Looking down at this floor from the lookout point on the southwest rim of the crater, the lava appears smoother than it really is when one attempts to walk across it. From the same rim viewpoint the larger rocks which form the talus slopes do not appear to be as large as 8 to 10 feet in diameter, as is actually the case.

Below the lookout point, and low down on the southwest talus of the deeper pit of the crater, is a sulphur patch very similar to those seen in the pit of Halemaumau.

This double crater is slightly over 5 000 feet long east and west, and about 3,200 feet wide north and south. The rim elevation opposite the end of the road is slightly over 2,900 feet above sea level, and the bottom of the deep pit is a little less than 2,100. The mezzanine floor is about 2,500 feet in elevation. R.M.W.

EXPLOSIVE ERUPTION OF TOKATI-DAKE

In the "Bulletin Volcanologique" Nos. 13-14, 1927, is given a description by Hidezo Tanakadate of the explosive eruption phases of Tokati-Dake beginning December, 1925. The first explosions seemed to differ in character from those which followed nearly a year later. The first phases showed no sign of new lava in the ejectamenta, and it is suggested that the explosions were caused by water heated in the upper strata of the plug of the volcano by the gradual rising of the lava column some distance below. That these eruptions were rather shallow in origin is also attested by the fact that the tremors and earthquakes which they inspired were not severe nor recorded at any great distance.

The second phase which occurred after several months of quiet brought to the surface lava bombs and fragments at such high temperature that a nearby wooden cottage took fire from the bombardment. The description suggests that these explosions of the second phase originated deeper in the throat of the volcano and were perhaps caused not only by the conversion of ground water into steam at high pressure, but perhaps also by the liberation of actual volcanic and explosive gases. R.M.W.

JAPAN'S LATEST EARTHQUAKE

Deep down in the Pacific Ocean east of Japan was the center of a severe earthquake recorded by seismographs throughout the world on Sunday, May 27. The epicenter was 39° north latitude and 149° east longitude, according to computations of the U. S. Coast and Geodetic Survey after a study of records from seismograph observatories in Samoa, the Philippines, Canada, and the United States. This is in the Tuscarora Deep, which is north of a ridge along the bottom of the Pacific Ocean extending northward from Tokio. Seismologists recognize this region as one of the world's great earthquake belts. (Daily Science News Bulletin, May 28, 1928.) R.B.H.

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No. 182 RELEASED WITHOUT COPYRIGHT RESTRICTION June 21, 1928

KILAUEA REPORT No. 856

WEEK ENDING JUNE 20, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. B. Hodges, Temporarily in Charge

There is nothing new at Halemaumau. A few slides have occured, but for the most part the pit is very quiet. A spot of yellow-green sulphur stain is plainly visible at the lower edge of the southeast talus. The solfatara on the east talus remains the same. Steaming has not increased. The weather remains fair, but the velocity of the northeast trade winds has increased considerably.

The east rim cracks, measured on June 18, show an extremely slight increase of width in the neighborhood of the 14-ton bowlder.

Thirty-two very feeble local earthquakes were recorded. In addition is the record of a distant shock beginning at 4:58:55 p. m. June 16 and continuing for about 2 hours and 20 minutes. The distance to origin appears to be 3.914 miles. This is very probably the earthquake at Oaxaca and Mexico City, mentioned in news dispatches.

There is steady tilting, in moderate amount, to the WSW, which is unusual at this time of the year.

PISOLITES

Pisolites, or mud rain drops, are commonly found in areas that have experienced ash fall, yet there has been comparatively little attention directed to them. Probably the earliest public mention of them was made by Dr. Edward Otis Hovey, following the explosions of Mont Pele in 1902. A few geologists have given them some attention, and recently they have been studied by Dr. J. Allen Berry, of Napier, New Zealand.

The mud balls are extremely hard and formed in layers, which give the term "pisolite." They vary somewhat in size, the largest being comparable to a marble or a large pea. A simple explanation as to how they are formed is given by Finch, in Volcano Letter No. 75, June 3, 1926, who states: "This type of ash is produced by rain drops falling through dust-laden atmosphere and collecting so much dust that they fall as mud pellets. Owing to the natural cementing qualities of the ash, they more or less retain their round shape.". Jaggar, in Volcano Letter No. 157, December 29, 1927, adds: "The condition for preserving layers of pisolites is when stiff mud-drops fall in light dry dust beds of previous eruption, and it is possible that the baking the dust has been subjected to accounts for its cement-like quality in rapid hardening." Dr. Berry, in the "New Zealand Herald," Auckland, March 24, 1928, likens their formation to hailstones, as follows: "In the formation of hailstones it is well known that the laminated structure they present is due to ascending currents of air causing the hailstone to be surrounded by alternate layers of ice and snow, due to its being carried up into layers of the atmosphere having varying degrees of temperature. In the same manner, these masses of mud were carried up into a layer of pumice dust, where there was not much water vapor, resulting in a dense lamination. As the result of increased weight, or a diminution in the velocity of the ascending currents, and these ascending currents are quite common, they fell back into the layer of pumice dust containing a large quantity of water vapor, and a less dense lamination resulted. This process of ascent and descent repeated several times would result in the formation of what is called chalazoidites, from the Greek words meaning 'stone resembling hail'."

Continuing to quote from the "Herald:" "Dr. Berry has shown from staining and X-ray methods that these laminations are characteristic of these bodies; in fact they are very similar to the layers of an onion. Although these pumice bodies, or chalazoidites, must in New Zealand have a widespread distribution, no geologist has previously directed attention to them. It is also remarkable that although they are probably a concomitant of every great volcanic eruption in any part of the world where dust with large quantities of water vapor is being ejected, the references to their occurrence in the literature are remarkably few.

"Dr. Berry has recently discovered that chalazoidites fell during the eruption of Vesuvius which overwhelmed Pompeii in 79 A. D., and that they were similar to specimens which have been found in Napier and Taupo."

Large quantities of pisolites are found on the lee slopes of Kilauea, obviously a product of the great eruption of 1790. They formed to a certain extent in the explosions of 1924. Other places where this type of ash is known to occur, other than those mentioned, are Brisbane, western Germany, Japan, and the Philippines. Doubtless it exists also in Alaska and other volcanic regions. It may occur many miles from a volcano. In the case of Napier it is 80 or 90 miles from the probable origin.

R.B.H.

NOTES

R. M. Wilson is temporarily absent from headquarters in order to install a new seismograph at the Kona station. A description of the installation will appear in the next issue of the Volcano Letter.

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No. 183 RELEASED WITHOUT COPYRIGHT RESTRICTION June 28, 1928

KILAUEA REPORT No. 856

WEEK ENDING JUNE 27, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

No changes have been detected at the pit. There are only infrequent slides and a slight increase of steaming following recent rains.

There were 18 very feeble local earthquakes recorded on the Observatory seismographs during the week ending June 27. Two teleseisms were also recorded, both on the 21st. The preliminary motion of the first one arrived at 12:18:27 a. m., and the indicated distance to its origin is 3,120 miles. The beginning of the preliminary wave of the second teleseism was recorded at 6:05:07 a. m., with 2,900 miles as the indicated distance. Both of these records were feeble, but the phases were fairly distinct.

Accumulation of tilt during the week was slight toward the east.

THE PAVLOF VOLCANO EXPEDITION

A brief radio message from Dr. T. A. Jaggar dated May 15 gave his address as King Cove, Alaska. Some additional news has now come from him in a letter of the same date written from his camp at Squaw Harbor. The expedition arrived at that place on May 9, camp was established, and the equipment tried out.

The "Honukai of Hilo" is the amphibious boat in use by the party, and was built for the expedition by the Powell Mobile-Boat Corporation, Chicago, Illinois. The name "Honukai" comes from the Hawaiian for "sea turtle." Photographs of the vehicle have appeared occasionally in the daily press during the last few weeks. It is in principle similar to the "Ohiki," described in Volcano Letters Nos. 156 and 165. The "Honukai" is a metal boat built upon a truck chassis for land travel, and is propelled in the water by twin screws as an ordinary motor boat. The amphibian was tested in Puget Sound before it was shipped to Alaska. Dr. Jaggar speaks highly of its behavior during the test and during the first days of work in establishing camp in Alaska. He states that it is tight and dry, its canopy top furnishing good protection from the weather. It is sufficiently seaworthy to navigate easily in moderately rough weather when white caps and ground swells are running. It can be "navigated" right up out of the water over the stony beaches and tundra directly to the camp site or elsewhere, and promises to be very useful and practical. Its power and speed in the water is augmented when necessary by the use of a Johnson outboard motor.

A sloop with a 5 h. p. motor has been hired locally as an auxiliary in water transportation. Two pack mules, towed upon a scow from base to base, are used when the party wishes to make expeditions inland into the mountains beyond the range of the "Honukai."

At the time of writing, it was planned to start work at Canoe Bay, at the head of Pavlof Bay, about May 18. The expedition is under the auspices of the National Geographic Society. The scientific data collected, the maps and photographs obtained, and the experiences of the party, we hope will appear in the National Geographic Magazine soon after the season is ended. R.M.W.

KONA SEISMOGRAPH STATION

The Monthly Bulletin and the Volcano Letter of the Hawaiian Volcano Observatory have from time to time mentioned the records of the seismograph that has been operated in Kealakekua since March 4, 1922. This single-component instrument has furnished data of great value. The usefulness of the station can be understood from the fact that it is directly on the other side of Mauna Loa from the Observatory, and is therefore in a strategic position to supplement the records of the Observatory in the study of that active volcano. The air line distance between the two stations is 43.6 miles, affording an excellent base from which to triangulate the epicenters of Mauna Loa earthquakes.

One of the new Hawaiian type two-component instruments has just been installed in place of the older and smaller seismograph that has so well demonstrated the value of seismic observations on the west side of the island. The new instrument is the same type as the one installed last summer in Hilo, except that the magnification is slightly reduced. The same concrete pier that was used for the old instrument is being used, with a few alterations, for the new installation. It is founded on solid pahoehoe lava, and is well protected from temperature changes in an insturment room built in a sheltered basement. Captain R. V. Woods remains in charge of the station. Operation of the new instrument was begun on June 22.

Surveys show the station to be at latitude 19° 31′ 18″ N. and longitude 155° 55′ 20″ W. Its elevation is about 470 meters above sea level. Using these coordinates, computations show this position to be 70.2 km. N. 81° 30′ W. of the Hawaiian Volcano Observatory. The summit of Mauna Loa lies almost exactly midway, in line, between these two stations.

The instrument has inertia masses of about 70 kilograms, and records on smoked paper. The static magnification is 120. Both N-S and E-W components have been adjusted to a free period of 6 seconds, and are oil damped to a 3:1 ratio. The recording drum is driven by an escapement clock mechanism, giving the paper a speed of 30 millimeters per minute. Time used is Hawaiian Standard, 10 h. 30 m. slower than Greenwich. The time clock is corrected by radio signals from U. S. Naval Radio Station NPM at Pearl Harbor. R.M.W.

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No. 184 **RELEASED WITHOUT COPYRIGHT RESTRICTION** July 5, 1928

KILAUEA REPORT No. 857

WEEK ENDING JULY 4, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Observations at Halemaumau fail to show any indication of changes in volcanic phases. Falls of rocks occur at infrequent intervals, but few of them are large enough to cause dust clouds. Wet weather has deepened the colorings in the wall stratification.

The Observatory seismographs have recorded 24 very feeble local earthquakes during the week ending July 4. One teleseism was also recorded on June 29, with its preliminary phase beginning at 12:28:15 p. m. The record was very feeble, so that all the phases as read from the record are doubtful. The indicated distance is therefore doubtful also, but is apparently 3,400 miles.

Tilt has accumulated slightly to the north-northeast during the week.

ACTION OF IRREGULAR IMPULSES UPON SEISMOGRAPHS

The general theory of seismographs is based upon the assumption that earthquake motion is simple harmonic. This is natural since the motion is an elastic vibration, but it is in fact the resultant of many simple vibrations in different directions and of many different periods. The actual net result is, therefore, a very complicated motion which defies mathematical analysis. In applying such formulas as are deduced by considering the earth's motion to be simple harmonic, it is to a certain extent unknown what errors are introduced due to this complication of motion that actually exists. The records made by seismographs cannot be expected to represent true earth displacements, motion for motion. The indicated accelerations probably roughly represent ground accelerations in order of magnitude only, except perhaps for very slow and simple movements and vibrations.

Some welcome investigation seems to have been undertaken by T. Terada and U. Nakaya to determine the effect of a series of irregular impulses upon an oscillating mechanism. In Volume IV, No. 5, of the Proceedings of the Imperial Academy (Japan) is a brief abstract describing the experiments made by these investigators. An oscillating system somewhat similar to an ordinary seismograph with its recording apparatus was arranged to be acted upon by streams of shot, so that impacts would result irregularly from opposing directions. The records made by these irregular impulses were then studied.

There are many factors entering into the action of a seismograph as ordinarily installed for the study of earthquakes. First there is the natural period of the seismograph itself; and the damping and friction attendant upon its mechanism. These are the usual instrumental constants determined by computation and experiment. Some individual parts of the seismograph, such as the recording levers or the wire suspensions of the heavy mass, perhaps have natural periods of their own which through the action of resonance may have a marked effect upon the action of the instrument under certain conditions. The foundation of the instrument may also have a natural period, and the very ground upon which the station is built may respond more easily to vibrations of certain frequency. Thus even if the earthquake motion were simple harmonic, its recorded result after passing through these various parts of the installation might easily yield a record of considerable complexity. And since actually the earthquake motion is itself complicated, its relation to the resultant motions of the recording pen is entirely too involved to be subject to exact analysis.

The records secured by the experiments here described show a remarkable resemblance in character to the usual seismographic records of real earthquakes and microseisms. In these experiments it is possible to govern the average frequency and intensity of the impulses given to the mechanism. A comparison of actual earthquake records with the records artificially obtained should show to what intensity and frequency of impulse the actual earthquake may correspond. The character of the earthquake may so perhaps be determined without the necessity of the long train of mathematical reasoning that must fall short of true results at the best.

The authors promise a more detailed description of the experiment, with discussions, to appear in Volume V of the Bulletin of the Earthquake Research Institute of the Tokyo Imperial University. R.M.W.

GENERAL DIMENSIONS OF HALEMAUMAU

The approximate center of the pit of Halemaumau is in latitude 19° 24′ 34″ north, and longitude 155° 17′ 10″ west. In its present condition it is almost circular in shape, though the northeast-southwest diameter is slightly greater. Its diameters are 3,420 by 3,980 feet. The perimeter is 1.96 miles. The depth of the lowest part of the floor below the average rim elevation is 1,170 feet. The summit of the southwest cone is 160 feet above the lowest part of the floor. The debris slopes or taluses repose at an angle of about 30° from the horizontal, which is about a 58% grade. The steeper walls stand at about 80° from the horizontal; while the average slope of the northwest wall is about 53° from the rim to its lowest toe. The area of exposed lava floor and the cones with their spatter is now about 19 acres. The horizontally projected area of all the taluses is 87 acres, and the area of the horizontal projection of all the walls is 81 acres; the slope areas are of course much greater. This makes the total area of the pit 187 acres. The southeast station at the "Halemaumau sign," which is the point from which the pit is most often viewed, is about south 30° east from the center of the pit, and the elevation of the bronze mark there is 3,651 feet above mean sea level. R.M.W.

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No. 185 RELEASED WITHOUT COPYRIGHT RESTRICTION July 12, 1928

KILAUEA REPORT No. 859

WEEK ENDING JULY 11, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Halemaumau is still very quiet, and there is nothing to indicate that any changes are about to take place. Activity of the walls is so slight as to be practically negligible. The only variation in conditions occurs when there is increased steaming in wet weather and a corresponding decrease in dry weather. Reddening of parts of the walls also occurs during rains.

Twelve very feeble local earthquakes and one faint teleseism are shown on the Observatory seismograms for the week ending July 11. The record of the teleseism, July 9, is too faint to show phases, and therefore distance to origin cannot be computed. The first sign of the preliminary phase is shown at 11:02:50 a. m.

Tilt has accumulated moderately toward the WNW.

CONTINENTAL DRIFT

The "Theory of Continental Drift," a symposium recently published by the American Association of Petroleum Geologists, Tulsa, Oklahoma, assembles the modern conceptions regarding the earth's outer layers, and digests them to brief outlines and discussions for application in this particular question. Dr. van der Gracht gives as introduction an outline of Wegener's theory of continental drift, setting forth the major evidences in its favor. Following this are comments by such authorities as Bailey Willis, Rollin T. Chamberlin, John Joly, G. A. F. Molengraaff, J. W. Gregory, Alfred Wegener, Charles Schuchert, Chester R. Longwell, Frank Bursley Taylor, William Bowie, David White, Joseph T. Singewald, Jr., and Edward W. Berry. Dr. van der Gracht then adds a few paragraphs in reply to these comments which are for the most part not in favor of the theory. Many modern ideas over a wide range of subjects have been brought forward as weapons with which either to support or to attack the theory. The discussions are of great interest not only to one who is concerned alone with the study of continental drift, but also to anyone interested in geology or geophysics in general.

Dr. van der Gracht added very materially to the strength of Wegener's theory by utilizing the calculations of Joly. These calculations tend to show that by radioactive disintegration enough heat is generated in 31 km. of depth of the earth's crust to about equal the amount of heat which that thickness of crust is capable of transmitting to the surface. This means that such a thickness of crust is a perfect blanket, and any heat generated below cannot escape through it. Joly suggests that the effect of this condition is the slow accumulation of heat, particularly under the continents, until the under part of the crust is brought to melting point. More and more of the earths under crust is fused until some escape for this heat is provided. Van der Gracht believes that this melted layer allows the continents an easy base upon which to slide and that the tidal effects of luni-solar attraction in such a liquid layer may produce the tangential power to effect the motion.

As evidences that this has happened, it is shown that the Atlantic coast lines of the Americas would approximately fit against the Atlantic coast lines of Europe and Africa. Other apparent parallelisms of coast lines would suggest that at one time there was only one great continent and one ocean, and that the continent was rifted and torn apart by these forces, the present continents being the separated fragments of the original one. The mountain ranges parallel to coasts are taken to be the crumpling of advancing edges of the continental masses as they meet with resistance in front of them. The theory attempts to plot climatic zones as defined by fossils, which existed in the geologic past about a different polar axis than the present one. These zones now seem to occur in separated arcs, but plotted on the re-assembled original continent become more perfectly arranged as true earth belts.

In a note by Wegener himself sent to be included in this symposium, it is suggested that a definite test of the theory will come from periodic remeasurements of geographic longitudes at various places. There is cited the case of the apparent change of relative longitude between Greenland and northern Europe amounting to as much as 1,190 meters in the interval of time between 1870 and 1907. Unfortunately this comparison depends upon longitudes obtained by lunar observations, which are subject to considerable error. The more recently determined longitudes by radio time signals throughout the world will establish a very definite base upon which continental movements may be checked.

Arguments against the theory are many. The most common one appears to be the doubt that there are available horizontal forces sufficient to accomplish these great results, even though great lengths of time are given these forces in which to act. It is suggested that the apparent agreement of coast lines supposedly left by the separation of continents once adjacent, is as conveniently explained as accidental. This is borne out by rock analyses taken from corresponding parts of these separated coast lines which should have been, according to the theory, at one time very close together. These analyses, made by Washington, fail to check as would be expected if the coast lines had once actually fitted together. The theory postulates that the continents are floating masses supported by a yielding layer, a condition somewhat similar to that called for by isostasy. The crust underlying the Pacific Ocean is supposed to yield slowly to the advancing continents, its action in yielding being considered more as a viscous yielding than one of crushing and fracturing. Yet it is pointed out that tectonic earthquakes occur under the Pacific, which would not be the case if the crust there could yield as a viscous layer.

The theory is based on considerable thought and the assembling of a great deal of data. Many vexing geologic problems might be solved by its acceptance. But the general opinion of those making comment upon it, however, is that the theory is not yet sufficiently well founded to accept.

R.M.W.

ERRATUM

In the "General Dimensions of Halemaumau," as given in last week's Volcano Letter, the pit diameters should be 3,420 by 2,980 feet. The latter was given too great by 1,000 feet through a typographical error.

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No. 186 RELEASED WITHOUT COPYRIGHT RESTRICTION July 19, 1928

KILAUEA REPORT No. 860

WEEK ENDING JULY 18, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Conditions have not changed at Halemaumau. Rockfalls are infrequent, and steaming is slight.

The seismographs of the Volcano Observatory have recorded but seven earthquakes during the week ending July 18. This is the smallest number for any week since June, 1927.

Tilt has accumulated slightly toward the east.

LASSEN REPORT No. 17

R. H. Finch, Associate Volcanologist

U. S. Forest Service Ranger W. J. Brokenshire and other Forest Service officials found a considerable quantity of lava in the top of a fir snag when it was felled during a forest fire in the latter part of May, 1928. The find was made on Sugarloaf Mountain near some fresh looking lava flows that are just to the east of Magee Peak. The lava specimens are covered with sulphate deposits, and some pieces contain charcoal. The snag, which appeared to have been dead for many years, was about 30 inches in diameter. A volcanic explosion may be offered as a possible explanation for the location of the lava specimens.

THE PAVLOF VOLCANO EXPEDITION

In Volcano Letter No. 183, June 28, 1928, there were notes on the progress of the Pavlof Volcano Expedition of the National Geographic Society, based upon letters from Dr. Jaggar dated May 15 in Alaska. At that time the party was organized in camp, and work was just beginning.

Another letter dated June 13 has just been received telling of the exploration accomplished up to that time. The amphibious autoboat "Honukai" is proving itself most practical and useful. Its weight is about the same as the "Ohiki," but it is more protected against weather and does not leak. The experiments with the "Ohiki" of the Hawaiian Volcano Research Association (see Volcano Letters Nos. 156 and 165) here in Hawaii furnished experience which has proved of the utmost value in handling the "Honukai" in Alaska. The woven steel mats first used with the "Ohiki" are being used with the "Honukai" frequently and with great profit. These mats when placed under the wheels of the vehicle allow it to be taken over soft sand and muddy places without difficulty. The "Honukai" is doing full duty both on land and water in hauling freight and passengers, firewood and camp material, in trolling for fish, and in bringing down from the foothills such game as is shot; Dr. Jaggar speaks of using five bullets to kill a 10-foot bear. As a boat it is not particularly fast, but has been found very seaworthy in heavy seas and in strong currents and tide rips, and has been found able to land successfully through fairly heavy surf. On land it is taken along the beaches and over the tundra quite easily. It makes excellent sleeping quarters for two men whether on land or on sea.

Mr. C. P. McKinley, the topographer furnished by the Geological Survey, had mapped 600 square miles of the mountain country on a scale of 1:180,000. He has used the mules to make topographic side trips up into the mountains. The rest of the party have been collecting and pressing plants and sea weeds, and at the time the letter was written had already taken about 150 excellent photographs.

Dr. Jaggar states that the geology of the region is very interesting. Some fossil leaves and shells have been found. A mountain north of Canoe Bay which is 4,300 feet in elevation has been identified as a new volcano. It has a large crater and a lake in its summit and Dr. Jaggar proposes to name it Dana Volcano.

The weather had so far been good, and on some days the temperature reached almost 70° in the sun. At that time of writing, the expedition was preparing to start on a somewhat pretentious overland trip with the "Honukai" across the foothill country on the east part of the Pavlof Bay-Bering Sea isthmus. The object was to get into a chain of lakes on the Bering Sea side.

It was expected that wild flowers would soon be out in great profusion. Specimens will be collected, and many color photographs will be taken. Already 1,500 feet of motion picture film have been taken and shipped out.

R. M. W.

LAVA SLICKENSIDES

In the New Zealand Journal of Science and Technology, Vol. X, No. 1, May, 1928, is a brief description of an igneous dyke recently exposed in a quarry at Aukland. The faces of the dyke show striations, which were apparently formed when the mass was still soft, and was being forced up into the volcanic debris and scoria in which it was found. The writer suggests that had striated blocks from such a dyke been found in a talus deposit, or in less obviously associated surroundings, they might easily have been taken to be of glacial origin.

R. M. W.

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No. 187 RELEASED WITHOUT COPYRIGHT RESTRICTION July 26, 1928.

KILAUEA REPORT No. 861

WEEK ENDING JULY 25, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

An avalanche from the northeast wall of Halemaumau occurred on July 20 at 4 p. m. Dust resulting was seen above the pit rim about five minutes later. On July 21 two dusty scars showed on the northeast wall, and a heap of new debris lay at the foot of the wall between the northeast and north-northeast taluses. The north wall is quite red from wetting. No other changes have been observed.

One feeble and 15 very feeble local earthquakes were registered during the week. The feeble shock occurred July 21 at 1:05 p. m., and had an indicated distance to origin of 15 miles. There was also the faint record of a distant earthquake beginning at 8:47:36 a m. July 18.

There was a slight accumulation of SSW. tilt.

Microseismic motion was slight throughout the week.

THE ISOTHERMAL SURFACES OF THE EARTH'S CRUST

In the American Journal of Science of June, 1928, is a discussion of isogeothermal surfaces by Van Ostrand. This represents a more general attack on the problem inspired by the various local investigations at different places for oil bearing formations. Mr. Van Ostrand applies formulas for conductivity of heat through earth crust materials, and works out the thermal gardients that would result if the earth had cooled to its present condition by conduction and radiation from an original state of high and uniform heat. The result of this mathematics is a set of perfectly regular isothermal surfaces. But actually these surfaces are irregular, conforming to local conditions of structure, conductivity, moisture content, and geologic formation. The oceans carry off heat from the underlying crust by convection, and therefore the isothermal surfaces in low latitudes are depressed under the oceans. It is supposed, however, that these isothermal surfaces are in general smooth and without abrupt variations.

In the discussion an important place is not given to the possible heat generated by radioactive decomposition, as suggested by Joly (see Volcano Letter No. 185).

The general problem when modified by the effects of surface configurations such as mountains, valleys, or oceans, by known details of geologic structure, and by known mean surface temperatures, will give the expected variation of temperature with depth Thus when abnormal temperature conditions are encountered, they may in many cases be used as indications of local irregularities of some sort in the earth's crust. It is found that the salt domes of oil bearing areas are associated with elevation of these isothermal surfaces and this principle is taken advantage of as an aid in determining the extent and shape of such formations.

This line of investigation would probably have application in the vicinity of a volcano to determine at least where the most recently active parts of the structure might be. It is known that heat flows slowly through rock, and it is probable that the intrusion of magma into a region could not be detected by changes of temperature at any great distance except after the passage of a considerable period of time. This assumes, however, that the layers blanketing such an intrusion are not cracked or punctured in any place to allow convection.

The temperature borings undertaken in the vicinity of Kilauea by the Hawaiian Volcano Observatory represent a still more localized application of the problem. Here the different strata have been laid down in very recent times at high temperatures. The entire floor of the crater is broken up by many cracks which furnish means of escape of heat from the lower layers by convection as well as by conduction. Since here the temperatures involved are great and the distances small, a great precision of temperature measurement is not so esseutial as in the case of the more thoroughly adjusted areas existing in older regions. Isothermal surfaces determined in the lava fill of Kilauea Crater should indicate by their shape the position of those parts most recently deposited, and should show where cracks are allowing heat to escape by convection.

R. M. W.

GEOPHYSICAL PROSPECTING

The use of specially designed seismographs in prospecting for oil bearing formations has been discussed occasionally in preceding issues of the Volcano Letter. The development of geophysical methods toward the particular end of commercial prospecting is receiving considerable attention, as may be judged by an article in the New Zealand Journal of Science and Technology for May, 1928, by Donald C. Barton. The use of the Eotvos balance is given the most important place among the methods he mentions. The seismic method comes next. There follow the methods using tests of the earth's crust for electrical conductivity, and for magnetic properties.

These methods of prospecting are considered sufficiently important to oil companies so that the expenditures in our southern oil producing states is estimated to be $400,000 a month on geophysical investigations alone. Other countries have been using the same methods in a lesser degree. The discovery of several oil fields and the mapping of others has come about through the use of these investigations.

The demand for their use has been greatest in the field of oil prospecting. There is no reason, however, why these methods, which are now so well developed, may not be used in prospecting for ores or other resources hidden beneath the earth's surface. Their application has already been used in Japan to account for certain details of seismic and volcanic mechanism. There is possibility that with more development it may yet be possible through their use to discover more definitely and more in detail the structure and mechanism of a volcano.

R. M. W

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No. 188 RELEASED WITHOUT COPYRIGHT RESTRICTION August 2, 1928

KILAUEA REPORT No. 862

WEEK ENDING AUGUST 1, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Wet weather at Kilauea Volcano on July 26 and 27 increased considerably the activity of steam jets in Halemaumau and on the outer crater floor. There have been a few slides from the pit walls caused by visitors rolling bowlders over the edge, but no natural ones of any size. Slight fresh cracking of the ground has occurred about the south rim station. Dusty slides at the south corner were noticed on July 19.

Several patches of buff colored ash of 1924 are still noticeable in depressions on the crater floor.

Measurements of the east rim cracks on July 30 showed a few minor differences.

The seismographs recorded 28 very feeble local earthquakes during the week.

Tilt has accumulated moderately NNE.

Recent surveys around the pit show that there have been four major cave-ins from the rim during the past 12 months. One strip about 400 feet long just to the northwest of the 1920 rift tunnels has fallen in. Directly over the northwest talus a strip about 700 feet long and containing nearly an acre has fallen in since the surveys of last year. The falling in of this part of the rim very likely represents the avalanche which caused the squeezing up of liquid lava on January 11, 1928. Another piece is gone from the north-northeast rim, just over the north end of the intrusive mass; probably the accumulative result of the minor avalanching that has been going on there so frequently during the past year. A long narrow strip having an area of about 0.7 acre has also fallen in from the east-northeast rim.

THE CALDERA PROBLEM

Several theories have been advanced to explain why many volcanoes are encircled by outer craters of which the diameters are great if compared to the apparently localized centers of activity. These calderas, sometimes with extended flat bottoms, are usually supposed to have been caused by volcanic explosion or by subsidence and collapse. Thus a volcano may build itself up as a perfect, sharp cone, with only a small summit crater, until an explosion causes its top to be blown off, thereby creating a summit crater of greatly enlarged proportions. This summit crater may then gradually fill, resulting in a large caldera with only localized activity within it. Again a volcano may proceed to build itself as a perfect cone until such time as the lava column retires and allows the summit portions to collapse inward upon the descending lava. This again would result in an enlarged summit caldera.

A new idea has recently been advanced by Sandberg, Koninklijke Akademie van Wetenschappen te Amsterdam, who believes that neither of the above ideas is the true one. He suggests that the explosion theory would not necessarily leave the inner walls so nearly perpendicular and so nearly circular in shape, as is the usual case. He believes that the large volumes represented by some of these calderas could not have collapsed into a comparatively restricted volcanic throat. The new theory is that these large calderas, which are usually circular and have steep inner walls, actually represent the tops of former great volcanic throats extending in undiminished size down into the volcano. Thus these "cone pipes" measured by the diameter of the outer caldera would suggest older volcanic activity on a greatly enlarged scale. As volcanic activity decreases, the volcanic throat diminishes in diameter until the remaining activity occupies a comparatively restricted area within a greater encircling caldera. As so many volcanoes now show smaller cones and throats within greater encircling calderas, it is taken as evidence that volcanism has diminished by that ratio within rather recent geologic time.

At Kilauea Sandberg describes the larger crater, which is approximately oval in shape and 3 by 2 miles in length and width, as being the top of the original "cone pipe" of Kilauea Mountain. The walls of Kilauea Crater, would, according to this idea, continue almost vertically downward nearly to the bottom of the mountain structure. Later activity having diminished, this large pipe has filled, and the activity has become centralized at Halemaumau, which now represents in turn the size of the reduced volcanic throat in which the lava column rises.

The explosive eruption of 1924 was a comparatively small one of its kind, as is testified by the much thicker beds of older explosive ejactamenta underlying its debris. During this eruption, the explosions which threw material from the pit, the avalanches from walls rendered unstable upon the retirement of the lava, and the material engulfed which followed the lava as it retired, enlarged the pit to double its former diameter. Geodetic measurements have shown that at this time the central parts of the floor of Kilauea Crater surrounding the pit settled by as much as nine feet in places with respect to the surrounding country. Thus even this small eruption did a great deal toward working the walls of the pit back and forming a larger caldera. Had the processes of this eruption been continued through longer time and in greater violence, the entire floor of Kilauea might have been eaten away and either engulfed or thrown out as ejected material. Had the processes continued still farther, the walls of Kilauea Crater itself might have been eaten back from their present position. The present position of the walls of the crater probably represent the limit of action of such a destructive phase in the history of the volcano. Evidences of this exist in the number of down-faulted blocks around the rim, which seem very suggestive of the method of development and enlargement of the great crater. These down-faulted blocks would have no place in the large volcanic pipe theory suggested by Sandberg.

R.M.W.

SAMPLE COPY

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No. 189 RELEASED WITHOUT COPYRIGHT RESTRICTION August 9, 1928

KILAUEA REPORT No. 863

WEEK ENDING AUGUST 8, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

There has been slightly increased avalanche activity at Halemaumau during the past week. The slides occur mostly at the north end of the northeast sill. No other noteworthy changes have been observed.

Twelve local earthquakes and one distant shock were registered on the seismographs. One of the local earthquakes, classed as feeble, occurred at 7:50 p. m. August 7, and was felt by a few persons in the volcano district. The teleseism recorded very faintly, the preliminary wave beginning at 8:06:24 a. m. August 4.

Tilt was moderate to the SW.

POWER FROM NATURAL STEAM

The development of power from natural steam issuing from the ground has been for some time a fact in Italy (Volcano Letters 32 and 97). Development of natural power of this sort has now been made in California at The Geysers. A brief description is given in the July 7, 1928, issue of "Nature" by Allen and Day of the Geophysical Laboratory of Washington. Experiments were started there about six years ago in a small way, until outside capital became interested, making possible a more complete development of the power at hand. The area which shows signs of abnormal surface temperature is a narrow strip about 25 miles long, but the more intense thermic activity is limited to a smaller area only about six miles long and one-quarter mile wide. Wells have been sunk to various depths from 400 to 650 feet by allowing cold water to flow into the well while the drilling operations were in progress. This cold water condensed the steam and so reduced the steam pressure, allowing the operations to proceed without undue difficulty. The steam pressure made available in five new wells varies from 95 pounds to 276 pounds per square inch, and issues in such volume as to make available for power an average per well of about 1,000 kilowatts. The wells are rather close together, the distance between them varying from 50 to 175 feet, yet apparently there is no lessening in steam pressure of any of these wells due to the discharge of steam from the others. The original two wells which were drilled before the advent of outside capital were utilized to operate the electric lighting plant for the inn and cottages located nearby. Plans have been made for the commercial use of the increased power available from the newer and larger wells.

It is pointed out that in all probability this steam comes directly from underlying masses of hot magma. The steam is superheated to such high temperatures that the idea of its coming from an underground water reservoir does not seem reasonable. Additional evidence is the fact that the gases brought up with the steam are those that would be expected to issue from hot magma. These are particularly carbon dioxide, hydrogen sulphide, nitrogen, and argon, and traces of other gases. Thus these indications seem to point to hot magma as the origin of the virgin steam, rather than to the mere heating of infiltrated surface water by hot strata. It is noted that here again heat at the surface in the form of natural steam or hot springs is probably an indication of the presence of a deep fault. R.M.W.

PREDICTION OF EARTHQUAKES

The daily press is prone to give considerable space to those who desire to predict calamities. The predictions of Professor Raffaele Bendandi, of Faenza, Italy, have been given considerable publicity. It is the habit of this forecaster to make frequent and rather vague predictions as to coming earthquakes, tornadoes, and tidal waves. Earthquakes occur in considerable frequence on our world, which may yet pass unnoticed except by seismologists, unless they happen to occur in some thickly populated area where damage to humanity results. It is safe to prophesy a great earthquake at almost any time one may wish, and then afterward to point to a selected earthquake which may appear to justify the prophecy, if one is not too particular as to precise time and locality. The prophecies of Professor Bendandi have been subjected to analysis by Mr. James Young, of Toronto, Canada, who has found that no more of these prophecies have been properly fulfilled than would be expected from the laws of chance, merely. He points out that many of the earthquakes selected by Bendandi as justifications of his prophecies, while they may occur within a few days of the time set, often fail by whole continents to agree with the prophesied locality. It is also pointed out that several of the greatest and most disastrous earthquakes were not predicted at all. Thus it would seem that Professor Bendandi may make his prophecies merely at random, afterwards making use of a far fetched chance method to justify them.

Earthquake prediction by conventional scientific methods is by no means impossible. The tiltings, changes of level, and horizontal creeps of the earth's crust discoverable by geodetic measurements are apparently proved to be forewarnings of earthquakes by a number of actual observed cases in Japan and California. These movements probably represent elastic crust yielding before earthquake fracture occurs. RM.W.

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No. 190 RELEASED WITHOUT COPYRIGHT RESTRICTION August 17, 1928

KILAUEA REPORT No. 864

WEEK ENDING AUGUST 15. 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Halemaumau presents an extremely quiet and peaceful appearance, and there is absence of any indication of volcanic activity in the near future. Slides were noted at 2:40 p. m. August 9, 3:15 p. m. August 11, and 9:15 a. m. August 15. Steaming is extremely slight in the pit.

Fourteen very feeble local earthquakes were registered on the seismographs at the Observatory. It is interesting to note that nine of these occurred on August 8, and that one shock was a three-minute tremor coming just after noon. Beginning at 9:51:21 p. m. August 11 is a brief disturbance, presumably a faint trace of a teleseism.

Microseismic motion is considerably below normal.

The net accumulation of tilt for the week is strong to the NNE.

SOUTH AMERICAN EARTHQUAKES

The following extract from "Harper's Weekly" of December 5, 1868, indicates that inhabitants of the Pacific Coast region of South America must always have lived in fear of disastrous earthquakes.

"The Spaniards in South America were not without early intimation of the insecurity of the soil. Lima was founded in 1535, under the high-sounding title of Ciudad de los Reyes, or City of the Kings, since altered to its present name. In 1582 Lima had its first recorded attack of earthquake. The centre of the shock, however, was lower down along the coast, in the neighborhood of Arequipa, founded by Pizarro some twelve months after the establishment of Lima. Arequipa was laid in ruins then as now; but Lima escaped with a warning. Lima's turn, however, was not long in coming. Four years afterward it was laid prostrate; and so great was the catastrophe, even in that land of catastrophes, that the anniversary of that destruction is solemnly commemorated to the present time, on the day of the Visitation of Elizabeth. Lima had its third attack in 1609. In November, 1630, there was another earthquake; but so many of the citizens contrived to escape that they, then and there instituted the Festival of Nuestra Senora del Melagro, which is celebrated annually to this day.

"Thenceforth, earthquake and city may be truly said to have entered into contest for possession of the soil. Earthquake returned to the charge in 1655 with such violence that, for the first time, the citizens camped for several days in the country districts around. When they returned they found no stone standing on another; nevertheless the city rose again. After this there was no earthquake for some twenty years. Again, ten years later, in 1687, at four o'clock in the morning, houses and public edifices came tumbling down without the least previous intimation, the inhabitants, as usual, rushing into the squares and open spaces. The miserable consolation, however, of looking on in safety was this time denied them. At six in the morning the earthquake repeated its attack with renewed vigor, and the sea, retiring and rising in a wall of inky waters—as it did in the great earthquake of this year (1868)—dashed back with overwhelming force over the land. Callao, which had arisen as the port of Lima, a few miles from it, was entirely destroyed, and most of the inhabitants were carried away by the receding waters. The local records, preserved to us by Don Antonio de Ulloa, captain of his most Christian majesty's navy, mention this as the most disastrous visitation to that date. December, 1690, September, 1697, July, 1699, February, 1716, January, 1725, December, 1732, were all earthquake months in Lima. In 1734 and 1745 there were more earthquakes. On the 28th of October, 1746, at half past ten at night, the first shock was felt of another earthquake, and within the space of three minutes all the buildings in the city, great and small, public and private, were heaps of ruins, burying with them those inhabitants who had not been quick enough in escaping to the squares. Then succeeded a moment's calm, as when the heavy ordnance has opened the battle, and the lighter, but more numerous, musketry prepares to follow. Soon it began again, and the houseless, homeless inhabitants counted two hundred distinct shocks within the following twenty-four hours. These shocks continued until the February of the following year, and were computed at four hundred and fifty in all. On this occasion the port of Callao sank quite down below the level of the sea. Nothing was left standing save a piece of wall belonging to the fort of Santa Cruz, on which twenty-two persons contrived to save themselves. Of the twenty-three ships then in port, nineteen were wholly sunk, and the remaining four carried a considerable distance inland. Of the four thousand inhabitants which the port of Callao then numbered, only two hundred survived. In Lima thirteen hundred dead bodies were excavated from the ruins, exclusive of great numbers of maimed, who afterward died of their hurts. Commander Wilkes, of the United States exploring expedition of 1849, was able in that year to define the site of the old port of Callao beneath the sea." R.B.H.

THE HAWAIIAN SEISMOGRAPH

Another set of instruments, of the type developed and manufactured in the laboratories of the Hawaiian Volcano Observatory, is being tested prior to shipment for installation at Dutch Harbor, Alaska. This is the sixth set of instruments of the series built at the Observatory. The other five sets are distributed as follows: Hilo and Kealakekua, Hawaii, stations operated by the Hawaiian Volcano Research Association; Kodiak, Alaska, station, and Lassen Volcano Observatory, Mineral, California, operated under the Section of Volcanology, U. S. Geological Survey; and U. S. Coast and Geodetic Survey, Washington, D. C., for test before installation at Sitka, Alaska. A description of the instruments appears in Volcano Letter No. 142. R.B.H.

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No. 191 RELEASED WITHOUT COPYRIGHT RESTRICTION August 23, 1928

KILAUEA REPORT No. 865

WEEK ENDING AUGUST 22. 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

At 9:50 a. m. August 18 the north wall of Halemaumau was working very slightly. Two falls of rocks were heard in 10 minutes from that side, and another from the northeast corner. The north wall and talus gave the appearance of having had numerous small slides. During the "Pageant to Pele," presented to a large audience at the side of the pit from 9 to 11 p. m., there was nearly constant avalanching, filling the air with dust, and at times drowning the exercises. By daylight August 19 could be seen heavy coatings of red dust on the floor and walls of Halemaumau and on the south Kilauea floor. The avalanching continued at irregular intervals, coming from blocks tumbling from the north rim, and gathering debris along their course. Examinations show that widely cracked areas formerly back of the north rim have gone in, and that there are numerous fresh cracks of varying sizes. Many of the new cracks are emitting steam, and several of those that are dry are allowing the escape of heat. At the present time there is still some sliding from the north rim.

The Observatory seismographs have recorded nine local tremors during the week ending August 22. These were all very feeble with the exception of one which occurred at 10:47 p. m. August 18. This one is classed as feeble, and was apparently caused by an unusually large avalanche in the pit of Halemaumau. Tremors of this magnitude can very seldom be ascribed to avalanches, yet the evidence points to the fact that this one is the result, and not the cause of an avalanche. The amplitude increases gradually to the maximum, and fades out again gradually; there are no phases to be recognized, as would be the case in a true earthquake. The record of the same disturbance from the Uwekahuna seismograph is 25% greater in amplitude, in spite of the fact that the magnification of that instrument is less than the corresponding factor for the instruments at the Volcano Observatory. This is easily explained in the case of an avalanche tremor by the fact that the Uwekahuna instruments are but 0.7 mile from the pit, while those at the Volcano Observatory are 2.6 miles away. This tremor was the climax of a series of five avalanche tremors, of which the first was at 9:41 p. m. Thus the Observatory seismographs bear witness to exceptionally heavy avalanching during the evening of the 18th, when there were present at the edge of the pit well over a thousand spectators who had come there to see the entertainment furnished by the program of the Cook Sesquicentennial.

Microseisms throughout the week have been normal. Slight tilt has accumulated toward the northeast.

THE PAVLOF VOLCANO EXPEDITION

A letter from Dr. Jaggar dated July 11 gives us additional notes of the progress being made by the National Geographic Pavlof Volcano Expedition, of which he is the Director. The letter was written in camp at the north end of Pavlof Bay, just east of Pavlof Volcano. The party had just completed a trip into the interior of the Peninsla, where two comps were made on the northeast base of the volcano. From these camps a nine-day side trip was made to the region north of the mountain, where an interesting bit of volcanic topography was found similar in nature to the Chaos Jungle at Viola on Mount Lassen, California. A view into the crater of Pavlof was had, and two inner cones were seen. In the crater there was also visible an old lava flow and considerable steam from a number of solfataras. No hot springs were found, but mineral springs were discovered on two occasions.

The topographic section of the expedition had mapped 2,000 square miles of country. The expedition had taken 225 photographs and a considerable number of color plates. Wild flowers are there in abundance, and specimens of the different kinds have been collected and pressed. Dr. Jaggar says that fossils have been found and that the geology of the region is very interesting. The geologic details, however, must wait for a more thorough investigation by some geologist in the future who will be able to base his work upon the present reconnaissance and the topographic maps being made by the party.

The weather has been bad, especially from the point of view of the topographic party, who need clear weather for long distance photography and plane table operations. There have been hundreds of caribou seen, and 25 to 30 bears. The expedition has had no difficulty in keeping its larder stocked with meat, fish, and clams at all times. Salmon have been caught with a small seine operated by the "Honukai."

The "Honukai" is still holding its place as one of the most useful units in the expedition's transportation. It traverses the beaches with ease, and can go over the greater part of the dry tundra country. Swampy tundra and "niggerheads" have at times caused it to turn back, however. The use of the steel mats in soft places, as suggested by the experience with the "Ohiki" in Hawaii, has proved valuable in the extreme.

At the time of writing, the expedition was planning to go westward to Volcano Bay as the last lap of the season's explorations.

A radio message has just been received from Dr. Jaggar stating that the work was completed and the expedition was starting back home from Alaska on August 16.

R.M.W.

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No. 192 RELEASED WITHOUT COPYRIGHT RESTRICTION August 30, 1928

KILAUEA REPORT No. 866

WEEK ENDING AUGUST 29, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

There was rather active avalanching from the north wall of Halemaumau on August 24. Since that time the wall has continued to be restless with numerous falls of rocks and an occasional dusty slide. The south wall has had a few slides recently, as shown by streaks in the heavy dust coating of the south talus. The whole pit interior is still thickly coated with dust from the avalanches of August 28.

There have been eight very feeble local earthquakes and one teleseism recorded on the Observatory seismographs during the week. The record of the teleseism was feeble; the arrival of the preliminary phase is shown at 11:23:00 a. m. on August 24. Subsequent phases suggest a distance of 2,800 miles to the origin.

Microseisms have been more feeble than normal. Tilt has accumulated moderately toward the NW.

THE ISOSTASY OF HAWAII

An article of exceptional interest to the Hawaiian Volcano Observatory has appeared in the American Journal of Science of August, 1928, by Roy W. Goranson. The primary object of the investigation outlined was to discover the density of the island mass of Hawaii. The method of attack, through the use of gravity observations, has also developed some interesting conceptions as to the state of isostatic adjustment of the island.

The first part of the paper outlines briefly the method of computing theoretical gravity. Correction for isostatic adjustment is given considerable space, and it is shown that lack of knowledge of the true distribution of mass in the earth's crust leads to a rather wide range of possible values in arriving at this correction. Isostasy is accepted as a fact, but its precise mechanism is not fully determined. Geology and seismology may eventually yield data which will determine how the variations of density are distributed in the isostatically adjusted earth crust. Another problem of isostasy which has a direct bearing on the calculation here discussed is the strength of the earth's crust. How large may an uncompensated topographic mass be and still be upheld by this crust?

The large values, all positive, of the local anomalies of gravity have led this investigator to believe that the island of Hawaii is for the most part not compensated. That is to say, the island mass is present as an isostatically unbalanced load upon the earth's crust, its excess of matter causing the large values in the observed gravity.

To put this in figures, the island is resting on the ocean floor with a pressure amounting to 9,700 pounds per square inch over an area of about 19,000 square miles. If this great mass is not isostatically compensated, it is being supported simply by the strength of the earth's crust which forms the ocean floor. It is suggested that this load is just about the greatest that can be so supported. Isostatic adjustment is probably attained only with the passage of geologic time, so that it is conceivable that this island has been volcanically built at such a rate as to be still largely uncompensated. He believes that the island of Hawaii is even now gradually accomplishing its adjustment by gradual sinking and downfaulting. This might easily account for the downfaulting areas around the coast of the island as in Puna, Kona, and perhaps Hamakua and northeast Kohala

Again to express this in figures. it is suggested that if the island as it now stands is not at all compensated, and if the earth's crust beneath it has no strength it would be expected that the island as a whole would settle downwards 11,000 feet to accomplish total isostatic adjustment. This would leave the tops of Mauna Kea and Mauna Loa projecting above the ocean as small islands with summit elevations of only about 2,800 and 2,600 feet above sea level. This of course represents the extreme case. Presumably isostatic adjustment is already partly accomplished, and it is known that the earth's crust has considerable strength, so that perhaps a sinking of only 8,200 feet should be taken as an estimate.

It is suggested that this mechanism explains the general progressive diminishing elevation of the islands of the Hawaiian group towards the northwest which may once have been as high as Hawaii. These islands perhaps increase in age toward the northwest; they have had more time to settle and to more completely accomplish their isostatic adjustments. This may also be an explanation of the gradual sinking of basaltic ledges in the ocean with the coral growths on their tops having to grow higher and higher to maintain their position at the ocean surface.

The object of the calculation was primarily to discover the density of the bulk of the island. H. S. Washington is quoted as giving a density of 2.96 for the average value of Hawaiian rock material. As it lies in place the apparent density of the rock would be considerably less, perhaps as little as 2.0, due to its vesicularity and loose bedding. From the evidence furnished by gravity stations on the side and top of Mauna Kea, Goranson calculates 2.12 as the density of the upper part of the cone of Mauna Kea. Similarly, the upper portion of Mauna Loa, lying above 4,000 feet of elevation is given a density of 2.52, resulting from the use of gravity determinations at Kilauea and at Mauna Loa summit. For the whole island cone from its base on the ocean floor to the summit he gives an average density of 2.69. Thus it is apparent that the densities at higher elevations are smaller. This would be expected due to the compacting by pressure of the lower layers and the probable intrusion of dykes of denser material in the lower structure. Summing up, the density of the mountains of Hawaii is given as lying between 2.40 and 2.63, the probability favoring the lower value. R.M.W.

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No. 193 RELEASED WITHOUT COPYRIGHT RESTRICTION September 6, 1928

KILAUEA REPORT No. 867

WEEK ENDING SEPTEMBER 5, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Avalanching from the north wall of Halemaumau is not so active; only a very few small slides now occur. Dusty slides were rather frequent on August 30 and 31. New cracks back of the north rim appear to have widened slightly. The odor of chlorine gas was noticed in that area during a circuit of the pit on August 31. There are scattered new coatings of white salts on the north wall.

There have been recorded only seven local tremors during the week. One at 11:04 p. m. on August 30 was classed as feeble, but was reported perceptible to a few people in the vicinity. All the others were very feeble.

Microseismic motion has been more feeble than normal during the past weeks, but increased slightly in amplitude on September 4. Tilt has accumulated slightly toward the NE.

TILT

Ground movements are becoming increasingly important as indications of forces acting beneath the earth's surface. Pressures set up by volcanic action or by the stresses accumulating in the earth's crust which tend towards earthquake conditions may be thus sometimes detected at the surface. Triangulation for measurement of horizontal displacements has yielded interesting data in a number of places, notably in the areas of the major faults in California, and in Japan in the region shaken by the great Kwanto earthquake of 1923. Leveling has shown vertical displacements largely resulting from earthquakes, in cases too numerous to mention. Triangulation and leveling are expensive operations, and cannot be used as a means of keeping continuous watch over ground movement. The accumulated movements during a period of months or years may be discovered by retriangulation or releveling over an area, but the day by day development of movement cannot be watched by these methods.

Tilt, or tipping of the ground surface, must obviously occur in a region where change of relative elevation takes place. Occurrence of tilt may therefore be taken as an indication of ground movement involving changes of elevation. It is possible to make continuous record of tilt. Omori, some 20 years ago, started the recording of tilt in Japan with a pair of long period horizontal pendulums. In fact, most horizontal pendulum seismographs are competent to record it with greater or lesser degrees of accuracy, according to their design. A clinograph designed by M. Ishimoto is a small bi-filar horizontal pendulum, optically recording, which has been used to some extent in Japan specifically for measuring tilt. Temperatures of ground and instrument affect all such arrangements to a certain degree. The most precise tilt measurements so far made perhaps resulted from the experiments of Michelson and Gale; these observations were so accurate as to detect tiltings due to the earth tide, for which purpose they were made.

Continuously recorded tilt as observed at the Hawaiian Volcano Observatory has been most valuable in the study of the volcanic phases of Kilauea (see Volcano Letter No. 41, October 8, 1925). Tilt as considered in Japan in connection with great earthquakes is briefly outlined by Imamura and Haeno in "Proceedings of the Imperial Academy," Tokyo, IV, 1928, No. 4. Here it seems possible that continuously recorded tilt may be the key to the foretelling of earthquakes. Stations near or in an area wherein ground stresses are accumulating would be expected to record the bending and elastic yielding of the rock crust caused by such stresses before their release in fracture and earthquake. It would not be difficult to maintain a considerable number of tilt stations scattered over a suspected region.

A number of cases in Japan are cited where abnormal tilt actually occurred and was recorded before an earthquake. The Kwanto earthquake of 1923, with its many and great upheavals of the earth's surface, would doubtless have been very rich in data of this sort had there been more stations to record the tilt. As it was, a slow shoreline subsidence was noted preceding the earthquake which must have meant the presence of very considerable tilts. Seismographs in Tokyo actually did record some of these precursory tilts. From July 30 to August 17, 1923, a definite surge of abnormal tilt was noticed, and then after an intermission of two weeks a very sharp surge of tilt in the same direction began and continued for eight hours, at which time the earthquake occurred. There are no less than nine other cases where abnormal tilts of from 7 to 30 seconds were observed as preliminaries to major earthquakes. The earthquakes followed the recording of these tilts after a period of from four days to two weeks.

The Advisory Committee in Seismology of the Seismological Society of America emphasizes the importance of tilt by making it one of the four subjects important for future attention.

With instruments of the horizontal pendulum type, and perhaps with others when they may be designed, the changes of air and ground temperature at the station cause trouble in recording tilt. Most records show cyclical variations, diurnal and annual, which are in all probability not caused by the volcanic or seismic tilt which it is desired to study. It is sometimes difficult to separate from the composite motion recorded the components which are due to these particular movements. Most types of tilt recording instruments are not provided with methods for absolute check whereby the accumulative instrumental errors may be eliminated. Thus an instrument may gradually settle on its foundation, and so record false tilt. It cannot be known whether this is true tilt unless it is determined that the ground upon which the instrument stands has partaken of the same amount of motion. This is a function of precise leveling in connection with tilt; that is, to analyze the apparently accumulated tilt. By leveling, or other outside observations, it may be possible to see whether the accumulation shown by the instrument over a long period of time is an actual accumulation of tilt or merely an accumulation of errors and instrumental change. R.M.W.

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No. 194 RELEASED WITHOUT COPYRIGHT RESTRICTION September 13, 1928

KILAUEA REPORT No. 868

WEEK ENDING SEPTEMBER 12, 1928

Hawaiian Volcano Observatory, U. S. Geological Survey

R. M. Wilson, Temporarily in Charge

Halemaumau has been quiet during the past week. A few slides have occurred, but no notable changes have been observed. Crack measurements on September 10 show a few minor differences.

There have been 24 local earthquakes and one teleseism recorded on the Observatory seismographs during the week. One of the local shocks, at 2:27 p. m. on September 11, is classed as feeble, but was felt by a number of people in the vicinity. The distance to its origin is 14 miles from the Observatory. All the other local shocks were very feeble. The teleseism, also on September 11, made only a feeble record, and the phases could not be definitely distinguished. The beginning of either the secondary or the long wave is shown at 2:20:06 a. m. Hawaiian standard time.

An earthquake reported felt in Kona at 8:30 p. m. on September 4, whose origin was indicated on the seismograph there as being seven miles from Kealakekua, was recorded at the Hawaii Volcano Observatory as a very feeble tremor.

Microseismic motion was slightly stronger during the first part of the week; and tilt has accumulated moderately toward the SW.

MICROSEISMIC MOTION

Microseisms are found to exist at practically all seismological stations, and it is presumed that all parts of the earth's surface are subject to these slight but continuous vibrations. They probably act differently in different localities, and have their origin in various causes. In general these oscillations have periods of from 2 to 10 seconds, and amplitudes of motion of from 0.02 mm. to 0.5 mm. They are usually continuously present, but wax and wane in amplitude. It is sometimes difficult to read from seismograms the weak preliminary motions of a true earthquake when microseisms are thus being continually recorded, as they frequently mask the earthquake motion which it is desired to observe.

Considerable study has been given to microseismic motion to determine its nature and cause, but a direct and satisfactory explanation has not yet been reached. An enlightening investigation by Takeo Matsuzawa is described in Volume II, Part 5, of the Journal of the Faculty of Science, Imperial University of Tokyo. This investigator in studying the types and causes of microseisms at Tokyo remarks that his results must of necessity be influenced by the particular locality. Studies carried on at other places would presumably develop individual microseismic characteristics. His suggestion is that each small part of the earth's crust composes a local oscillating system, having in each place its own characteristics as to natural period and ease of oscillation. Such a system, depending upon local topographic shape, density, material, geologic structure, etc., would naturally be very complex, and would probably respond to a number of different natural periods, together with their harmonics. Microseisms at stations only a few kilometers apart have different characteristics, while those recorded at stations close together usually appear to be somewhat similar in period and amplitude.

At Tokyo Omori found three particular types of microseisms, perhaps resulting from the more outstanding natural periods of vibration of the particular locality. For the first of these types Matsuzawa gives periods of from 2 to 3 seconds, with normal range of motion of about 0.02 mm.; the second type has a normal period of 4 seconds, and range of motion of 0.05 mm.; and the third has somewhat irregular periods ranging between 6 and 9 seconds, and sometimes attains a range of motion amounting to 0.5 mm.

As to the agencies inspiring these vibrations, those suggested are changes of atmospheric pressure, changes of temperature, wind, ocean wave action on nearby coasts, ocean tides, precipitation. This investigator considers change of atmospheric pressure the chief cause of microseismic motion at Tokyo. Wind produces certain effects due to the shaking of the buildings which shelter the instruments, but apparently affects true michroseismic motion only to a limited degree.

The correlation between changes of barometric pressure and the amplitude of microseismic motion seems well established at Tokyo. Many cases are cited wherein the general presence of barometric depressions due to cyclones has produced definite increase of amplitude of microseisms. Conditions of barometric pressure less violent than those accompanying cyclones, such as the presence of steep pressure gradients merely, have been also shown to swell the microseisms. Studies of these correlations have progressed so far that the character of response of microseismic motion has been found to depend upon the character and location of the atmospheric disturbance. Thus it is stated that apparently at Tokyo the more rapid microseismic motions are inspired by atmospheric disturbances in the northeast part of Japan, while the slower motions are inspired by disturbances to the southwest. It has also been noticed that where a marked barometric depression travels from west to east, there is a time lag in the climax of microseismic motion produced thereby amounting to three or four hours after the nearest approach of the depression. On the other hand, if the depression is traveling from east to west, the maximum microseismic motion appears to occur coincidentally with the nearest approach of the disturbance. This perhaps has something to do with a difference of effect of the barometric depression on land areas and on water areas. In general, the coming of a time of increased microseismic motion is heralded by the development of the quicker motions first, while the waning phases are marked more by the predominence of the slower motion.

Whether or not atmospheric pressures produce microseisms through a direct mechanical compressing or flexing of the earth's crust is not definitely known, but is suggested as what may possibly happen. Thus perhaps the pressures and impulses applied to the earth's structure are causing it continually to vibrate and to ring like a great bell.

The discussion suggests that if it is true that each particular locality has its own natural periods of vibration, that very probably the recording of earthquakes is affected thereby. Thus a natural period of a locality would tend to control the period of the earthquake as transmitted and recorded. It would seem that the care taken to design seismographs which will not impose their proper periods upon their records is somewhat lost if the natural period of the locality, which cannot be controlled, is to impose its effect on the recorded results anyway. R.M.W.

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No. 195 | RELEASED WITHOUT COPYRIGHT RESTRICTION | September 20, 1928

KILAUEA REPORT No. 869

WEEK ENDING SEPTEMBER 19, 1928
Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

Heavy coatings of white salts formed on the fresh surfaces of the north wall during the week. Today, however, they have disappeared after a night of rain. The thick layer of dust on the Halemaumau floor is finally being washed away, and yellow-stained areas are again showing. Steam vents are all mildly active.

There were 20 very feeble local earthquakes recorded at the Observatory during the week. Microseismic motion was normal, and tilt accumulated slightly towards the N.

PROJECT FOR ALEUTIAN GEOGRAPHIC OBSERVATORY

By T. A. Jaggar

The writer on September 7, 1928, addressed the Seattle Chamber of Commerce on a proposed Aleutian Geographic Observatory to be established at Dutch Harbor, Alaska. This project is formulated in extension of a report on a possible Alaskan volcano observatory, revising somewhat and broadening the project. (Volcano Letter Nos. 116, 128, 134 and 147.)

Experience shows that mapping should be the main aim, and that all sciences should be represented. The founding of the Hawaii observatory by the sugar and other industries through the Volcano Research Association, with government collaboration, suggests that the fish, fur, and shipping industries might do something effective for southwest Alaska.

Modern exploration and discovery is extended by each new invention. Montana and Arizona have been "discovered" to be garden spots through irrigation and agricultural machines. The "Carnegie" is mapping all the oceans with echo sounding and new electrical instruments (Volcano Letter No. 175, May 3, 1928).

The advent of the salmon canneries, of Diesel engines in 60-foot boats of 2,000 miles fuel radius, of radio communication, and of some new maps, have greatly improved the Alaskan field for the explorer.

It is proposed that the observatory be at Dutch Harbor as a fixed home for land and sea mapping and for measuring geophysical, biological, and chemical processes along the arc of the Alaskan peninsula and the Aleutian Islands. The station will work in concert with eight scientific bureaus of the government, seven civil offices, and two outside institutions. It is called geographic, because it will study that part of the earth in relation to man.

It will measure and secure data all the year around concerning the weather, tides, currents, magnetism, earthquakes, volcanic activity, crust upheaval, animals, plants, fish, natives, and commercial needs.

For the summer half of the year, the observatory will maintain expeditions to collect land and marine organisms, minerals, rocks, and human antiquities; to map the lands, the geology, the depths of the sea, the air currents, temperatures and pressures, and such earth activities as magnetism, tremor, tilting, and changes of mean sea level. The snowy craters of the big volcanoes will be explored and photographed with the aid of alpinists and aviators.

It is a land of ancient inhabitants who linked America with Asia; it contains the greatest craters on earth; it exhibits volcanic activities that should throw light on the origin of the earth and the origin of ores; on the mainland there are known occurrences of gold, silver, lead, copper zinc, sulphur, petroleum, and coal, and the numerous big western islands have not even been prospected.

It is a grassy country without trees. Sheep, reindeer, and cattle are grown there, but ranching is a new industry. There is much fur produced, largely foxes, mink, and land otter. The Aleutian land is one of the great breeding grounds for the study of migratory birds.

There has come recently a demand for scientific study of the Aleutian lands from numerous scientific institutions and conventions, so that the matter is being pressed by the National Research Council of the United States. The writer has reconnoitered the field by three expeditions devoted primarily to volcanology.

The proposal is to place four workers at the main station winter and summer, equipped with a powerful Diesel yacht and small boats, also laboratories, shop, quarters, dock, and photographic dark room. The station will keep in radio communication with its yacht and with existing stations. It will provide a base and a boat for the Coast Survey and the Geological Survey in mapping the coasts and interiors. It will publish weekly and quarterly reports.

The substations will work from April to September, and each summer will produce a new substation, for intensive geophysical measurements, photographing, and collections, on a volcano for instance, setting up a seismograph and weather instruments, and keeping a journal. The summer staff will be eight persons, and the substation will report to the main station. The substation camp will be left for future use. Specialists in all sciences will be imported from outside institutions for work at the substations.

The observatory vessel will carry the observers, the pack horses, and the camp equipment to the substation site, and the base camp may be moved by boat as often as necessary, when the substation work is in the nature of an exploring expedition. It will probably be advantageous for the first established substations to work in conjunction with map-making expeditions.

It is useless to establish such an institution without adequate funds. The following is the estimated cost of equipment and operation:

EQUIPMENT		ANNUAL UPKEEP	
Boats	$25,000	Salaries	$22,200
Houses	12 000	Station Upkeep	6,000
Horses	400	Boat Upkeep	4,200
Apparatus	1,000	Food Supplies	3,500
Contingent	8,600	Travel & Freight	3,000
		Contingent (Incl. publications)	11,100
	$50,000		$50,000

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No. 196 RELEASED WITHOUT COPYRIGHT RESTRICTION September 27, 1928

KILAUEA REPORT No. 870

WEEK ENDING SEPTEMBER 26, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

There have been no changes in Halemaumau. The bottom region is remarkably dry and free from steam.

During the week 27 local earthquakes and one teleseism were recorded on the Observatory seismographs. One of these local shocks, at 10:02 a. m. September 20, although feeble was yet possibly strong enough to have been perceptible. All the others were very feeble. The teleseism made a weak record from which the distance could not be estimated. The beginning of either the secondary or the long wave is shown at 9:21:54 p. m. on September 21.

Microseismic motion was normal throughout the week, and the accumulation of tilt was moderate towards the NNE.

THE 1928 OUTBREAK OF KRAKATOA

The volcano Krakatoa in the Sunda Strait between Java and Sumatra consisted of an old engulfment crater in the sea prior to August, 1883. The crater rim protruded above the water as the islands Verlaten, Lang, and Krakatau. The latter was the largest, five miles long, consisting of three cones, the basaltic Rakata the largest, 2,623 feet high, the other two smaller and andesitic named Danan and Perboewatan. These two last occupied the extension of Krakatoa island from the region of the ancient andesitic crater rim, on which Rakata was built, northwestward to the site of the ancient crater center.

The colossal eruption of 1883 followed two centuries of quiet. Danan and Perboewatan became explosively active in May, and on August 28th, 1883, one of the most enormous volcanic explosions ever recorded occurred. These two cones were engulfed completely, leaving water 900 feet deep, columns of ash and pumice went miles into the air, and the engulfment wave drowned 36,417 people in the low coastal villages of western Java and southern Sumatra. Rakata was left with a sector of its cone gone, and a great bluff reaching to sea level like the northeast side of Molokai.

Krakatoa since then has been quiet. A new submarine eruption about the center of the triangle made by the three remaining islands began December 29, 1927. Fishermen reported columns of smoke rising from the sea sixty feet or more, with bombs that glowed at night. Gas bubbles had been seen here earlier in 1927.

Early in January, 1928, feeble eruptions every half-minute or minute culminated in a repose interval of 5 to 8 minutes every quarter hour, and this was followed each time by unusually heavy explosions. The water would rise in a dome. Out of this a black mass of ashes and bombs, clinging together, emerged in tree-like forms. The sea in contact with the incandescence boiled, surrounding the ash column with a wreath of steam. When the ash reached its greatest height, the black color disappeared in rocket trails of white steam and gases. A few bombs floated for awhile buoyed by gas. A white central steam column remained, encircled by the wreath at its base. The relapse of the water dome made a wave, and the ring of falling matter made other waves, felt at some distance as a swell. Sometimes the eruptive material was ejected obliquely in several directions. There appeared to be six crater orifices below sea level. The photographs taken are very striking, showing the central column like a lily, and the basal wreath like a flower pot.

The sea water was made turbid by the ash. Water temperature was 103° F. 1,600 feet away, the normal water being 84° F. The glow of the ejected bombs could be seen at night. The width of the eruption center on the water was 2,000 feet in a WNW.-ESE. direction. The sea had been about 600 feet deep where the eruption occurred.

A temporary observatory, with seismograph and radio sending apparatus, was set up on Lang Island. Others on military motor trucks were maintained on the mainland to receive warnings for the populace. There were tremblings and rumblings. The first eruptions were only 200 feet high. After January 13 glowing masses were thrown up occasionally 4,000 feet. Regular observations were inaugurated night and day. After January 26 the activity dwindled. On that date the new crater rim appeared above sea level and reached in a few days a height of 10 feet and a length of 570 feet, consisting of loosely piled cinder. The waves quickly washed this away. On February 4 only three eruptions occurred and 11 rumblings were heard. The next day one eruption and two rumbles. Nothing but seismographic shakes and gas bubbles with sulphuretted hydrogen occurred after that date in February.

In March a thorough survey was made. A depth of 113 feet of water was sounded at the new crater. The bottom temperature was 97° F. There is a cone on the bottom at the wall-crack region of the submarine engulfment pit of 1883, steepest toward the deeper pit-center. There was a small eruptive revival the end of March, and another the last half of April. Some sulphurous gas bubblings in the sea several miles apart were found in Sunda Strait spread over 500 square yards, off Tjarita, and have been noticed by fishermen for some years. (Bull. Neth. East Ind. Volc. Surv. 1927-28 and Overdruk Leidsche Geologische Mededeel., 1928, pp. 325-329: articles by Ch. E. Stehn and J. H. F. Umbgrove.) T.A.J.

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No. 197 **RELEASED WITHOUT COPYRIGHT RESTRICTION** October 4, 1928

KILAUEA REPORT No. 871

WEEK ENDING OCTOBER 3, 1928
T. A. Jaggar, Volcanologist in Charge

Halemaumau has been particularly quiet throughout the week. During the first part of the week the pit was dusty from previous avalanching, and steam vents were only slightly active; but with the southerly rainstorm of October 1 the pit walls and floor were washed clean of the dust coatings, and steaming was very noticeably increased, particularly at the fountain vents of July, 1927. Ocassional small rock falls are difficult to locate because of the lack of dust to mark them.

The Observatory seismographs have recorded 18 very feeble local earthquakes during the week. Microseismic motion was normal at the beginning and end of the week, but was more feeble than normal on September 29 and 30. Tilt accumulated very slightly towards the east.

THE HALEMAUMAU SEISMOGRAPH

The seismograph installed at Uwekahuna, the west wall summit of Kilauea Crater, in December, 1927, has in general recorded the same earthquakes shown on the records of the instruments at the Volcano Observatory. As would be expected from its magnification, most of the Uwekahuna earthquake traces are smaller in amplitude. But a few which apparently originate at the pit of Halemaumau are shown larger on that instrument, perhaps due to the fact it is nearer to the pit than are the Observatory instruments. To carry the idea thus suggested still farther, a seismograph has recently been installed close to the edge of the pit. It is expected that this will record tremors due to avalanches that are too feeble to be recorded on the more distant seismographs at Uwekahuna and at the Volcano Observatory. By comparison it should then be possible to discover definitely which of the tremors recorded at the Observatory are caused by avalanches.

Spirit leveling near the pit has made it apparent that the tilting motions there are large. It is perhaps these tilting movements and the corresponding change in inclination of the pit walls that are the cause of periodic spells of avalanching that have been evident during the past years. This tilting measured close to the vent of the volcano may prove to be a more sensitive key to the movements of the lava column, just as the tilts at the Volcano Observatory are known to be correlated when the lava level is visible within the pit and the tiltings are correspondingly stronger. This new seismograph is in a position to pick up the first feeble indications of returning activity.

The installation is distant 1,900 feet radially from the center of Halemaumau in direction S. 34° 05′ E, and is back 450 feet from the edge of the pit along the same radius extended. This places it a little north of the trail from the automobile parking place to "Halemaumau sign," and it is about 300 feet from the shelter hut. The elevation is approximately 3,635 feet above mean sea level. A shallow depression was dug in soft pahoehoe lava till a more stable layer was reached, upon which was founded a pier for the recording drum and a column for the support of the pendulum. The pendulum axis is approximately parellel to the pit edge to make it sensitive to shocks and tilt from the direction of the pit. The shelter hut is 4 by 5½ feet, inside dimensions, and is about 4½ feet from floor to roof in the highest part. Its walls are of one-inch boards, with tar paper both inside and out, and with rocks and gravel piled against the outside up to the eaves. The roof is double, with a four-inch space packed with sawdust. It is further protected from rain and sunshine by a corrugated iron roof with a ventilated air space beneath it. The floor is of gravel and asphaltum so sealed as to prevent steam from rising inside the chamber from the floor, as this area of the crater is porous with small steam ducts rising through it almost everywhere. The building was constructed during the first two weeks of September, and the instrument was first set up on September 12. Operation was experimental for several days, the useful run beginning on the 18th.

The seismograph used is the one removed from the Kona station when the larger Hawaiian type seismograph was installed there this summer. This instrument has been overhauled and somewhat revised. It is a single component horizontal pendulum, with suspension similar to the Bosch-Omori. The boom axis hangs from the column to the drum in a direction S. 78° 45′ W. The inertia mass is 30 kg., and static magnification is 70. It is at present adjusted to a period of nearly seven seconds, and the damping ratio is 2.6. Sensitivity to tilt is 2.5 seconds of arc for one centimeter displacement of the null point of the writing pen. Recording is on smoked paper, which moves about 23.5 mm. per minute. The instrument will run nearly 60 hours without attention. Before it was installed at the pit its constants of magnification and sensitiveness were tested on the oscillating table at the Hawaiian Volcano Observatory.

The records so far accumulated do not cover a long enough period of time so that deductions may be made from them. The useful run of the instrument began on the 18th, but was interrupted during the first few days by lack of proper adjustments. From that date up to and including October 1, there were 13 very feeble tremors recorded. It seems so far that this new instrument is recording an entirely different group of very feeble tremors than those recorded at the Hawaiian Volcano Observatory. None of the 13 recorded is identified as recorded at the Obeservatory. There has not yet occurred a heavy enough shock to be recorded on both instruments.

Large tilting movements close to the pit are to be expected, and the seismograph is apparently to bear out that expectation. From September 28 to October 2 there was recorded no less than 10 seconds of arc tilt away from the pit. This is perhaps not due entirely to volcanic causes, however, as the instrument may not yet be fully settled on its foundation. On October 1, beginning at 3:54 p. m. and ending at 6:45 p. m., there was an apparent surge of tilt which accounted for more than half the amount above noted; but this interval of time represents very closely the time and duration of a very heavy shower of rain. In this instance the pen movement was probably caused by wind, temperature, or other effects of the shower, rather than by actual ground tilting, though there was evident no tendency for the pen to return to its former position after the effects of the shower had ceased.

R.M.W.

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No. 198 RELEASED WITHOUT COPYRIGHT RESTRICTION October 11, 1928

KILAUEA REPORT No. 872

WEEK ENDING OCTOBER 10, 1928

T. A. Jaggar, Volcanologist in Charge

The past week has developed no changes at Halemaumau. Fresh wall surfaces are conspicuous north and southeast, but no slides of magnitude have been observed.

On October 6, during a visit to Mauna Iki, the lava cone of 1920 six miles southwest of Kilauea, temperature measurements taken at the second hot area with a 550° C. thermometer, showed a temperature at the first vent of 260° C., and at the second vent 275° C. (527°F.). At the latter place a stick caught fire.

The Observatory seismographs have recorded 16 very feeble local earthquakes during the week, and one teleseism. The teleseism was on October 8, with its preliminary phase recorded at 4:40:47 p. m. The indicated distance to its origin is 3,815 miles, suggesting another earthquake off the Pacific coast of Mexico to add to the series that has been taking place there during the past year.

Microseismic motion was strong during the first part of the week, but diminished to normal during the last part. Tilt accumulated moderately toward the NNE.

EQUATORIAL BELT HAS THE MOST EARTHQUAKES

A remarkably interesting statistical investigation of violent earthquakes has been made by Charles Maurain showing gradual diminution in frequency from the equator to about 50 degrees of latitude, and very rapid diminution thence to the poles. ("On the Distribution of Earthquakes by Latitude," Comptes Rendues del l'Académie des Science, Paris, Vol. 184, 1927, p. 612; Matériaux pour l'"Etude des Calamités, Geneva, April-June, 1928, p. 90.)

The investigation is based on seismograph records locating big distant earthquakes made by stations all over the globe during the first two decades of this century. The most modern group concerns 542 shocks reported by the International Seismological Summary between 1914 and 1920, and secondly 1,009 earthquakes listed by John Milne between 1903 and 1910. These 1,551 great earthquakes are distributed as follows among zones of 10 degrees of latitude from the equator northward or southward; and the third column takes account of the surface area of these different latitude belts:

Latitude (Northward or Southward)	Nos. of Earthquakes	Nos. of Earthquakes Per 10,000,000 Square Kilometers
0°–10°	450	50.8
10°–20°	329	38.3
20°–30°	244	30.4
30°–40°	258	35.4
40°–50°	152	24.1
50°–60°	87	17.1
60°–70°	21	5.6
70°–80°	9	3.9
80–°90°	1	1.3

This list shows strikingly that large earthquakes have greatest frequency in the equatorial belt, and are remarkably few in number near the poles. An examination of the 542 more modern records (1914-1920) indicates that the earthquakes are distributed almost equally between the north and south hemispheres (273 north of the equator, 264 south of the equator), and five actually equatorial. The statistics of the first decade show a larger number in the northern hemisphere than in the southern. Of the whole 1,551 shocks for both decades, 927 are at the north and 624 at the south.

It seems likely to the reviewer that the greater number of northern earthquakes registered in Milne's time was due to the scarcity of instruments in the southern hemisphere, a defect which was later remedied.

Maurain concludes that the distribution of mass in the crust of the earth may be sufficiently uneven with reference to the equilibrium between centrifugal force and terrestrial gravity to produce tensions greatest at the equator, and diminishing from the equator to the poles, Other investigators have shown that the strongest seismicity is in regions where geological movements such as volcanism and mountain building are most rapid. If we combine these two things, centrifugal stress and geological activity, the greatest sensitiveness would be in the equatorial belt, and this would account for the increasing earthquake frequency in that direction.

With reference to the influence of volcanism on the distribution of big earthquakes, it is interesting to compare Maurain's results with the tables of volcanic outbreaks between 1801 and 1914 compiled by Sapper (Zeitschr. Vulk., Aug. 1917, p. 130; also Volcano Letter No. 4, Jan. 22, 1925):

Latitude (Both North and South)	Nos. of Eruptions	Nos. of Eruptions Per 10,000,000 Square Kilometers
0°–10°	944	107.0
10°–20°	826	96.5
20°–30°	238	29.6
30°–40°	437	60.0
40°–50°	157	24.9
50°–60°	101	19.7
60°–70°	47	12.4
70°–80°	115	49.5
80°–90°	0	—

T.A.J.

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No. 199 RELEASED WITHOUT COPYRIGHT RESTRICTION October 18, 1928

KILAUEA REPORT No. 873

WEEK ENDING OCTOBER 17, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

There has been an increase of avalanching at Halemaumau. Probably the greatest slide was on October 11, when a dense cloud of dust rose out of the pit about 4:15 p. m. An avalanche of large size occurred also on October 13 at 3 p. m. from the north wall. It was followed a few minutes later by a smaller slide from the south wall. The north wall has had numerous slides for two months past.

On October 15 at noon much steam was rising from Halemaumau following several hours of rain.

There have been 16 local earthquakes recorded at the Observatory during the week. Two of these were feeble, but were a little larger than the others, which were all very feeble. The first of the two larger shocks was caused by a big avalanche in the pit at 4:07 p. m. on the 11th. The second shock at 4:11 a. m., October 12, apparently originated a few miles south of Kilauea, and was felt by a number of persons at Kilauea and in Hilo. This earthquake was recorded on the seismographs at the Observatory, at Uwekahuna, at Halemaumau, in Hilo, and in Kona. The indicated distances from these stations, in the order given, were 11, 15, 11, 29, and 49 miles.

On the 14th, at 10:30 p. m., there is recorded a very faint disturbance that is probably the long wave of a teleseism.

Microseismic motion was slightly stronger than normal during the first part of the week. Tilt accumulated moderately toward the east.

POSSIBLE 1851 LAVA FLOW AT LASSEN CINDER CONE

The evidence of two flows from Cinder Cone, the small recent volcano 10 miles northeast of Lassen Peak in California, is very clear. The older flow is covered with volcanic sand, and the newer flow overlies the sand. The locations of trees that existed before the sand eruption are still plainly marked by depressions in the sand.

There are several small cinder cones to the southeast of the main one. Where the lava flow is crossed along the line of these small cones, it quickly appears to an observer that the so-called younger flow might itself really be two flows.

The writer knew that Doctors Day and Allen had dated the last flow over 250 years ago, and during his own trip, made to take photographs, the evidence of the presence of three flows came as a complete surprise.

Later Mr. A. E. Jones, who worked as seismologist at Lassen Volcano Observatory during the summers of 1927 and 1928, provisionally dated the last two flows as of 1795 and 1832 approximately, with a probable error of 10 years more or less, measuring magnetic declination of fixed ledges. This is on the theory that the declination constant of the ledge preserves record of the earth's regional magnetic field at the time the lava congealed. (Volcano Letter Nos. 45, 144, and 162.)

The magnetic work thus suggested a possible lava flow eruption in the middle of the nineteenth century. Dr. H. A. Harkness, for whom is named Mount Harkness in the southeastern part of Lassen Volcanic National Park, wrote an account of activity at Cinder Cone (Cal. Acad. Sci. Proc. Nov. 2, 1874) said to have occurred during the winter 1850-51. Dr. Harkness made the mistake of attributing all the lavas and ejecta of Cinder Cone to 1850-51, a contention that can easily be shown to be in error. His evidence was unacceptable to Dr. Diller and to Drs. Day and Allen, and by them was dismissed. Diller however (Lassen Peak Folio 15, U. S. Geol. Survey), writing in 1894, states that the second or effusive eruption was much later than the first. "but certainly more than 50 years ago, and was of such a character as not to attract attention."

I read the account by Dr. Harkness at the library of the California Academy of Science in January, 1928. The following statements are taken from his article:

Lights were observed apparently by different observers to the east of Lassen "Butte" from time to time from 1850 to 1854. The Indians of that country were hostile, so no attempt was made to ascertain the source of the light.

Dr. Wozencraft from above Red Bluff observed a great fire to the eastward of Lassen during the winter of 1850-51 which continued for many nights without change of position. He dismissed the Indian camp-fire theory. Dr. J. B. Trask at Rich Bar on the north fork of the Feather River, to the southeast of Lassen, also saw light for many nights.

Mr. Charles Gibbs with a party of miners saw the same lights and reported them as due to a volcanic eruption. Miners arriving at a hotel near Georgetown, El Dorado County, during the summer of 1851, reported passing an active volcano and hot rock, their location of which agrees exactly with that of Cinder Cone.

The same miners gave a description of Boiling Lake and the geyser near Drakesbad, features of the present Lassen district, and their description would apply at the present day were the activity at those places a little greater than at present. R.H.F.

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No. 200 RELEASED WITHOUT COPYRIGHT RESTRICTION October 25, 1928

KILAUEA REPORT No. 874

WEEK ENDING OCTOBER 24, 1928
Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

At Halemaumau avalanches were noted at 9:35, 9:40, and 9:45 a. m. October 18, so that dust was rising rather steadily at the north rim at 10 a. m. On October 20 at 11:20 a. m., thin dust filled the pit, and this recurred in the afternoon. At 2 p. m. fresh debris was observed on the SW., S., and SE. bottom slopes. The pit was very dry, only slight vapor appearing at the center cone and the SE. and S. taluses. At 9 a. m. today fresh rocks were seen on the north talus, and the noise of falling material was heard at the west.

During the week ending October 24 there were 20 local earthquakes recorded on the seismographs of the Volcano Observatory. Two of these, at 10:41 a. m. on the 21st and at 9:56 a. m. on the 22nd, while feeble, may have been felt. The distances to the origins of these shocks were 13 and 12 miles, respectively. All the other earthquakes recorded were very feeble.

Microseismic motion was normal during the week. Tilt accumulated moderately toward the north.

RECENT ACTIVITIES IN NEW ZEALAND

We are indebted to Mr. Birch of the New Zealand Herald, published at Auckland, for clippings noticing a number of earthquakes in the spring and summer of 1928.

Opotiki, on the shore of the Bay of Plenty opposite White Island Volcano, reports earthquakes as follows: A slight shock January 16 at 1:18 p. m., a sharp shock February 5 at 1:30 p. m, a sharp tremor February 16 at 3:30 a. m., another February 19 at 3:30 p. m., a short and very snappy shock on June 20 at 1:10 p. m., another more severe at 5:50 a. m. July 11; and at Waihi, on the west side of the Bay of Plenty, an earthquake at 6:10 a. m. August 13 seemed to travel in a north and south line, sufficiently pronounced to awaken many persons. All of these shocks are of interest as occurring in the northern part of the belt of active volcanoes, and close to White Island, reported as showing some activity in June.

Other earthquakes have been felt in various parts of the North Island, and at least two in the South Island. Mercer, south of Auckland, felt a slight shock at 6:55 a. m. February 17. March 7 produced a really severe earthquake in the city of New Plymouth at 6:50 a. m. This seemed to come from the slopes of the great volcano Mount Egmont, 8,260 feet high, immediately adjacent to New Plymouth on the south, and the damage was greatest in the southeastern quarter of the borough.

Chimneys went down in all parts of the town, and the shocks were said to be the most severe felt there for many years, lasting about 30 seconds, working up to a climax, and then dying away. The damage was estimated at many hundreds of pounds. Shops suffered severely, goods being shaken off of shelves and falling in show windows. In one grocer's shop everything on the eastern wall fell, resulting in many broken bottles, but the other walls were not damaged, and generally the drug stores appear to have escaped. In one shop a plateglass window was cracked. There was a landslip on the Frankley road which barely missed a passing motor truck. The villages at the northeast base of Mount Egmont all experienced the earthquake, but were not severely damaged.

The capital, Wellington, felt a slight earthquake at 7:27 a. m. March 16, and another at 5:15 a. m. July 31.

On June 12 the volcanic belt at its southern end, between Lake Taupo and the Rangitikei River, was shaken. Taihape reported tremors preceded by heavy rumbling which lasted for several seconds about 5:30 a. m. Presumably the same earthquake reported as about 6 o'clock was felt in the Rangitikei district accompanied by a rumbling sound which made a rapid crescendo and then diminished. The north end of Lake Taupo reported an earthquake at 9:25 a. m., with vibration from east to west. This was not noticed at the south end of the lake.

On the evening of July 17 Raetihi, southwest of the Ngauruhoe group of volcanoes, felt two shocks, the first reported severe and accompanied by a loud rumbling noise and lasting about 30 seconds. The second tremor was mild, only a few seconds long, and occurred only 10 minutes after the first shock.

For the South Island Oamaru on the southeast coast reported a series of severe shocks in the Ben Avon district for the fortnight preceding February 7 which had set rocks tumbling down the hillsides and terrified both the cattle and the inhabitants. The convulsion was confined to a limited area. Greymouth, near the state collieries on the northwest coast of the South Island, felt slight tremors shortly before 9:15 a. m. March 25, and these were followed by a greater shock progressing apparently from northwest to southeast. T.A.J.

On March 3 Ngauruhoe began to rumble after smoking and steaming all day, and at 6 p. m. threw up rocks to a height of 500 feet. One rock dropped outside the crater and rolled down the slope, and glow was seen over the summit at night. The rumbling resembled thunder. At 10 a. m. March 4 the thundering began along with ejection of great clouds of white and blue vapor, and lasted five minutes. Heavy sulphur fumes rolled down the slopes of the cone. Twenty minutes later, and again at 10:30 a. m., loud explosions occurred, accompanied by jarring which shook the mountain huts at Whakapapa, and the smoke column rose 2,000 feet while showers of rock rolled down the northern slope, where dust arose as the material slid. Far away at Opotiki a severe earthquake occurred this day at 3:30 a. m., preceded by a prolonged rumble. A thick column of black smoke was rising at 5:50 p. m. March 9, reaching a height of about 8,000 feet, and spreading to drop a shower of ash over Tongariro Volcano to the west. Glow was seen over the crater March 9 and March 10.

The White Island activity was said to have begun in June with excessive steam as seen from Opotiki which died away during the following week. It was believed some sort of an eruption occurred during the night June 24-25, for the next day the volume of steam from the blowhole was enormous, rising to a height of 2,000 feet in clear frosty air, and stretching away in a long white cloud for a mile. The local radio station reported hearing nothing from the sulphur workers on the island.

As no news since June is presumably good news, it may well be that all of this excessive steaming seen from Opotiki did not really amount to an eruption. T.A.J.

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No. 201 RELEASED WITHOUT COPYRIGHT RESTRICTION November 1, 1928

KILAUEA REPORT No. 875

WEEK ENDING OCTOBER 31, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Kilauea Volcano continues to remain in repose. A few slight avalanches from the northeast and east walls of Halemaumau were noticed. They caused dust clouds during the forenoons of October 30 and 31. Dense steam was rising from the fire pit following rains on the latter day.

The number of local earthquakes recorded on the Observatory seismographs during the week is 15. They were all very feeble.

Microseismic motion became somewhat stronger than normal toward the end of the week.

Tilt accumulated only very slightly to the south.

POISONOUS GASES IN JAVA

Beginning in the autumn of 1927 the East Indian Volcanological Survey has produced in English, a monthly bulletin of volcanic activities. The excellent volcano service of the Dutch East Indies has erected observatories on the volcanoes Semeroe, Tangkoeban Prahoe, Papandajan, Merapi, Keloet, Lamongan, Idjen, and Karmodjang. Most of these have permanent observers, five of them have seismographs, five report thermometric measurements of gases or hot springs, two report chemical tests, and six make meteorological measurements. In two of the volcanoes crater lakes are sounded occasionally, and 10 other active volcanoes are visited from two to four times a year. (Bull. Neth. East Ind. Volc Surv. Nos. 1 to 11, Nov. 1927 to Sept. 1928, Bandoeng, Java).

The word kawah means crater, and Tangkoeban Prahoe, in west central Java, has seven vents. In three of these craters after August, 1927, increased solfataric action produced the suffocating gases carbonic acid and hydrogen sulphide. Throughout 1927 the locality known as "Death Valley, outside of the Ratoe vent of this volcano, had its gases sampled by means of the Bunte burette. At the same time the temperature was taken, and such weather conditions recorded as might influence the gas measurement, such as air temperature, humidity, pressure. cloudiness, and wind. Carbonic acid in August varied from 36 to 69 per cent, in September from 46 to 78 per cent; hydrogen sulphide, in August, between 7 and 16 per cent. and in September between 4 and 15 per cent.

In Papandajan, of southwestern Java, the hottest place is the Kawah Mas, where a self-recording electrical thermometer automatically registers the temperature every 12 minutes. The maximum reading was 372° C. September, 1927, and the highest temperature during that year was 420° C.

Here also suffocating gases are abundant in the Roeslan Valley, named after a native observer who was suffocated there December 18, 1925.

In October, 1927, "Death Valley" gave from 59 to 75 per cent carbonic acid, and 10 to 12 per cent hydrogen sulphide. Observed at a place where at the end of June 1923, three high school boys had met with sudden death caused by asphyxiating gas, the measurements showed a decline of the percentages, especially in the case of carbonic acid. On September 13 the sum total of both gases had been 35 per cent, whereas on October 29 it was 18 per cent.

At Papandajan, in the Kawah Mas, maximum temperatures were higher in October, and minimum temperatures lower, than in the preceding month. The highest temperature recorded was 379° C. In Roeslan Valley carbonic acid varied from 20 to 42 per cent, hydrogen sulphide from 7 to 12 per cent. The crater Nangklak No. 4 gave carbonic acid 4 to 33 per cent, hydrogen sulphide 2 to 11 per cent.

In December, 1927, cold carbonic acid gas was coming out at Death Valley, and a spring showed sulphur in suspension. In Roeslan Valley hydrogen sulphide varied between 10 and 20 per cent. carbonic acid between 41 and 51 per cent. At another crater of Papandajan, Nangklak No. 4, hydrogen sulphide varied from 10 to 12 per cent, and carbonic acid from 43 to 68 per cent.

In January, 1928, Roeslan Valley on Papandajan gave hydrogen sulphide 16 to 17 per cent, carbonic acid 47 to 49 per cent. Nangklak No. 4 gave hydrogen sulphide 6 to 9 per cent,carbonic acid 43 to 49 per cent.

Papandajan in February, 1928, showed higher temperatures, and along the banks of a small brook traversing the volcanic crater hydrogen sulphide developed in a new place near an old camp, so that a native who passed the place swooned.

In March Tangkoeban Prahoe increased its gas pressure, and in a ravine between two of the craters suffocating gas appeared in such high concentration that one of the dogs of the observatory was choked. The carbon dioxide there was found to be 75 cm. deep, by the capacity of the gas to extinguish a flame.

In April Bromo Volcano in eastern Java was reported as having been active since the middle of March when the eruption had begun with loud explosions, the ejection of big stones, and ash clouds of reddish color. A light ash fall continued, and a sulphurous smell was perceived some miles away. At Papandajan in May a blow-hole in the Baroe Crater threw up black sulphurous mud, staining the whole region round about. In central Java a sudden eruption occurred near Batoer, a well known tobacco producing center. Strong earthquakes occurred May 4-13, and then an explosion amidst the tobacco fields, where three vents opened, a dull noise occurred, and the material thrown up was saturated with water and flowed south in three hot mud streams, while the stones ejected destroyed a large part of the hamlet Timbang. One man was killed by a falling stone, there were new cracks in the ground the crops and vegetation were destroyed and highly concentrated suffocating gases came forth.

In July these gases were investigated, and carbon dioxide was found escaping from fissures under high pressure along the road from Batoer to Dieng. The gases streamed down drainage ditches, forming a layer 20 cm. deep, which would extinguish a candle flame 60 meters away from the vent. On June 13 a light wind blowing up the grade depened the gas until it was 16 cm. deep (5 feet ,and so was dangerous. The gas layer became visible by condensation, and produced giddiness, high pulse, and heavy pressure at the back of the head. Birds were killed. and the lush bamboo vegetation, as well as fields of tobacco, withered from exposure to the gas. T.A.J.

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No. 202 RELEASED WITHOUT COPYRIGHT RESTRICTION November 8, 1928

KILAUEA REPORT No. 876

WEEK ENDING NOVEMBER 7, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

In Halemaumau pit at noon of October 31 a slide was reported, and beginning at 9 p. m. of November 1, a series of heavy avalanches occurred repeatedly for about two hours. In the still night air these were distinctly heard at Volcano House. An especially heavy slide at 10:30 p. m. was registered on the several seismographs. Dust from avalanches at the northern wall of the pit was seen at 8:30 a. m. November 2, and at 4 p. m. November 5 thin dust from slides rose above the pit in a veil.

Examination of the walls at 3:30 p. m. November 3 indicated that the avalanches had fallen mostly at the north and northeast corners of Halemaumau, making red debris on the two talus cones at the ends of the large intrusive sill.

For the week ending at 8 a. m. November 7 the Observatory seismographs have registered 17 very feeble earthquakes. A tremor at 2:37 a. m. November 1 has the gradual development to a maximum, followed by similar gradual decline, which is characteristic of avalanche tremors. Throughout the week microseismic motion was strong, but is now decreasing.

Tilt accumulated moderately to the north.

ERUPTIONS OF ETNA

Press reports indicate that the volcano Etna in Sicily is giving vent to a lava flow. The last lateral eruption was in June-July 1923. Since that time activity has been confined according to last reports to jets of vapor and dust from the summit crater. (1926 Bulletin Volcanologique, Nos. 9-10, Etna From August 1923 to the end of 1925, By G. Ponte.)

The activity of Etna, according to Perret, has been marked by eruptions during the past 300 years at intervals averaging about six years, making some 17 eruptions per century. It is a volcano in many ways resembling Mauna Loa. In the surrounding country have occurred some of the most disastrous earthquakes of history, notably at Messina, and the volcano itself has occasioned serious loss of life.

The observatory stands about 1,000 feet below the summit, where there is a central crater, but just as in the case of Mauna Loa, the serious eruptions of modern times do not occur at this crater but rend open the flank of the mountain. The observatory was originally designed for astronomical observations, but is now assigned to the Volcanologic Institute of Catania University.

A small eruption occurred on the 29th of April, 1908, which lasted only 12 hours, following upon a repose period of 16 years. Such a long sleep required greater relief than this, and therefore the succeeding months were considered a time of anxiety. This was justified by the terrible earthquake at Messina on December 28. After the earthquake both Etna and Stromboli diminished in activity, as though the earthquake had relieved a subterranean strain. Finally, however, March 23, 1910, a greater eruption occurred, and still another in September of 1911. The lava of 1910 flowed at the speed of 11 miles per hour from a vent which threw up spatter to a height of about 150 feet. Mr. Perret obtained a photograph of a remarkable smoke ring which floated upward over 5,000 feet and expanded until it was about a quarter mile in diameter. The lava of Etna is basaltic containing from 44 to 49 per cent of silica. From a chimney at the vent Perret observed banners of flame due to burning gas rising 10 or 15 feet. Rafts were observed floating down the lava stream, the latter was from 6 to 12 feet in depth, and as the big masses on top of the stream were carried along at about four miles an hour they gave the impression of big barges floating past. The color of the hotter parts of the flow at night was a golden yellow, estimated to have a temperature of about 1,200°C. Lava tunnels were found, through which the stream poured, and the lower portion of the flow was typical aa lava.

Mr. Perret makes the point that tunnels very commonly form along the line of the fracture or fissure through which the lava flow pours, and the lava tunnel left exposed extended from crater to crater along the rift, and was revealed only after the slope of the mountain slumped away near the lowest crater at the end of the eruption. The entrance to the tunnel was a perfect arch 12 feet high, and in the interior it was 25 feet high in places. All this closely resembles the lava tunnels of Ki'auea and Mauna Loa, where the flows are smooth and slaggy near the source vents in the portions of their courses where the tunnels are formed, but farther down the mountain the lava turns to clinker. It will be remembered that the tunnel now exposed in the southwest wall of Halemaumau is a true rift tunnel, through which poured the lava flow of Mauna Iki in 1920. (The Eruption of Etna in 1910, by F. A. Perret, Science Conspectus, Massachusetts Intitute of Technology, Vol. I, No. 3, Feb. 1911.) T.A.J.

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No. 203 RELEASED WITHOUT COPYRIGHT RESTRICTION November 15, 1928

KILAUEA REPORT No. 877

WEEK ENDING NOVEMBER 14, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Conditions at Halemaumau do not change materially. Rains of the past few days have not soaked the pit to any great extent. The areas of steaming are conspicuous through being wet, in contrast to surrounding dry areas. The south and central cones steam thinly, and other vents are more or less flocculent.

The week has been particularly quiet seismically, only three very feeble local earthquakes having been registered. Microseisms appear normal, despite a strong, steady northeast wind.

Tilt is strong to the northeast.

HORIZONTAL MOTION IN JAPANESE EARTHQUAKES

The work of the United States Coast and Geodetic Survey in reoccupying triangulation stations in California after the great earthquake of 1906 showed that horizontal motion had shifted large blocks of country. The triangulation stations east of the fault had moved south; those on the west had moved north. This agreed with observed displacement of fences, trails, and roads, which were offset over 20 feet north of the Golden Gate.

The same method has now been applied to Japan. In the case of the Tango earthquake (Volcano Letter No. 119, April 7, 1927), the Gomura fault exhibited dislocation on the ground of as much as eight feet. The fault trends NW-SE, and the country round about contains bench marks placed during trigonometric surveys made between 1884 and 1888. These stations were retriangulated in June and August 1927, some months after the earthquake. It was found that the stations east of the fault line had moved north several feet, while those to the west had moved south.

A geometric method was devised for platting on a diagram the amount of displacement of those bench marks lying nearest to the fault plane on both sides of the rift, and then projecting on the line representing the fault the amount of the several displacements so as to obtain a figure representing the total offset along the fault trace. Just as in California, the basis for displacement of any station was a base-line connecting two distant monuments that lay outside the area affected by the fault.

The results indicated that the total offset shown by triangulation is about 2.4 meters, while the maximum movement measured directly was 2.7 meters. In general the amount of shift of the triangulation stations is the greater, the nearer the station lies to the rift.

It next became of interest to apply this triangulation method to the great Kwanto earthquake, which produced the terrible Tokyo-Yokohama conflagration of 1923 (see Volcano Letter No. 171, April 5, 1928). The actual fault in this case trends NW-SE in the middle of Sagami Bay, where, it will be remembered, there was actual deepening of the soundings by from 400 to 600 feet along the zone of fault blocks which subsided at the time of the earthquake. As this fault plane had no marked extension on land, and yet the bay is surrounded by lands containing trig stations, it is clear that in order to find out the horizontal displacement on the rift, the triangulation method is the only one available.

The whole Tokyo area has been retriangulated, and the stations lying in the Misaki and Boso peninsulas nearest to the rift on the east side, all show strong displacement to the south. On the other hand the bench marks on Oshima Island and the Izu Peninsula, west of the rift, show still greater displacement northward. The base line used lies 90 miles to the north between Teruisiyama and Tukubasan.

Using the same graphical method as before, platting the line of the fault, and the line at right angles thereto on which are laid off the several distances of the trig stations from the fault trace, and then projecting on the fault trace the displacements north of the western stations and the displacements south of the eastern stations, it is found that the net offset or shift horizontally along the rift amounts to eight meters, or over 26 feet.

This triangulation was all carried out by the Military Land Survey Department. An extraordinary feature of the map exhibiting all the displacements around Sagami Bay, which represent the changes between the surveys of 1884-1899, and the post-earthquake surveys of 1924-1925, is that the land stations appear to have shifted somewhat uniformly in a circular arc around the west, north, and east sides of the submarine earthquake center. That is to say, Sagami Bay is an indentation in the southeastern coast of Japan, and the land southwest of it has moved north, the land northwest of it has moved northeast, the land north of it has moved east, and the land northeast of it has moved southeast. Here again, as in the Tango earthquake, the maximum displacements are at those stations nearest to the rift, and the amount of displacement diminishes quite consitently in proportion to the distance from the Sagami Bay center. The map gives one the impression that the land has executed this rotation around Sagami Bay almost as though it were plastic. (A. Imamura and F. Kishinouye, On the Horizontal Shift of the Dislocations Accompanying the Recent Destructive Earthquakes in the Kwanto District and in Tango Province, Proc. Imp. Acad. Japan, IV, 1928, No. 3.) T.A.J.

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No. 204 RELEASED WITHOUT COPYRIGHT RESTRICTION November 22, 1928

KILAUEA REPORT No. 878

WEEK ENDING NOVEMBER 21, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Volcanic conditions at Kilauea have not changed. There is very little working of the walls, and earthquakes are very infrequent, only eight very feeble shocks having been registered during the past seven days. Tilt accumulation is moderately northwest.

THE ERUPTION OF ETNA

The volcano Etna occupies an oval tract 30 miles long in a north south direction, and 23 miles wide, on the northeastern coast of Sicily. The city Catania is at the southern edge of the mountain, and was destroyed by earthquake in 1169 and invaded by lava in 1669. A railroad connecting Catania with Messina follows the coast line east of Etna. Taormina lies northeast of the mountain and Messina is 35 miles farther to the northeast on the strait that separates Sicily from the mainland of Italy. Etna is 10,758 feet high, and its height was reported to have decreased 112 feet between 1861 and 1900. The circumference of the mountain is about 91 miles, and its area about 460 square miles. The summit is truncated, and an inner cone rises from the summit plateau containing the large crater. East of this is the Valle del Bove, a vast desert gulf three miles wide, bounded on three sides by cliffs 2,000 to 4,000 feet high, and constituting apparently a collapsed area much like the crater of Haleakala.

Numerous lava flows have poured out in the Valle del Bove, and others have come from the flanks of the mountain on other sides, forming minor craterlets below the base of the large central cone. Historic eruptions of Etna are reported as far back as 693 B C.

The lower belt of vegetation to about 3,000 feet of elevation is the zone of cultivation, where vegetables are grown, and in the drier upland vines and olives flourish. The slopes are densely populated, having 930 inhabitants per square mile below elevation 2,600 feet, and more than 3,000 inhabitants per square mile in the southeastern sector. The highest zone is wooded up to elevation 6,800 feet. For much of the year the summit region is covered with snow.

The present eruption began about November 1, and from press reports we learn that four streams of lava started about elevation 3,000 feet on the east flank. This appears to mean north of the lava flows of 1811 and 1852, near the north rim of the Valle del Bove. Mild earthquakes preceded the eruption, and one flow appeared to be headed in the direction of Sant Alfio and Giarre which is east of the mountain, on the railroad. On November 4 Pontanazzo, with a population of 2,000, was threatened, 22 farm houses on its outskirts had been engulfed, and officials were causing evacuation of the danger zone.

It now became apparent that the flows were moving more to the north, road traffic was disrupted, and on November 5 the large town Mascali was being deserted.

November 8 the eruption was said to be spreading destruction comparable to that of the great flows of 1169, several hamlets had been destroyed, the flow was widening as it reached lower levels, and hundreds of persons were reported homeless. At this time three men who had returned to their homes to rescue household goods and had decided to sleep there overnight, were said to have been surrounded by lava flows so that fellow townsmen looked on helplessly as the molten slag engulfed the victims.

On November 9 Mascali was invaded, although the three principal streams seemed to be diminishing in volume. The central stream had advanced several miles, and two other flows had gone less than a mile. By November 11 the largest flow was said to be moving toward the shore at the rate of 15 feet an hour, with a front two miles wide and 16 feet high. Twelve thousand persons were homeless and being cared for in schools, churches, and railway stations. Villages, cultivated fields, and orchards had been destroyed, and the government was preparing to provide measures of relief. The railroad was overwhelmed by the flow, trees were blazing, the torrent was following the valleys and factories and mills were being dismantled. A roaring noise was heard, the usual explosions occurred about the front of the lava, where coal gas from burnt vegetation was mixed with air in caverns, and out of the cracks came forth the odor of hydro-carbons.

By the 13th the speed of the flow had greatly decreased. Relief funds were appropriated by the Mussolini cabinet. The Italian press estimated damage to agricultural lands at three million dollars, and to habitations, roads, railways, bridges, and engineering works, 15 million dollars. Only 50 out of 800 houses are left standing in Mascali, and 100 houses are reported destroyed in Serrageano. Other places mentioned as suffering are Annunziata and Carraba. Earth rumblings were heard as far as Messina and the explosions from the lava caverns are reported as hurling up flakes of stone, just as they do about the front of Mauna Loa flows when the lava enters a forest. The last report from Rome (November 12) states that 4,000 acres have been laid waste, 700 houses destroyed, and 5,000 persons made homeless. It is worthy of note that this eastern region has hitherto been mostly free from lava flows of historic dates, so that the mountain is merely fulfilling the law of symmetrical cone-building. T.A.J.

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No. 204 RELEASED WITHOUT COPYRIGHT RESTRICTION November 29, 1928

KILAUEA REPORT No. 878

WEEK ENDING NOVEMBER 28, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

Dense steam was rising from Halemaumau on the afternoon of November 22 due to falling moisture. On November 24 at noon there were no changes whatever in the pit that could correlate in any way with numerous earthquakes registered in the early morning. A slide from the northeast wall made dust at 8:20 a. m. November 26. Nothing new was seen today.

Earthquakes increased materially during the week, a total of 36 having been registered. Twenty of these were recorded between 5:17 and 5:43 a. m. November 24, and five of this number were of sufficient intensity to be felt locally. Two shocks, slightly larger than the others, had phases indicating distances to origins of 0.4 mile and 1.3 miles from the Observatory.

Tilt for the week accumulated SSW. As most of this took place on November 24 and 25, the earthquakes seem indicative of a partial collapse of the center floor, possibly due to subsidence of the lava column.

CRATERS OF THE MOON NATIONAL MONUMENT

The large basaltic areas of the Snake and Columbia rivers have long been considered flows that emerged from obscure fissures. Gradually the fracture lines that constitute the vents are coming to light. One of these is the rift zone trending NW.-SE. lying Southeast of the White Knob Mountains in Idaho, which has been set aside as the Craters of the Moon National Monument, including about 80 square miles south of Arco, Idaho. The reservation is about 23 miles long by 8 miles wide, and stands between 5,000 and 6,000 feet above sea level in a semi-arid district. A roadway penetrates the northwestern end of the Monument, and the whole district is in every way similar to the Kau Desert southwest of Kilauea, or the Puu o Keokeo desert of the southwestern rift of Mauna Loa.

There are both aa and pahoehoe lava flows, many horseshoe-shaped cinder cones made by fire fontains at the sources of the flows, numerous lava caverns in the pahoehoe, which become natural bridges were these are partially broken down, and a large number of tree moulds and lava trees. There are also ice caves and water holes, all of which owe their existence to ground ice. (H. T. Stearns, Bull. Idaho Bureau of Mines and Geol. No. 13, July, 1928, Moscow, Idaho.)

There are yawning crater pits, and many spatter cones, and the floods of lava for six miles against the southern spur of the White Knob Mountains filled the valleys as if they were bays, and left the spurs like projecting headlands in a black sea. These mountains are of granitic rocks, and when in recent geological time the great rift opened on their slope, and thick jagged lava flows poured to the south and east, there were left small and large fragments of granite that broke off from the roof of the lava reservoir and floated upward in the molten lava during the eruption. Obsidian occurs among these older eruptions, and this was quarried by the Indians to make arrow heads.

A second series of eruptions broke out making many of the large cinder cones in the middle of the Monument area. The third and last eruptive epoch gave vent to barren black lavas which form the latest veneer over much of the area, these flows in many places surrounding the earlier cones. Altogether about 35 cones and vents and 30 different lava flows are found in the Monument. Everything indicates that the actiivty was accompanied by quiet fountaining of vesicular lava, with much foaming and great quantities of gas, but without explosive eruption such as would spread volcanic dust for hundreds of miles. The bombs are of the spindle, ribbon, and bread-crust types associated with the ejection of clots of liquid lava.

The rock is basaltic, with 51% of silica, 14% alumnia, 15% iron oxides, 6.5% lime, 2% magesia, and 6% alkalies.

Pahoehoe flows cover about half the area, often with blue glassy crusts and billowy, ropy surfaces, these flows being filled with caverns. The caverns invariably occur in pahoehoe and not in aa. The aa flows. just as in Hawaii, are in many cases produced where pahoehoe changes to clinker some distance away from its source, but the aa never changes back into pahoehoe. Some of the aa lava flows are 25 to 100 feet thick, and have moved several miles out on the plain.

The cones of the Craters of the Moon area are large cinder heaps about 450 feet high, or lines of smaller spatter cones about 50 feet high and 100 feet in diameter, or lava domes rising 30 to 50 feet above the surrounding country, and sometimes surmounted by tiny spatter heaps less than 10 feet high. These lava domes are compared with Mauna Iki, which was formed in 1920 at Kilauea.

The tree moulds vary from a few inches to three feet in diameter, and are sometimes 10 to 20 feet deep. Sometimes the liquid lava flowed into the checks or shrinkage cracks in the charred surface of a log, forming a checker pattern, easily mistaken for bark impressions. Lava trees rising one to five feet above the general surface occur where part f the lava flow has drained away, leaving the mouded trunk in relief.

The abundant water holes are due to the freezing period, which at this elevation in Idaho covers about seven months in the year. This is much like the summit regions of Mauna Loa and Mauna Kea. The caves and cinder heaps act as heat insulators, and in one place called Ice Cave a heap of ice and snow 20 feet thick is found even in summer. Fifteen perennial water holes are listed. The temperature of the water rarely exceeds 34° F.

Stearns concludes from the evidence of pine trees and other vegetation growing on the flows that the youngest cones in the area are over 400 years old. The charred wood seen in many places was set on fire artificially or by lightning, and was not fired by hot lavas. There is some very fresh pahoehoe lava which may be little more than 250 years old, and there are obscure Indian traditions of fire seen in the region. All of this resembles similar evidence concerning the Lassen country, and indicates the possibility of other eruptions yet to come near the Craters of the Moon National Monument. In detail the photographs of stalactites, shore-line marks of lava in caverns, festoons, pits, and the rift landscape in Mr. Stearns' report are extraordinarily like Hawaii. T.A.J.

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No. 206 **RELEASED WITHOUT COPYRIGHT RESTRICTION** December 6, 1928

KILAUEA REPORT No. 880

WEEK ENDING DECEMBER 5, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

There are no changes at Halemaumau. Some large slides occurred on the forenoon of December 3. At 10:55 a. m. there was a big avalanche at the north, with a column of dust spreading NW.-SE. rising from the pit. The debris fell from the north rim, in the region of the active avalanching of last August. The north wall is thickly coated with white salts, and much white material covers the north talus.

A section of the southeast rim near the tourist outlook has caved away. It is still very unstable, and further slides will occur there until all the loosened area goes.

Crack measurements along the east rim show practically no changes in nearly three months.

The count of earthquakes for the week is but three very feeble local shocks. One of these at 6:17 p. m. December 3 had an indicated distance to origin of 9.3 miles.

Tilt accumulated moderately to the NE.

WHITE ISLAND VOLCANO

It will be recalled that White Island, in the Bay of Plenty, near the north island of New Zealand, is an active volcano which has a sulphurous crater nearly at sea level, surrounded by fuming cliffs, and separated by only a bar from the ocean. On the back-slope of the cone, away from the crater, dwell the operatives of a sulphur-mining company, equipped with a launch, wireless, and a tramway to the workings at the crater. In the second decade of this century (1914) a former group of sulphur workers, who lived on the lowland between the crater and the beach, were all exterminated by an evisceration of the crater which no one survived to describe. The wreckage suggested an explosive eruption and a flood.

In Volcano Letter No. 200 of October 25, 1928, we described White Island activity in June, 1928, seen as excessive steam from Opotiki on the neighboring coast.

On September 1, 1928, a new eruption of White Island occurred. This "was accompanied by a phenomenon in the form of a sulphurous dust cloud," believed similar to the one experienced some days earlier by the steamer "Emlynian" in the Netherlands East Indies, about 30 miles north of Flores and 200 miles east of Java. It appears that this dust cloud in both cases coated the decks of ships. In White Island it swept south, across Crater Bay, where the company's launch, the Whaakari, was moored, and dusted it without arousing the men sleeping on board. (New Zealand Herald, September 13, 1928.) It should be pointed out that the "Emlynian" was close to the volcano Rokatinda, which has just had a disastrous eruption.

The men in the camp, which is removed from the active area of White Island, were unaware that anything unusual had taken place during the night. The telegram to the head office of White Island Products, Ltd., Auckland, from the island, was as follows:

"A minor eruption occurred in the active crater area about 1 a. m. on Saturday, September 1. Series of new vents formed from two to four chains from the main blow-hole in the direction of 'Lot's Wife'."

"The whole of the upper crater area is covered eight to 24 inches deep with very fine blue-gray dust. Stones and bowlders up to two and three hundredweight were scattered in a radius of about 200 yards around the activity. We have not yet been able to make a full inspection, but from the edge of the activity it appears that the force has subsided, although steam is blowing over an area of about half an acre. The chief trouble is that we are completely cut off from the sulphur suppiles, as the road is impassable."

Professor J. A. Bartrum, geologist of Auckland University College, considered that the main interest of the White Island activity lay in whether the activity was caused by avalanching from the crater walls at the back of the main blow-hole, believed to have caused the 1914 eruption, or whether there was some other cause. Mr. Welsh, the general manager of the company, stated that slips had not caused the recent eruption. Professor Bartrum thought that " in that case the occurrance is certainly a little disconcerting, and the tendency to any special activity needs watching.

We previously reported earthquakes about the Bay of Plenty in January, February, March, June, July, and August. A sharp earthquake was felt at Opotiki shortly before 1 p. m. September 12, and Rotorua reported several shocks after 1:30 a. m. on October 2. They terminated at 3:15 a. m. with the heaviest shock experienced here for many years. All the geysers at Whakarewarewa were very active in the early morning. At Tauranga, again on the Bay of Plenty, a sharp earthquake shock was felt at 5:17 a. m. November 6, and the tremor was felt at Te Puke. All of these jarrings, throughout the year, around the bay in which White Island is situated, make that volcano an interesting object, especially as it has had two reported outbreaks, one just at the June solstice, the other just before the September equinox. (See Volcano Letter No. 66, April 1, 1926.) T.A.J.

ERRATUM

The previous issue of the Volcano Letter should be numbered 205, instead of 204.

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No. 207 **RELEASED WITHOUT COPYRIGHT RESTRICTION** December 13, 1928

KILAUEA REPORT No. 881

WEEK ENDING DECEMBER 12, 1928

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

There is nothing new to report about Halemaumau pit of Kilauea Volcano. There has been little avalanching, and the visible vapor from the cones on the bottom and from the vents about the border talus varies with the weather. After excessive rain such as has fallen during the last twenty hours vapor fills the pit, but there is equally great increase of vapor from the cracks of the floor and rim of the greater crater.

Sixteen very feeble local earthquakes were registered during the week ending at 8 a. m. December 12, including two continuous tremors each of about 2½ minutes duration, both on December 11, beginning respectively at 10:31 a. m. and 11:19 a. m. Tilt for the week was slight to the NE. Microseisms were normal.

THE ROKATINDA ERUPTION

A newspaper report of August 9 stated that the eruption of Rokatinda killed a thousand people, injured 600 with flying rocks, and in addition six villages were wiped out by eruptions and earthquakes, and a large section of the seaboard had been submerged and recurrent waves of enormous size had caused the sinking of nine vessels.

The exact facts of this eruption have now been investigated by the volcanologists of the Netherlands East Indies and it appears that 226 people were killed, of whom 128 perished by flood waves caused by landslides at two places on the southeast and south coasts of the island. Four villages were covered with ash and pumice, and two others were partly destroyed.

The volcano Rokatinda is on the southern flank of the circular island Paloeweh which lies north of Flores in the eastern part of the Javanese Archipelago. The eruption occurred in the night August 4-5. It was preceded by local tremors which increased in intensity from July 25 on. Many of the inhabitants of the southern villages near the crater fled to the northern part of the island. The greatest destruction was between 10 p. m. and midnight. Great masses of new material in the form of pumice and ash were thrown out, and of old material in the shape of lava blocks. The new craters were enlarged by subsequent explosions. The red hot stones could be seen far away from the north coast of Flores. As this is the dry season the grass and trees were fired by the incandescent material so that the southern half of the island was ablaze.

Three new craters were formed, some 500 meters apart, one 400 meters in diameter. During the violent eruptions of the first few days ash and pumice to a depth of from one to two meters accumulated at a distance of one kilometer from the craters. Large blocks fell 1.5 kilometer away from the center. These blocks were as big as a man's head and made large impact cavities in the ground. Pumice fell all over the island. Ash, carried by the prevailing wind covered the southwestern part of the island with a thick mantle of light gray dust. On August 5 and 6 this ash fell on Bali and on East Java.

On August 8 only white clouds of steam were issuing from these pits. In the large southern crater a plug had appeared consisting of coarse loose porous light gray block lava containing many inclusions. After this conditions were tranquil the crater could be approached without danger, one of the smaller craters threw off some ash, another went out of action at the end of August, and on September 9 a new craterlet was formed throwing out stones in the immediate vicinity of the vent and fine ash that fell all over the island.

This new eruption ceased September 25 and thereafter only white steam clouds were emitted. The three earlier craters had thrown out light gray ash, whereas the later crater ejected dark gray ash and angular blocks of old material.

A beach on the southeast shore of the island disappeared, and a steep bluff was formed by sinking of the seacoast on the south shore. Fumeroles and solfataras are found on several parts of the island about lava flows, old domes and fissures, and some of these as well as the elevated fringing reef around the island, indicate that the island is subject to fracturing by uplift. There is no previous historical record of eruption on Paloeweh.

It is of interest to note that Krakatoa was still showing recurrent volcanic activity at its submarine vent in between the three islands, as seen from the observation post and seismograph station which was established in January to keep track of the eruptions. August 25 there were 19 explosions, three upwellings and ten tremors. August 27 tremors were recorded. August 28 there were 21 explosions and tremors were increasing day by day. August 31 produced 15 explosions, seven upwellings and 12 tremors. (Bull. Neth. East Ind. Volc. Surv. No. 12, Oct. 1928.) T.A.J.

SAMPLE COPY

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No. 208 RELEASED WITHOUT COPYRIGHT RESTRICTION December 20, 1928

KILAUEA REPORT No. 882

WEEK ENDING DECEMBER 19, 1928

Section of Volcanology, U. S. Geological Survey

E. M. Buckingham, Temoprarily in Charge

No new phases have been discovered at Halemaumau. Conditions remain unchanged. Ocassional rockfalls are heard. Fresh wall scars north and northeast were observed today.

Only five very feeble local earthquakes were registered during the week. Microseisms were very slight. Tilt accumulated very slightly to the SW.

WORLD EARTHQUAKES

The literature of seismology is hopelessly dry. It consists of long lists of figures. Moreover the figures are technical and the headings of columns quite incomprehensible to the layman. There is great value however to the lists of figures for the interested experimenter, who possesses a delicate pendulum swinging free in a quiet basement room, which has suddenly begun to swing in long sweeping strokes at a certain hour of a definite date, and has then written an autograph lasting over three hours. It is unfortunate that the fascination of building and using seismographs has not taken hold of amateurs the way the construction of telescopes has done. If we had more amateur seismologists the science of the earth would progress faster. We believe the dryness alluded to above could be remedied, and that hundreds of persons might be led to take an interest in recording earthquakes and reporting on their findings, if some of the many organizations for popularizing science would start a campaign for popularizing seismology. This would be particularly welcome in such earthquake lands as California, Japan, India, Italy, New Zealand and western South America, and a comparatively simple instrument might be placed in the hands of hundreds of persons who are interested in local earthquakes by reason of their habitat.

Two documents have come to hand recently, issued by the British Association for the Advancement of Science. One is the 33rd report of the Committee on Seismological Investigations, of which the astronomer, Professor H. H. Turner, is chairman. The other is a catalogue of earthquake as registered by seismological observatories all over the world for seven years between 1918 and 1924.

The notes show that earthquakes are apt to recur at the same epicenter. In one case the same epicenter has done duty for thirty-four earthquakes. Most earthquakes are believed by measurement to originate at approximately the same depth below the earth's surface. By this is meant big shocks. Most seismologists believe this depth to be about thirty miles down. According to Professor Turner there is evidence that a certain number of earthquakes are above the normal depth in their origin, while still stronger evidence shows that some earthquakes are touched off from very deep foci, and so shake a very large area of the surface of the globe.

In the Committee report we learn that there is not a single day during the whole seven years on which no earthquake was recorded, though there are many days on which shocks were recorded at one or two observatories only.

The monthly counts of epicenters show that twenty-nine large earthquakes occur somewhere in the world most months, and that September for this group of seven years has more earthquakes than any other month. The figure for September is fifty-one, even leaving out the exceptional year 1923 when came the Tokyo disaster with its many aftershocks in September. To judge by the table of averages shown, there are more in spring than in winter, more in summer than in spring, more in September than in summer months, and then a gradual decline to a low level in frequency in January.

There is an interesting note on vertical component seismographs. It is well known that the elasticity of a suspension spring is liable to changes when temperature varies. With the Galitzin vertical pendulum a change of 1° C. in the temperature of the apparatus is sufficient to put the instrument out of action.

At Strasbourg a spring made of elinvar, an alloy with a low-temperature coefficient for elasticity, has been in use for some time. Such a spring tested at Kew Observatory is found to yield continually under the load, but the effect of ordinary temperature change is almost eliminated.

The work of the International Seismological Summary published by the British Committee every quarter is a very useful and valuable adjunct to every earthquake station. It must be very laborious to compile. The seven-year catalogue is a digest of this summary, and is intended to reach geologists and geographers, so as to interest them in using the statistics of latitude and longtitude and numbers of earthquakes, in connection with their field knowledge. We believe that this catalogue would be still more popular if it could have two columns added to the tables; one to express the general locality of the epicenter in a geographical name; and another to express the probable intensity or "size" of the earthquake in terms of its seismographic range. It is true that the number of stations represented is somewhat a measure of extent but it would seem that an obvious aftershock ought to be labelled as different from a world-shaker. T.A.J.

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No. 209 **RELEASED WITHOUT COPYRIGHT RESTRICTION** December 26, 1928

KILAUEA REPORT No. 883

WEEK ENDING DECEMBER 26, 1928

Section of Volcanology, U. S. Geological Survey

E. M. Buckingham, Temoprarily in Charge

There has been a slight increase in the working of the Halemaumau walls. It is believed that this is due to possible fluctuations of the Kilauea floor as indicated by tilt measurements.

On December 20 considerable steam was escaping from the south cone and a vent on the SSE. talus. On December 23 an avalanche from the NNE. wall was observed at 3 p. m. On December 26 there was evidence of avalanching from the north and east walls, and dust from two slides was seen. Several falls of rocks were heard.

There were six very feeble local earthquakes registered during the week. In addition were two perceptible shocks having epicenters from 10 to 12 miles southeast of the Obseravtory. The first, at 8:43 p. m. December 24, was accompanied by a tilt at the Observatory of seven seconds to the north. The second shock occurred at 10:13 p. m. December 25. Tilt for the week accumulated slightly northeast.

Measurements made at the Halemaumau seismograph station on December 19 and 26 indicate a tilt of 10 seconds away from the pit during this interval. Tilt has been slowly accumulating in this direction since the early part of November.

EXPECTED HAWAIIAN ERUPTION

In 1912 the writer wrote that Mauna Loa should become active before 1915; it broke out in 1914. In 1917 he wrote that a great crisis in Hawaiian volcanism should come around 1920; both Mauna Loa and Kilauea had flank outflows within the twelve month preceding July 1, 1920, and a great explosive crisis came in 1924. In 1923 he wrote that the nine year cycle following 1913 would probably be unusually long and representative of one of the long term intervals such as 1868 and 1790 had illustrated; the 1924 engulfment accompanied by shore collapse at Kapoho was a close parallel to 1868. All of these tests of reasoning with reference to forecast are merely based on observation and experience, coupled with a logical deduction from the records of the nineteenth century.

Experience has shown that in Japan, Italy, Hawaii and the Caribbee Islands, one hundred and thirty years or some such figure is a common interval between either big eruptions or big earthquakes near eruptive centers, or both. On the other hand Vesuvius and Kilauea both exhibit a minor interval of from nine to ten years, and the larger volcanoes Etna and Mauna Loa tend to average their outbreaks at intervals of one half this period, or about four and one half years. Mere charting of the facts for the last thirty years has shown a distinct tendency in the pit-lava of Kilauea to rise when Mauna Loa breaks out, and to sink when Mauna Loa stops action. These things are not invariably observed, for the simple reason that the Kilauea lava column is not always visible.

It is not permissible to say that Kilauea and Vesuvius shall break out every nine years, or Mauna Loa and Etna every four and a half years. A volcano is not a clock. The interval theory is based on averages, and the averages are based on certain laws of nature such as those that determine the space intervals of ripple marks in the sands of the sea or the time intervals of waves when they break rythmically on the beach. The lava under a volcano has been pressing upward for ages through a crack of a certain size. It has blocked or impeded that crack with its own heap of lava and so has forced itself to adopt a rhythm or interval like the puffs from a steam engine. If it has several vents, these divide responsibility for the interval, and if one vent is low and close to the water table, while the other is high and far above the ground water of the island, the probability of explosion is greater for the lower vent. This is because a sudden drop in the lower vent may place the lava column below the water table and so develop a steam chamber. This is the situation of Kilauea as compared with Mauna Loa.

The whole great edifice or volcanic system is itself involved in responsibilities to large masses of lava underground which it perhaps shares with other active or half extinct volcanic systems along the same rift or crack, and these responses may demand certain major eruptions or major dormancies at very long intervals of time, when the whole crust of the earth for that part of the world is disturbed to an unusual extent. It is like the intake and outgo of a large corporation, itself made up of the accounts of smaller stores. One must know all the books or the accounts will not balance. So when we argue about the expectancy of eruption at Kilauea, we must take account not only of average small intervals and average great intervals but also of the volume of output of lava in relation to the intervals as compared with the volume expected by analogy with average eruptions in the past.

As compared with the outpourings of 1852, 1855, 1859, and 1868 the lava output of the island of Hawaii in the last eighteen years has been very small, unless there has been an enormous unseen lava flow under the ocean. Yet there are many features of the flows of 1914, 1916, 1919 and 1926 from Mauna Loa, and the intervening effusions about the crater of Kilauea, that closely resemble the double cycle that followed 1850. We have platted a curve of the combined activities of Mauna Loa and Kilauea, which shows a pronounced low level about December of 1913 and December of 1924, and a remarkable high level about December 1919. The lava of Kilauea rose rapidly after 1913 with arresting depressions after each Mauna Loa flow. After 1924 the lava has risen slightly in the bottom of Halemaumau pit and Mauna Loa flowed vigorously in 1926. If the curve of rising now continues comparably to what happened after 1913, it is logical to expect activity from either Kilauea or Mauna Loa in 1929. T.A.J.