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

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TITLE PAGE AND INDEX FOR 1926

(Nos. 54 to 105)

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No. 54 RELEASED WITHOUT COPYRIGHT RESTRICTION January 7, 1926

KILAUEA REPORT NO. 730

WEEK ENDING JANUARY 6, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The first week of the new year finds the Hawaiian volcanoes quiet. The last lava activity was at the end of July, 1924, when for a fortnight basaltic frothy lava spurted up vigorously amid the debris in the bottom of Halemaumau, the Kilauea pit. This was the return of lava through the engulfed material of the explosive eruption that had preceded. During the last year and a half the pit has gradually become quieter with respect to avalanches from the walls, and sulphurous emanations have lessened. There is no sign of new activity on Mauna Loa.

During the week at Halemaumau there have been some dusty slides. the weather has been dry and white sulphate coatings are abundant on the walls of the pit and on the 1924 ash in the desert. Flocculent steam boils out voluminously from wall and talus vents about the bottom and rim of the pit. It was discovered that a large pinnacle of the rim rock at the south edge has fallen. The taluses have grown higher during 1925. Today slight sulphur odor was perceptible at southeast rim. The north corner of the pit "works" with rock slides more than elsewhere.

Seven quakes were recorded on the 4th, 5th and 6th. Two on the 5th should have been perceptible and caused squawking of peasants. Tilt was slight NE.

HAWAIIAN EARTHQUAKES IN 1925

During the year 1925, 922 local earthquakes were registered on the observatory seismographs. Of this number only 49, or a little over five per cent were strong enough to be perceptible to human beings at Volcano House. The distribution of the earthquakes by months is shown in the following table:

Month	Number of earthquakes	Month	Number of earthquakes
January	94	July	109
February	94	August	94
March	79	September	102
April	70	October	50
May	83	November	48
June	51	December	48

R.H.F.

TWELVE YEARS RECORD OF EARTHQUAKES

From the time that seismographic records were first kept at Hawaiian Volcano Observatory, the summer of 1913, to the close of 1925, 12,264 local earthquakes were registered. The yearly totals are shown in the following table:

Year	Number of earthquakes	Year	Number of earthquakes
1913	167*	1920	211
1914	274	1921	279
1915	456	1922	921
1916	1319	1923	650
1917	207	1924	5877
1918	281	1925	922
1919	700		

*For last 6 mos. of year only.

The yearly average for the 12 complete years, 1914 to 1925 inclusive, is 1022. This value is over twice that for Italian earthquakes. (Volcano Letter No. 42, 1925.)

The majority of the earthquakes occurred in swarms at times of crises, such as outbreaks of Mauna Loa, movements along one of the Kilauea rifts, or collapses in Halemaumau. In 1922, for instance, about 645 of the 921 earthquakes for that year were due to a collapse of Halemaumau and the opening of the northeastern rift of Kilauea. If appropriate deductions for such swarms are made from the total number of earthquakes for years with molten lava in the pit the yearly average becomes about 230. The years 1917, 1920, and 1921, during which molten lava was continuously present, were without great crises and it will be noted that the 230 is comparable to their totals, 207, 211, and 279 respectively. The average per month for quiet times with lava in the pit is then about 19. 1925 furnishes a year for giving the monthly average for quiet times without molten lava and gives 77, or about the same as when all earthquakes are counted.

The greatest total for any month for the 12 years is 5313 for May. The May total is swelled by great swarms of earthquakes in three different years. Aside from the June total of 1680 which was affected by the swarms begining in May, April furnished the next monthly total with 672 shakes. The least of the monthly totals is 285 for February.

R.H.F.

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No. 55 RELEASED WITHOUT COPYRIGHT RESTRICTION January 14, 1926

KILAUEA REPORT No. 731

WEEK ENDING JANUARY 13, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The week has had northeast winds and dry weather at the Volcano, and no activity has appeared. Avalanching in Halemaumau pit, however, has been more or less active in small slides so as to carry away much of the north wall over the west horn of the large intrusive sill. On January 9 the north station flag was in place and on the 10th it had fallen in; a big slab of rim rock 15 feet wide was left hanging out over a very precipitous bluff, backed by a large crevasse. The soil was freshly cracked 30 feet back.

Six earthquakes were registered, the one at 10:07 a. m. January 11 being felt at Hilo as a slight vertical jolt. Tilting at the Observatory was moderate NE.

PROTECTION AGAINST VOLCANIC DISASTER

Two articles on this subject have recently appeared, showing that the twentieth century has made progress in knowledge and education about volcanology. (Materials for the study of Calamities, Soc. Geog. Geneve, under the Red Cross, No. 3 A. Brun, No. 6 K. Sapper, 1924 and 1925.) Some practical results of this progress have been seen in the better handling of Vesuvian and Etnan eruptions than in the case of the Pelee disaster, and in the still better preparation and protection at Sakurajima in Japan. Also Java and Hawaii have cared for disasters with science and forethought, and all these places are giving attention to economics, transportation, construction and organization for crisis, as never before.

Brun mentions abnormal deflection of the magnetic needle in eruptions, the study of earthquakes at volcanoes, the registration of sound-waves, measurement of ground temperatures, chemical analysis of gases, the use of aviators for reconnaissance, and the steady observation of crater, hot spring and fumerole processes, as being the fundamental occupations for a volcano observatory.

Sapper states that 190,000 people have been killed by volcanoes in the last four centuries, 93 per cent of the deaths were about the Pacific, and the maximum loss has occurred at volcanoes erupting only once with such violence, and after long inactivity. Each volcanic system has its peculiar type of eruption.

Sapper does not agree that a rise of temperature, the appearance of new vents, underground noises, exhalation of gas and local tremors are themselves sufficient evidence of a coming eruption, citing Cotopaxi, Kilauea, Awoe, Kloet and others as breaking out without such signs. He thinks in thinly populated districts Brun's proposals for observatory work would be too costly. He suggests popular propaganda and education in schools concerning precautions, building regulations, sites, steep roofs to shed ash, and readiness to migrate in case of danger. Avoidance of valley bottoms is a measure suggested against possible lava flow. Famine and disease may be caused by heavy ash fall as at the Tambora eruption of 1815, 44,000 deaths, and the Laki outbreaks of 1783 when a fifth of the population of Iceland and most of the livestock were killed. This sort of happening may be met only by governmental insurance reserves, and rehabilitation as at Sakurajima. Volcanic flood waves on the shore, the boiling over of crater waters, the downrush of snowy melted avalanches, the dispersal of ash by wind, have all been the causes of immense suffering and destruction of life and property. All that can be done is to educate the populace that what has happened before may happen again, and to be ready with measures of relief. For the volcanic lands are fertile and the volcanic seas rich in food supply; people will live there.

Earthquakes and earthquake sea-waves have caused vastly greater losses of life and property than all the volcanic eruptions put together. Lava streams and their secondary effects such as melting snow floods account for only two per cent of volcanic disaster. Explosive eruption on the Pacific half of the earth has done almost all the volcanic damage.

The reviewer would summarize prediction, prevention and protection at volcanoes as requiring the following:

(1) Scientific knowledge and education; economics, construction, insurance, investigation, preparation.

(2) Forewarning, organization, administration in crisis, transportation, policing, housing and food.

(3) Protection, prevention of disease and famine, rehabilitation.

With reference to scientific research, our experience in Hawaii places first those recordings and measurements not dependent on visible lava or actual crater activity, but rather on intrusive magma always present underground; tremor, tilt, level changes, temperatures, and the chemistry of gases and salts. The position of earthquake centers and the distribution of volcanic centers for the district appear to be vital matters. It remains for geophysicists to prove whether there is any value in gravity, magnetism, sound and meteorological controls for volcano diagnosis. It remains for geologists to prove whether an explosive eruption is anything more than a big geyser due to superficial water reaching a lava chamber. T.A.J.

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No. 55 RELEASED WITHOUT COPYRIGHT RESTRICTION January 21, 1926

KILAUEA REPORT NO. 732
WEEK ENDING JANUARY 20, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

On January 14 the northeast wall or Halemaumau had been working sufficiently to open new cracks in the soil ENE back from the pit rim. The N corner was making noisy avalanches. On the 16th the pit was dry and quiet. On the 18th the big sill NE and N had been peeling as shown by gray talus below.

In the very early morning hours January 19 the roars from avalanches were heard and light southwesterly wind brought the dust to the Observatory in droplets of mud rain. By daylight the east floor of Kilauea was seen to be coated with red dust. In the forenoon the northern walls were working strongly, and at 9:45 a. m. a spectacular avalanche at the north corner of the pit made a salmon-colored cauliflower cloud. There was fresh gray talus NE and red N.

Seventeen earthquakes were registered. One at 12:33 p. m. January 16 indicated origin-distance 14 miles and was plainly felt in Hilo. Thirteen of the shocks were on the 18th and 19th, when avalanches were numerous at Halemaumau. Tilting was moderate SW; seasonal change from NE to SW is expected about this time of year.

THE EARTH'S MAGNETISM

There are several reasons whereby volcanology is interested in terrestrial magnetism. At Kilauea in 1913 J. W. Green of the U. S. Coast and Geodetic Survey determined differences of declination of 16 degrees near the fire-pit, and of over 5 degrees about the greater crater. All kinds of basaltic lava fragments deflect the needle, even the Pele's hair. In 1902 when the volcanoes Pelee and Soufriere exploded violently in the Caribbee Islands, a horizontal disturbance was noted at many magnetic stations about the world starting at almost the minute of the St. Pierre destruction and lasting thereafter for several hours.

The conception of the earth as a great magnet with its poles near to its axis of rotation was long considered untenable. It was supposed the heat of the earth's interior would demagnetize it. (See D. L Hazard, The Earth's Magnetism, Special Publication 117, 1925, U. S. Coast and Geodetic Survey). In view of current beliefs, however, in a ferruginous lava substratum and a terrestrial core of nickel-iron, and recent investigations suggesting that these materials under high pressure may have magnetic properties even though hot, magneticians are again turning to the earth-magnet idea.

What is earth magnetism, what causes it, and what causes it to change? Cathode rays, the electronic theory of matter, the constitution of the sun and the earth are all being studied in this connection. When it was thought that the hot globe could not be a permanent magnet, a mathematical analysis was made to see whether our magnetic field might be due to electric currents flowing around the earth, making the sphere an electro-magnet. Such an analysis by Bauer in 1922 showed that 94% of the field is internal, with 3% external and 3% representing a non-potential system. His results indicated that the intensity of magnetization of the earth had decreased during the last 80 years at a rate irreconcilable with the age of the earth and the present intensity of its magnetism, unless we suppose that there have also been periods of increasing intensity. This is interesting in comparison with Joly's idea of increasing evolution of the latent heat of radioactivity at long intervals. (See VOLCANO LETTER, nos. 3, 37 and 40, 1925.)

The laws governing the mutual attraction and repulsion of moving positive and negative electrons probably cause the phenomena of gravitation, and there is a growing belief that gravitation and terrestrial magnetism are probably to be traced to a common origin. As volcanism on the earth and sun is intimately associated with the physics of hydrogen, and electronic motion has a similar association, it would appear that volcanism, gravitation and magnetism may be cousins.

The variations of earth magnetism take the form of magnetic storms, diurnal variation and secular variation. Magnetic storms are irregular disturbances of short duration. They occur almost simultaneously all over the earth. Like auroras they coincide with large sunspots, but the coincidence by averages is better than that by individual cases. Magnetic storms may be due to streams of electrified particles shot out from the sun. Hale at Mount Wilson has shown that the sun has a magnetic field, and that pairs of sunspots have opposed polarity, with remarkable reversals of polarity in the two hemispheres every 11 years.

The daily variation of magetism is a function of the position of the sun above the horizon for any place, and so is independent of absolute time. The extremes occur in daytime. There is a slight effect during a solar eclipse. It is supposed a solar electrical emanation by way of the upper atmosphere affects electric currents flowing about the earth.

The secular change of terrestrial magnetism does not agree with the notion that a systematic change in the magnetic axis of the earth causes it. The periodic change every 11 years in numbers of sunspots, is paralleled by an 11-year period in the secular magnetic change. Bauer and Abbott are working toward a relation between magnetism changes and the variations in the sun's heat. Here again thermal controls, as in volcanism, may be closely related to magnetism. All three types of magnetic change in the earth appear to be related to the sun. This has given new interest to the study of atmospheric electricity and earth currents.

T.A.J.

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No. 57 RELEASED WITHOUT COPYRIGHT RESTRICTION January 28, 1926

KILAUEA REPORT NO. 733
WEEK ENDING JANUARY 27, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

As the end of January approaches nothing new has yet been inaugurated for 1926 in the way of Hawaiian volcanic activity. Seismic motion is sufficiently in evidence, with tilting of the ground and high temperatures at some places, to indicate to the observers that Kilauea and Mauna Loa are just as active as ever underground. The quiet spell that followed upon the explosive eruption of 1924 has not yet endured for any unusual length of time. The excessively hot spots where a stick may be lighted at the surface of the ground, on the summit of Mauna Iki in the Kau desert, where lava was flowing in 1920, show some sign of growing hotter. Sticks may now be lighted at two different areas. The well drilled in the Kilauea floor 80 feet deep in July, 1922, shows a temperature today, 67 degrees Centigrade, only 2° cooler than when it was drilled, and adjacent steaming cracks at 57° are 2° hotter than they were then. There is no sign of cooling or diminution of sulphur deposit at the Sulphur Bank near hotel.

Halemaumau the lava pit has been dusty with small slides from the steep north wall, but avalanches have not been so big as during the previous week. On January 23 the bottom was dusty but sulphur-stained spots on the east floor were not obscured at all. The talus slopes were red with fresh debris at the north, and with broken gray fragments of the big sill at the east. All along the wall that overlies this large intrusive sill the steepest overhang is maintained, and motion of sliding and breaking away of the edge of the pit has been stronger and more continuous there for a year than anywhere else. This dense white ledge was red hot after the 1924 eruption, and it seems as though its peeling and undermining of the wall above must be connected with its heat.

At the Observatory during the week 15 local seismic movements were registered, all small, and a few were of the type that accompanies avalanches at the pit. Tilt was slight to the SW.

A large distant earthquake was registered at 2:16 p. m. January 24, the vibrations continuing for over an hour. The distance indicated by the preliminary tremor on the gram is 3600 miles, equal to that of the ocean off Central America or Japan, or of the western Kurile Islands, the Bonin Islands or the Guam region. A tidal wave from it would have reached Hawaii about 10 p. m.

FOREWARNING OF TIDAL WAVES IN HAWAII

A terrific earthquake happened somewhere at a quarter past two in the afternoon of January 24 by Hawaiian time. It was well registered by the Kona and Kilauea seismographs of the Hawaiian Volcano Observatory. Its long slow waves exhibited on the seismogram sheets were preceded by preliminary quicker vibrations lasting 7 minutes, 25 seconds, indicating a distance of transit of the waves of compression through the earth of 5800 kilometers or 3600 miles; the origin might have been in the deeps of the Pacific off Salvador or off Japan, in which cases a water wave of 20 minutes period and over 100 miles amplitude might have been sent across the ocean. (See R. H. Finch, On the Prediction of Tidal Waves, Monthly Weather Review, March 1924, p. 147.) The time taken by the first rock vibrations to travel from the source to Hawaii was 9 minutes and 19 seconds.

The time of transit of a sea wave for approximately this distance, is dependent not only on the distance, but also on the mean depth of the ocean between the locality where the bottom of the ocean is suddenly displaced, and the coast which the wave reaches. The observed velocities of the water waves range from 3 to 8 miles per minute. From observed and computed velocities, Finch has determined in Hawaii, that the transit time of the seismic rock waves making the first preliminary seismograph vibrations, is very nearly equal in minutes and seconds to the hours and minutes taken by the water waves. Thus on the morning of February 3, 1923, a big earthquake somewhere in the north Pacific estimated 2200 miles away from Hawaii, at 5:32 a. m., made seismograph record at Kilauea 5:39 a. m., seven minutes after the shock occurred, and the water wave reached Hilo in Hawaii about 12:30 p. m., seven hours after the shock occurred. This same wave reached Honolulu's island, Oahu, thirty minutes before it reached Hilo; the distance is 225 miles northwest. The Hawaiian islands are thus a valuable gauge for the progress and direction of seismic sea waves, particularly as these waves travel all the way from Alaska to Australia, or from Chile to Japan.

Many more tidal waves may occur than are reported, when they are so small that only tide-gauges register them. The times of such tide-gauge registrations deserve more attention by seismologists than they have had, for they would yield valuable lists of transit times for water waves at different distances and through waters of different depths. These lists could be compared directly with earthquake centers, times and distances, as computed by seismograph publications.

Finch cites an earthquake in the Kamtchatka region September 7, 1918, distance 3200 miles, water wave 8 miles per minute, doing some damage in Hilo. Another southwest of Hawaii in shallower waters, the water wave reaching Honolulu at 4.7 miles per minute and San Francisco at 5.9 miles per minute. The Chilean earthquake sea-wave of November 11, 1922, travelled to Hilo at 7.5 miles per minute and registered on the seismograph early enough for a prediction of its coming over nine hours in advance. A Kamtchatkan earthquake 3200 miles away April 13, 1923, registered here at 5:17 a. m. and made a small tidal wave at Hilo at 12:40 p. m. In general the very dangerous tidal waves would be due to very big earthquakes a few hundred miles away, the water wave arriving on a shelving shore in from 3 to 6 hours, and the rock vibration arriving in from 3 to 6 minutes, thus giving several hours warning.

T.A.J.

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No. 58 RELEASED WITHOUT COPYRIGHT RESTRICTION February 4, 1926

KILAUEA REPORT NO. 734

WEEK ENDING FEBRUARY 3, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

There has been no change during the week to indicate any new activity in Kilauea or Mauna Loa craters. The pit Halemaumau gave up a dust cloud due to avalanche about noon January 28. At 1:45 p. m. slides were moving down a vertical notch grooving most of the height of the east wall athwart the end of the big north intrusive sill. This filled the air with dust along the bottom region of the east wall. The pit was dry. Nothing new was observed January 30 and February 1, no glow in the evening could be detected anywhere inside the pit, but the northeast talus was observed to be growing high and sharp-pointed. The interior surfaces were quite dusty February 2. About noon this day a rock slide fell from the west wall of the larger Kilauea crater.

Nine earthquakes were recorded during the week, one of these at 8.18 a. m. January 28 being in the perceptible class. Tilting was slight NNE. The weather was the coldest for the winter so far, and drought continues.

DAY'S THEORY OF PRESENT-DAY VOLCANISM

After quoting the evidence from Kilauea and Lassen, Dr. A. L. Day reaches the conclusion (Some Causes of Volcanic Activity, Journal Franklin Institute, August 1925) "that volcanoes are local and superficial developments representing (geologically) the last stages in crystallization in a mass of magma below, of which little remains fluid, and this in small (as geologic dimensions go) pockets, which are quite variable in gas content, pressure and conditions of chemical equilibrium." "The outstanding factor in determining the character of modern volcanism is the gas content of the crystallizing magma. If this be mainly of steam released in a closed chamber, as at Lassen Peak, then only steam explosions are to be expected as the surface manifestation of the crystallization of the magma below; if to the steam are added such chemically active gases as chlorine, sulphur, hydrogen and the hydrocarbons, then chemical reaction between these will be a sufficient cause of higher temperatures and lava flows of the character well known at Vesuvius, Stromboli or Kilauea."

The supporting evidence for this theory cited is:—The temperatures in Kilauea lava lake are very variable; the viscosity of the material in the lava basin is diversified; gases maintain fluidity remarkably and more gas brings more heat: the gases are variable and not in equilibrium; surface temperatures are hotter than those below; the Lassen eruptions on the other hand showed little red heat; they produced merely great explosions of water vapor; the Kilauea pit after the 1924 explosive eruption showed red hot crystalline bodies and possible lateral vents; on other occasions it has shown lava flowing from different levels. All this is summed up as proving that "the heterogeneous character of the gases collected, the temperature conditions within the lava basin, the appearance of the crater when free of all its liquid lava, and the dynamic relations within the lava body when present in the crater, all point to many sources rather than to a single source both of gases and of magma." Day thinks that the great Tertiary floods of lava of Africa, India and North America may have been from a crustal substratum, but that modern volcanoes have no such source. T.A.J.

THE ERUPTION OF SANTORIN

The activity of this volcano in the Grecian archipelago cited in the VOLCANO LETTER of October 22, 1925, has continued (H. S. Washington, Jour. Wash. Acad. Sci. Jan. 4, 1926) and is likely to last for a year or more. The general quality of its stiff aa lava flows and explosions recalls Sakurajima. The active central islands are in the midst of an oceanic lagoon about seven by five miles in diameter, partly enclosed by the inhabited islands Thera and Therasia; the lagoon is probably an ancient engulfment crater. The present eruption was started by small earthquakes in July, 1925 and during the first nine days of August an islet was built up in a strait between Mikra and Nea Kaimeni. By vulcanian explosions and hypersthene andesite flows this filled the strait and united these island conelets. The water was heated to nearly boiling, and 69 degrees C. was measured.

The lava piled up several meters and on October 27 the eastern flow was still moving into the lagoon. Another flow was moving on the land. Steam and sulphuretted hydrogen were given off. The lagoon water was colored orange with iron hydroxide. The new hill formed, Fouque' Kaimeni, was 75 meters high and 120 meters in diameter. It was a fissured incandescent dome continually changing with violent explosions making cauliflower clouds and throwing showers of rocks. Elsewhere there were hissing steam jets and 'coronet' jets from encircling incandescent crevices. Bluish, yellow and red flames played over the lava dome. T.A.J.

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No. 59 **RELEASED WITHOUT COPYRIGHT RESTRICTION** February 11, 1926

KILAUEA REPORT NO. 735

WEEK ENDING FEBRUARY 10, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

There has been some avalanching in Halemaumau during the week, seismic activity has been feeble at Kilauea, but an earthquake was felt in Honolulu and on Maui about 11:28 a. m. February 7.

On February 4 conditions in the pit were quiet. February 6th there was fresh talus NE, new cracks were found in the soil WNW of the pit, and small slides occurred SW and NE after 3:30 p. m. Light southerly wind caused the gas from the pit to nucleate and make visible the northerly steam jets on the Kilauea floor. This nucleation effect was noted at 5:30 p. m. February 7 in the western floor jets of the pit itself, which at first appeared feeble, then changed to densely flocculent steam tails without any apparent cause. Dust does not nucleate the steam, as shown February 10 when a northeast gale filled the pit with dust. Feburay 8th the northeast wall was dropping rock in bunches every few minutes and making red cauliflowers. The gale of the 10th, which blew down a chimney at Volcano House, did not seem to start avalanches.

Six earthquakes were registered, including a tremor simultaneous with the Honolulu earthquake, apparently a coincidence merely. Tilt was strong SSW.

DALY'S THEORY OF VOLCANISM

It would be hard to imagine any more completely different explanation for the same phenomena than is R. A. Daly's doctrine of the cause of volcanic action, as compared with the crystallization-pocket theory of A. L. Day cited last week. (Daly, R. A. Relation of mountain building to igneous action, Proc. Amer. Phil. Soc. LXIV, 2, 1925, pp. 283-307). Daly is geologist at Harvard, Day is physicist and director of the Geophysical Laboratory at Washington.

Daly makes the fundamental cause of volcanic action a rising of molten rock from the interior. Fluxing gases from such an injection are responsible for the long lives of ordinary volcanoes. Effervescence of the gas-charged slag is one of the conditions for lava outflow. Gas pressure is one of the causes for the initial rise of this material. But it is not the main cause.

The main cause is the weight of the crystalline crust of the earth, which from time to time breaks so that the continental blocks slip or glide sideways, underlain by a thick shell of hot basaltic glass, which is rigid but weak. This hot basalt, released of pressure, rises into tension cracks that open when the broken continents slide toward lower basins of sedimentation (oceans).

The migration of crust blocks of continental dimensions, over a substratum of lava-glass which is easily strained by prolonged pressure in one direction, is the Wegener "drift theory" of the origin of continents and compression of mountain chains. The existing continents broke away from an Asia-Europe center, migrating toward the Pacific both westward and eastward. The crust is some 40 miles thick. The substratum is "slippery." The continental movements have been like great landslides, leaving widening tension cracks behind, which are now the Arctic, Atlantic and Indian oceans. These have shore-lines peculiar to such origin. The Americas and the Australia-Asia blocks migrated towards the Pacific center, "folding and rafting together" the strata downstream, and so crumpled up and finally lifted the mountain ranges of the Cordillera, the Andes and eastern Asia and Australia.

The granite intrusions of the mountains are accounted for by Daly as follows. At the front of the advancing continents huge crust fragments sank in the lava substratum. There they were melted and produced solutions more siliceous than the original basic glass. New gases from limestones were introduced into the melts so formed. These account for the concentration of alkaline lavas and intrusions. This deeply assimilated matter was injected into or through the crumpled mountain sediments as granites, diorities, rhyolites and andesites.

This explanation is said to accord with the tidal-disruption theory of earth origin, which demands a primitive molten stage for the globe, and a thin crust. Proofs for the basaltic under-layer are the computed deep temperatures, too high for crystallization (See Volcano Letter No. 3, January 15, 1925). Isostatic balance implies plasticity in the substance beneath the crust (See Volcano Letter No. 48). The sinking of sedimentary basins, and their great squeezing together and shortening long before they are lifted and eroded into mountains, are facts that appear to agree with the idea that a substratum makes room for them and that something advances to crush them. The tension cracking and sinking of large areas of the crust of the earth over which basaltic floods of lava have poured out, and the repeated upgushing of black "trap rocks" as dykes in all geologic ages, are evidences of a basaltic underpinning capable of effusion when the crust breaks up above it. Such broken and flooded areas are the great rift of Africa, the Deccan of India, the Columbia basin of Idaho and Oregon, and the Bushveld of the Transvaal.

Earthquake wave caculations show sudden changes in substance, of layers of the globe 35 and 75 miles beneath central Europe. The rock is believed to change from siliceous to something heavy like basalt 35 miles down. Such a change is estimated to be only 15 miles down under the Atlantic, and is absent under the Pacific. T.A.J.

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No. 60 RELEASED WITHOUT COPYRIGHT RESTRICTION February 18, 1926

KILAUEA REPORT NO 736

WEEK ENDING FEBRUARY 17, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in charge

There is nothing to say about the Hawaiian volcanoes for the past week to the effect that they have changed in any perceptible or measurable way. They are dormant. In Halemaumau there is moderate quantity of bottom vapor, little stones fall occasionally from the walls, no dust over the pit has indicated internal slides, and the only fresh debris on the talus is on the northeast side where there were slips last week. The vapor jets are less condensed in dry weather, and in such weather a greenish yellow sulphate patch may be seen on the lava floor.

Six local seisms were registered, very small, two of them being of the avalanche type. Long waves of a distant earthquake, of small amplitude, were recorded at 5:00 p. m. February 14. Tilting of the ground during the fore part of the week was to the NE, later to the SW, the net result being slight ESE.

HOBBS' THEORY OF VOLCANISM

Professor W. H Hobbs of the University of Michigan bases his idea of volcanic action on a conception of pockets of melted sedimentary rocks. (Earth Evolution, Macmillan, 1921.) He believes in giving up the notions of permanence of oceans, of nebular origin for the earth, of intrusive rocks being connected with a substratum, of earthquakes having an epicenter, of subterranean flow and outthrust from Asia of mountain-forming pressure, of isostasy, and of tensional stress anywhere. Compression is the rule. Strata of stiff limestone arched up over shale by compression, the rocks being restrained from melting only by pressure, relieve the pressure on the hot shale so that it melts. Laccoliths are formed by this mechanism, and according to Hobbs have no feeding dykes below.

Proofs of the hypothesis are adduced as follows: The planetesimal theory is right and calls for no molten planet. On the basis of Gutenberg's 1914 conclusions from earthquake wave velocities, the center of the earth is like the stone-iron meteorites, next outward comes a layer of heavier nickel-iron, then meteoric stone of density 3.6, and outside is a thin rind of sediments and igneous rock. The fusing point is elevated with increase of pressure. Mountain forming sediments are under great pressure and very hot. Local release of pressure will fuse them. The interior of the earth is proved rigid by physical experiments, hence cannot be molten. Water greatly lowers fusion point and sediments contain water. In pegmatites all gradations exist between water solution and rock melt. According to Hobbs less than five per cent of the igneous rocks are as heavy as the lightest of the meteorites (he appears to take no account of the possible distribution of basalt under the bottom of the sea). And finally, the average composition of shale is like the average composition of the igneous rocks.

This last argument is developed at great length, and groups of slaty sediments are said to constitute petrographic provinces just as igneous rocks do. No argument is brought forward, however, to show that any gradations are anywhere found between unmelted and melted shales in the hollows of folds.

It is granted that normal faulting means extension of earth surface area, apparently, but Professor Hobbs thinks the overwhelming proof of shortening of the surface everywhere is that rails, pipes, bridges and masonry always buckle in earthquakes and never stretch. The reviewer has before him a photograph of a curved water-pipe in Hawaii subjected to the Puna earthquakes of 1924, which was pulled out to a straighter curve, and can recall other cases of tension in earthquakes. The fallacy of the Hobbs position appears to lie in the much greater difficulty of proving tension, whereas buckling is easy and obvious. Hobbs states that in those lenticular intrusions called laccoliths, "the supposed conduit feeders have never in a single case been discovered." This is simply an error. (Laccoliths of the Black Hills, by T. A. Jaggar, 21st Annual, U. S. Geological Survey.)

Other evidences cited for the shale-melting origin of lava are that the gases in sediments are like those in volcanoes, that the limited range in chemical composition of magma is accounted for, and that this composition is systematically different in block-faulted regions from folded regions. Professor Hobbs believes that geologists have over estimated the span of geological time because the science grew up around the Atlantic where processes are slow.

T.A.J.

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No 61 RELEASED WITHOUT COPYRIGHT RESTRICTION February 25, 1926

KILAUEA REPORT NO. 737

WEEK ENDING FEBRUARY 24, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in charge

In Halemaumau pit everything remains quiet. About the 19th sliding made fresh debris NE. During a half-hour February 22nd one slide occurred on the NW wall in the afternoon, and one NE in forenoon of February 23 while it was raining. The rain greatly augmented the steam jets in pit.

Eleven tremors occurred, six of them February 18 and 19 of avalanche type. A shake 7:39 a. m. February 21 was felt, though very small, as a single bump with a cracking noise, followed by rumble. The slip that caused it appeared to be close to the Observatory. Tilting for the week was moderate NE.

TILT AND CHANGES OF ELEVATION, KILAUEA

In VOLCANO LETTER No. 41, 1925, it was shown that there was a marked subsidence of the top of Kilauea mountain accompanying strong southwest tilt at the Observatory from 1921 to 1924 inclusive. Referred to the bench mark in front of the Volcano House one point near Halemaumau, the great pit in Kilauea crater, about two miles away, sank five feet and another nine feet. These amounts must be corrected for whatever movement took place at Volcano House.

In June 1925 R. W. Hendry, engineer, Department of Public Works, Territory of Hawaii, ran a level line to the Volcano House bench mark from a point about six miles down the mountain toward Hilo, in Puna district. Mr Hendry found that the bench mark where the Crater Hotel formerly stood, one and one-fourth miles from Volcano House, was relatively down 3 32 feet and the one at Volcano House down 3 97 feet. The ground at Volcano House sank 0.65 foot more than at Crater Hotel site. Some such difference is to be expected as the Volcano House bench mark is about one-half mile nearer Halemaumau, the place where maximum sinking is suspected, than the one at Crater Hotel. The actual sinking of the two places near Halemaumau is, therefore, about 9 and 13 feet respectively, relative to Hendry's datum mark, itself up the mountain about 24 miles from Hilo. A new level line has not yet been run all the way to sea-level. R.H.F.

BOWIE ON VOLCANISM AND ISOSTASY

The leading American expositor of the doctrine of isostasy, W. Bowie, considers volcanism superficial. (Geology from the isostatic viewpoint, Scientific Monthly, January 1926; Journal Franklin Institute, August 1924 and other papers). Dr. Bowie is chief geodesist of the U. S. Coast and Geodetic Survey. He writes "mountains are not formed where the crust is weakest, but where conditions are favorable to the expansion of crustal matter. Volcanoes are due to local causes," citing Day and the Geophysical Laboratory. "Active volcanoes seem to be only in areas of recent uplift or where uplift is still taking place. Volcanoes probably are mere incidents to the processes involved in the decrease in density and increase of volume of crustal material."

"It is probable that earthquakes are phenomena caused by local processes. Earthquakes probably are incidents to the up-movement of materials when mountains and islands are formed, to subsequent erosion, and to the sinking of the earth's crust as sediments accumulate. They are exceedingly rare in areas not subjected to the above three processes.

There are at least two statements here that geologists may take exception to. The greatest floods of lava in the world have been in regions of tension and down-break, and present-day volcanoes, since Tertiary time, are mostly breaking down and lowering. This is true of the Bay of Naples, Hawaii and most of the island volcanoes. On the other hand, where lava volcanism is in process of extinction through stages of explosive eruption, as in the Andes, elevation has occurred. This does not agree with the notion that **active** volcanoes are characterized by uplift. Moreover earthquake centers are abundant along the great deeps of the oceans, some of them extremely remote from land derived sediments. This does not agree with the statement that they are rare in regions not subjected to either erosion or sedimentation.

To Dr. Bowie the dominant crust movements are vertical. Horizontal pressures are mere lateral components of up and down stresses. The "crust" is about 60 miles thick, and below this depth the earth's material acts as though it were plastic. The dominant control of the movements today is lightening by erosion and weighting by sedimentation. The reason why a sedimentary basin sinks for a long time before the heat from below expands and raises it, is that sediments are poor conductors and there is a long lag in the heating; in the same fashion there is lag in the cooling of eroded areas, but when it is achieved the sub-crustal material that has flowed in is dense and aids contraction in bringing about final subsidence. This is much like Sandberg's view (Volcano Letter No. 48).

"The earth's crust rises under erosion areas and sinks under the sedimentary areas." Therefore the crust is very weak in yielding to long-continued pressure due to weight. It seems to the reviewer that Bowie over-accents sedimentation, and disregards the great differences in weight of quartzose continental intrusions, and iron-charged oceanic lavas and their probable enormous volume. We know nothing of the amount of sluggish volcanism going on on the ocean floor to keep it heavy and low. We do know that quartz is the commonest mineral of the continents, and that both are light and stand high. As by Bowie's own showing the deficiency or excess of mass in theoretical earth columns is far below the surface at sea-level, it would seem possible that intrusive and extrusive processes may lighten or weight the crust much more profoundly than the movement of sediments. T.A.J.

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No. 62 RELEASED WITHOUT COPYRIGHT RESTRICTION March 4, 1926

KILAUEA REPORT No. 738

WEEK ENDING MARCH 3, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in charge

The only volcanic event of note during the week was an earthquake that appears to have centered under Mauna Loa. At Halemaumau February 25, at 5 p. m., there was some rock sliding at the west. On March 1 at 3 p. m. there was an avalanche from the SW wall and the steam vents at the base of the south wall appeared to be yellowing with sulphur increasingly.

Ten local earthquakes were registered. One at 8:20 p. m. February 24 was accompanied by a deep booming noise and felt here, origin very near station. At 6:41 a. m February 28 an earthquake generally felt on the island dismantled seismographs at Observatory and Kona and was perceptible more than 10 seconds at Kilauea. The shaking dislodged rock at Kapapala ranch which broke a water-pipe there and was the strongest felt there in two years.

Tilting of the ground at the Observatory was slight to the SSE.

J. C. Beam, topographic engineer at the station, has started surveys for a net of bore-hole locations on Kilauea floor, wherewith to determine the isothermal lines of surface temperature of the rock in the crater region by means of shallow drilling, and thermometer measurements.

THE GAS VENTS OF THE KATMAI ERUPTION

In 1919 Allen and Zies of the Geophysical Laboratory studied the fumaroles at Katmai Volcano, Alaskan peninsula (See Volcano Letter, No. 5; Technical Papers, National Geographic Society, No. 2, 1923, A chemical study of the fumaroles of the Katmai region by E. T. Allen and E. G. Zies). These gas craters at very high temperatures were mostly in the "sand-flow" of the eruption of 1912, and the following conclusions were reached:—

The vents are along deep fissures, with secondary characteristics, and temperature-pressure features partly unaccountable.

Temperatures range up to 650°C. The borders of the area are cooler.

Fumarolic activity is declining. Steam is about 99 per cent by volume of the gases, the remainder are hydrochloric acid, carbon dioxide, hydrogen sulphide, nitrogen, hydrofluoric acid and methane, with minor amounts of oxygen, carbon monoxide, argon and ammonia. Hydrogen was not determined apart from the sulphide. Sulphur dioxide was not detected. Fluorine as hydrofluoric acid occurs in amounts comparable with hydrogen sulphide and nitrogen, a quantity unheard of elsewhere.

The argon and nitrogen are largely atmospheric and the water largely from surface sources, as the fumaroles below the surface appear to be accessible to surface air and steam.

The water appears to have been vaporized and heated before it entered the fumaroles.

The heat is not from oxidation by atmospheric oxygen.

No combustible gases burn at the surface, and decrease of temperature downward in some places is due to hot lateral gas vents higher up.

Except for the soluble gases, no relation between temperature and gas composition was observed, and the Deville-Fouque' generalizations of a world-wide order of gas change with declining eruptivity, do not hold. T.A.J.

THE GEYSERS, CALIFORNIA

Steam for power is being drilled for at "the Geysers" in Sonoma County. The hot areas extend along the side of a narrow canyon, repeated at intervals for six miles. No lava or igneous products are visible, and like the Larderello power area in Italy (Volcano Letter No. 32) serpentines are present, along with sandstones, schists and shales. At the Geysers drilling reaches sandstone at less than 100 feet depth. Close to the surface the temperature is 100 degrees Centigrade. "As cracks are cut by the drill the steam flow increases and the temperature rises rapidly 25° C. or more per 100 feet in the upper strata, and measurements show that water could not penetrate to any considerable depth without being vaporized." (E. T. Allen, Jour. Wash. Acad. Sci. p. 74, Feb. 4, 1926. Further evidence of the nature of Hot Springs.)

Small hot springs are frequent, often of high mineral concentration. Their maximum temperature reaches the boiling point for the elevation 98° C. The acid springs contain sulphates of amonium and magnesium, the alkaline ones carbonate, bicarbonate and sulphate. "The evidence shows that the volatile matter is derived from volcanic gases which are escaping from springs and fumaroles," the non-volatile matter coming from serpentine and other metamorphic rocks. Oxidation is shallow as shown by fresh pyrite in the drillings; the surface water cannot penetrate deeply.

Allen accounts for the phenomena "on the assumption that superheated steam and other volcanic gases are ascending from a hot batholith" or body of intrusive magma "through a deep crack in the overlying strata; that the steam is heating surface water by condensation, and the gases hydrogen sulphide and carbon dioxide through logical chemical changes are decomposing the superficial rocks." T.A.J.

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No. 63 RELEASED WITHOUT COPYRIGHT RESTRICTION March 11, 1926

KILAUEA REPORT NO. 739

WEEK ENDING MARCH 10, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in charge

On March 4 there was some revival of avalanching from the walls of Halemaumau. Off and on all day dust clouds were rising from the northeast side, with maximum about noon. The northern talus and walls were covered with red dust. The slides were occasionally from the west. In a steam jet at the base of the south wall sulphur stain is conspicuous. Slides continued the next two days and then diminished. The southwest and west wall showed stripping, as well as the northeast. Now the pit is quiet and dry.

Thirteen earthquakes were registered, of which two were of the avalanche type, and all were very feeble. A shock at 1:25 a. m. March 8 had distance of origin indicated at 11 miles. A few waves of a distant earthquake were recorded 11:13 p. m. March 3. Tilt for the week was very slight SW.

COMPRESSIONAL HEAT IN VOLCANIC BLASTS

An original conception of the cause of the burns to victims and shredding of tree stumps in such volcanic blasts downhill as those of Mount Pelee and Taal Volcano is presented by G. N. Cole and supported in discussion by C F Brooks. (Monthly Weather Review, Oct. 1918, p. 453).

The question is asked, "Do the hot crater gases actually sweep down the mountain as a withering blast effective for miles around? If not, the hot blast must be the result of compression on the front of the explosive wave. The fact of pressure disruption of trees, buildings and bodies indicate a pressure wave of sufficient magnitude to produce the observed heating and wind effects." Cole explains the hot blast as the passage of a tremendous compressional wave travelling at a speed exceeding the velocity of sound (335 meters per second). Brooks supposes kinetic energy moving the gas forward at a velocity exceeding the molecular velocity of air, 510 meters per second. If the second zone of air did not move while the first zone, a half kilometer thick, was driven into it, the initial temperature being 80 degrees Fahrenheit, the temperature would be raised to 621 degrees F. Even if 85 per cent of the second zone of air gave way, the temperature would still rise high enough to burn people.

Cole's analysis is as follows. The compression is called adiabatic because there is little time for dissipation of heat. The gas is compressed by three actions: (1) The crater lava is in the condition of water in an exploding boiler. The ejecta of the volacno are conceived as possibly being entirely vaporized and on condensation becoming the sand and grit that covers the landscape. This makes the first wedge to crush the air into compression. (2) The heat of this matter expands the surrounding air, compressing the air of the second zone. (3) Combustion of some of the gases may cause further heating adding to the secondary compression. This all gives rise to destruction as complete in the outer zones of action, as if done by a tornado. Both rise and fall of pressures suddenly are believed to produce phenomena observed. Trees denuded of bark, with fibre cut and shredded, are believed accounted for by "some such action as that which pops corn or puffs rice when the pressure is removed after heating." The sudden rise in pressure "must be indescribably worse on the ear drums than going through an air lock in caisson work. Lung and heart action must be stifled." Mr. Cole thinks that the only hope of protection in such countries is to have steel volcano cellars with stability, heat insulation, and pressure insulation.

The reviewer visited St. Pierre at the time of the Pelee eruption, and he has seen similar effects at Sakurajima, Bandaisan, and at St. Vincent. There may be compressional heat in volcanic blasts, but there is so much other heat not mentioned by Mr. Cole, as well as attrition and obvious asphyxiation by dust, and so little evidence of pressure, that the pressure argument seems to prove too much. Mr. Cole says that "if the pressure comes on it will heat the air of a cavern a hundred feet underground." Yet people in cellars, in steamer cabins, a sailor who wrapped himself in a tarpaulin, and Cibaris the convict cited by Mr. Cole, survived with comparatively flimsy protection. It is not a fact that at St. Pierre there was "pressure disruption" of trees, buildings and bodies. The trees were shredded by a sand blast, with the pebbles left sticking in the wood. Boiler plate was left punctured by bowlders, with the rocks left sticking in the holes. One end of St. Pierre was buried under 40 feet of gravel and dust. The heat of a burning city disembowelled bodies. There was no mystery about the deaths, to the medical officers; at the end of the town near the volcano the rock dust was incandescent and falling by tons. People and houses were burned. At the far end of the town the dust was scalding hot in a steam emulsion. Thin clothing was spared while flesh was burned. The awful cases of bronchitis in the wounded were due to nothing but hot dust. The population of St. Pierre died chiefly from instantaneous pneumonia The dust was not volatilized lava, but plain ground up rock. A mighty jungle was burned away by hot sand.

The most puzzling feature of these volcanic blasts is that they move downward and in one direction only, with dynamic effects uni-directional. Their heat is contained in ordinary volcanic ash. T.A.J.

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No. 64 RELEASED WITHOUT COPYRIGHT RESTRICTION March 18, 1926

KILAUEA REPORT NO. 740

WEEK ENDING MARCH 17, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in charge

The week past has shown marked increase of local earthquakes and tremors. Halemaumau when visited was dry and quiet from March 11 to 13. About 10 a. m. March 14 an avalanche sent up a considerable reddish dust cloud. On the afternoon of March 15 some rocks were slipping on the west wall. Along the trace of the southwest rift dykes up and down the wall of the pit there was a dust trail clear to the top of the wall. This was interpreted to be an avalanche track; there were two such vertical markings.

Twenty-five earthquake movements were registered for the week, four of which were of the avalanche type. A felt shock at 11:51 a. m. March 14, felt also at Hilo, appeared to originate on the northeast rift of Mauna Loa, like the quake of February 28. A tremor was slightly felt about 4 a m. March 11. A shake distinctly felt at Kapapala 3:23 a m March 14 was only very slightly registered at Observatory. Tilt was moderate to WSW.

EXPLORING THE EARTH FOR MAGNETISM

The earth is a big but not very powerful spherical magnet, with both its actual poles near the earth's center. The magnetic poles are the outcrops at the surface of this interior axis The magnetic poles move, the compass direction varies with time, and there are magnetic storms which vary somehow with sunspots Not only does the compass vary in its nearness to pointing north, but it varies in the force with which it swings, and in another force which it exerts downward toward those interior poles. Of course the compass is only an indicator of a terrestrial force affecting the particles of balanced iron in the needle. Much of navigation is dependent on the forces that pull this needle There are earth-air electric currents passing from the air into the earth and vice-versa, apparently associated with the general circulation of the atmosphere, in places downward with downward positive electricity, elsewhere upward for streams of both positive electricity and of the air motion.

There has just been published the fifth of the most complete series of volumes on magnetism exploration ever produced by science. (Carnegie Institution, Ocean Magnetic and Electric Observations 1915-1921. Ault, Mauchly, Peters, Bauer and Fleming, Washington, January 1926, 430 quarto pages).

This volume describes the magnetic results obtained from cruises IV, V and VI of the non-magnetic ship Carnegie, 1915 to 1921; logs of the voyages and auxiliary observations on ice-bergs, sea temperatures and meteorology; atmospheric-electric results; and special reports on the Hudson Bay expedition, navigation of air-craft by astronomical methods, the compass-variometer, sun-spot variations in relation to atmospheric electricity, and studies of atmospheric electricity with reference to potential gradient, ionization, conductivity, current density, radio-activity and penetrating radiations.

The two vessels in this service, the Galilee and Carnegie, in nine cruises between 1905 and 1921, have spent 2668 ocean days, covering 316,536 nautical miles, making 3316 observations of magnetic declination, 2147 of inclination, and 2147 of horizontal intensity. To show the improvement in skill and instruments, the Galilee cruises between 1905 and 1908 averaged 1.8 days between observations for declination; the Carnegie averaged 0.7 day. Hence the advantage of the ship constructed without iron in its composition. The Galilee averaged 196 miles between stations for declination; the Carnegie 84 miles. The Galilee made a total of 325 observations for declination; the Carnegie, in twice as many voyages made almost ten times as many such observations.

A map of all the work on land and sea from 1905 on shows extraordinary achievement; the continents dotted with magnetic stations, the oceans zigzagged by cruises from 60° south latitude to 80° north. All of this was planned by one man, Dr. L. A. Bauer, who has directed magnetism for the Carnegie Institution from the beginning. In 1906 he wrote, "However great this task of a general magnetic survey of the earth may appear, I have now had sufficient experience to know that with good system and management, and ample funds, the work can be completed in a period of about fifteen years."

The volume before us appears to justify this forecast. So far as the discovery of the magnetic constants for all latitudes and longitudes used by mariners are concerned, the tables of figures in these volumes will correct most of the charts. Many of the charts have been wrong in their compass variations by one or more degrees. The yearly changes known as secular variation now have a basis for new reckonings in many places where before there were no data at all. This secular change is what future voyages will measure.

In reading the logs of this three hundred and seventeen thousand miles of cruising in some of the stormiest water in the world in two small sailing vessels, one is impressed with the romance of achievement in modern science. No shipwreck, no savages, no scurvy, almost no adventure. No long narratives of heroism. Continuous observations every hour with delicate instruments rain or shine away to the south of the roaring forties and away to the north of fifty-three. Computations made en route and reduced results sent home from every port, quickly corrected, and supplied to the nautical bureaus of the world. The whole world studied with one object in view, magnetism. This is the sort of thing we would like to see done for the rock bottoms of the oceans of the world, and for volcanism.

T.A.J.

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No.65 RELEASED WITHOUT COPYRIGHT RESTRICTION March 25, 1926

KILAUEA REPORT NO. 741

WEEK ENDING MARCH 24, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Though the number of local earthquakes was not large, the position and intensity of some near shocks during the past week has been interesting. Nothing new in volcanic activity has happened. The increased frequency of local shocks last week and the widely felt Hawaiian earthquake of March 19 point to correspondence, with equinox, of seismic activity.

A steaming hole in the wall of Halemaumau just west of the south talus has been growing increasingly yellow with sulphur. Hot steaming cracks at the east edge of Kilauea crater next to the gravel bank have recently produced a marked increase of alum, sulphur and probably other salts which cover the surface of the lava at the contact with the underlying gravel.

An examination of the southwest edge of Halemaumau showed that the two upright white streaks there were probably produced by the avalanche of March 14, for the top of the rift notch had caved away, and also a place a few feet farther west. The material which had fallen was largely the white floury ash of 1924, there one to two feet thick at the surface, and this in falling had made a white streak on the wall below. No fresh breaks in the soil along the edge cracks were noticed farther back.

After this the only motion observed in the pit was some tinkling of stones heard falling March 22 and dust seen rising from a small slide March 24. Some fresh whitish debris was left on the northeast talus.

Twelve earthquakes were registered during the week, three of which were perceptible. A large earthquake centering some eighty miles away from the observatory was plainly felt here as a prolonged gentle swaying at 10:33 p. m. March 19. A small but perceptible aftershock from the same origin occurred at 7:27 a. m. March 20. Both of these made good records on the seismographs of Kona, Hilea and Hilo as well as at Kilauea, and from the indicated distance to origin from the three stations it appears that the disturbance was on the ocean floor 26 miles north of Honokaa, or 25 miles northeast of Kohala. At the Observatory both instruments were dismantled by the larger shock, which was felt at Honolulu, strongly felt at Kohala and Honomu, and less strongly felt in Hilo. It produced a weak rocking in Kona. Tilt was slight WSW. A small jolt occurred March 21 11:38 a. m.

THE QUERVAIN-PICCARD SEISMOGRAPH

The two professors named, in Zurich, have built a three-component seismograph with pendulum weighing twenty-one tons. By "three-component" is meant registration of up-down, east-west and north-south motion, and in this instrument all three are registered from the motion of the same suspended body. (Iberica, Madrid, No. 522, Nov. 15, 1924, Fr. M. M. S. Navarro, Meeting of the Seismologic Section, Second Assembly of the International Geodetic and Geophysical Union).

A most interesting cut is shown in this article, representing a portable seismograph made by the same investigators. It is described as designed for the registration of local earthquakes. Its plan is the same as the 21-ton instrument. The photograph shows an upright skeleton cylindrical frame on three projecting feet with levelling screws. Within the frame apparently hangs the normal pendulum and three pens write on clock-driven smoked paper. From the electrical devices indicated, apparently the damping is magnetic. Upright spiral springs appear inside the frame, suggesting that the vertical component is in some way identified with the same mass that writes the two rectangular horizontal motions. The whole instrument appears to be about three feet high and quite compact. T.A.J.

GAS WELL PIT

Dr. Sidney Powers, chief geologist of the Amerada Petroleum Corporation of Tulsa, Oklahoma calls attention to an extraordinary photograph of the pit left by a gas well blow-out. In appearance it is precisely like the Hawaiian pit-craters, subcircular, with vertical walls and internal talus and clinging rim pinnacles. The picture is published in the Oil Weekly of February 26, 1926, p. 23, and the pit appears in a wide flat terraced country, with a few trees. The walls show horizontal bedding. The caption states that this is a big gas well that blew out at White Point, South Texas. The crater developed a "vortex" in the center in which the derrick and machinery sank to unknown depths. It is said now to contain boiling water and burning gas. Perhaps there is here a lesson to be learned for volcanology, showing that pit craters are easily produced by engulfment, when deflation of something below, through loss of gas, decreases bulk locally, and a superficial pit is the result. T.A.J.

NEW SEISMOLOGICAL QUARTERLY

Referring to critical study of tide-gauge registration recommended in the Volcano Letter No. 57, Dr. William Bowie writes that for more than a year the U. S. Coast and Geodetic Survey has been examining the tidal records and every seismic sea-wave is studied with reference to the earthquake record for the same occasion. This will be a feature of a forthcoming quarterly seismological report of the bureau, the first number of which will cover January-March 1925. "Science Service" of the National Research Council so cooperates with telegraphic reports as to locate epicenters immediately. Thus Dr. Bowie has located the big earthquake of January 24 as in the Solomon Islands (Volcano Letter January 28). T.A.J.

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No. 66 RELEASED WITHOUT COPYRIGHT RESTRICTION April 1, 1926

KILAUEA REPORT NO. 742

WEEK ENDING MARCH 31, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

There is practically nothing new to record of volcanic activity in Hawaii. Halemaumau and Mokuaweoweo are dormant. The weather has been calm to southerly at Kilauea, with rain, and northerly at Hilo with fresh wind and dry weather. Halemaumau has shown much steam and the big sill northeast has caved away a little, but there have been no avalanches noticed.

Ten local earthquakes were recorded on Observatory seismographs. One at 12:34 a. m. March 29 dismantled one seismograph, and the distance to origin indicated was about 19 miles. A distant earthquake apparently 3560 miles away occurred March 27 at 12:30 a. m. Tilting for the week was slight to the SW.

Work has been begun on the Kilauea floor, with compressor and hammer drill, in making small holes at surveyed stations 1000 feet apart, to serve as permanent places for measurement of the temperatures of the bedrock.

THE WHITE ISLAND VOLCANO

In the Bay of Plenty on the northeast side of New Zealand's north island, there is an active volcano islet which strongly resembles Bogoslof of the Aleutians. This is known as "White Island" and in September of 1914 it was the scene of a frightful disaster when all the operatives of a company mining sulphur were swept away by an eruption. All that was seen from the adjacent shores of the bay was the ejection of steam clouds, but the crater lagoon appears to have been blown out after the fashion of a gigantic geyser and to have overwhelmed the camp.

The Auckland Weekly News of January 7, 1926, brings word that after some years of idleness the sulphur camp has been reestablished, not on the sand flat separating the open crater from the sea, but on the opposite side of the island more than a mile from the crater and where on the southwest side of the volcano the principal area of vegetation has developed, groves of pohutukawa (metrosideros). The crater rim a thousand feet above the camp, which is on the windward side of the island, forms a barrier between the workers and the poisonous solfataras always steaming violently on the crater side. The new camp is described as peaceful and delightful, with imported poultry, pigs and sheep, numerous buildings and huts, a fresh water supply from a natural spring which is said to contain an excess of iodine, abundant firewood, a receiving and transmitting wireless plant and a track communicating with the sulphur works at the mouth of the crater on the other side of the island. A motor boat and three row boats are kept on hand and there is a telephone between the camp and the workings. A medical officer is stationed at the plant. There is good fishing. A rookery of boobies is close at hand.

Just over the divide every vestige of life has been destroyed by the poisonous fumes of hydrochloric acid and sulphur which rise with roaring steam jets from a main blow-hole in the center of the crater floor and from lesser vents about the talus slopes.

Dr. J. Allan Thomson, director of the Dominion Museum, sends an article from "The Dominion" of Wellington, February 18, stating that the side fumeroles have from time to time been blocked by avalanches, this seeming to increase the force of the central blow-hole. About the end of January the central vent gave out "unusual volumes of superheated sulphur, the fumes carrying with them dense clouds of red oxide dust. On calm days the cloud reached measured heights varying from eight to ten thousand feet."

"Finally on the night of February 3, 1926, a fault apparently developed at the base of a 200-foot cliff on the western side of the main blow-hole, and some hundreds of yards of the cliff collapsed. The pressure of gas and steam blew forth a mass of sulphurous mud covering an area of ten acres three inches deep." A new vent broke through the disturbed earth fifty feet above the crater floor. For forty-eight hours the air was full of dust-charged steam. The main blow-hole was giving off overpowering fumes. Between it and the new vent the crater saucer was covered with massive volcanic bowlders smothered under fresh mud. When visited the place showed that a new gas vent had created the landslide, with activity very similar to the central blow-hole, sending up sulphur fume with a roar and, owing to the intense heat, not condensing its steam until the vapor reached a height of fifty or sixty feet. The steam rose to the top of the crater walls, where it was caught by the wind and blown away in clouds.

The new vent did not produce the same "nerve-wracking noise" as the central blow-hole, but it had lessened the force of the latter. "The formation of the new vent's cone is not yet permanent. Occasionally a minor landslide above the vent is blown into the air by the tremendous force, and the dust thus formed is scattered broadcast over the crater floor." The writer of the article states that the two blow-holes of the White Island crater constitute the greatest thermal activities of their kind in the world. He is of the opinion that the new eruption, by adding to the safety-valve openings "obviously has rendered the crater even safer than previously."

We would venture to caution our friends in New Zealand against putting too much confidence in this safety-valve theory. White Island has all the characteristics of a dangerous volcano like Bogoslof or like Krakatoa. The collapse above described, accompanied by red cauliflower clouds thousands of feet high, and the opening of a new wall-crack vent, means engulfment. If engulfment continues it may mean the retirement of lava lying below, at the end of a pressure cycle. If our diagnosis of what happened at Kilauea in the spring of 1924 is correct, such retirement of deep lava may take several months, and be followed by sudden collapse of the crater bottom. This we believe accounts for the considerable delay of the Krakatoa, Kilauea and Pelee eruptions after the first symptoms. Tarawera in New Zealand was a clear case of engulfment. Engulfment opens voids which fill with water, and steam explosion follows. In the event of a true explosive eruption, which can throw eight-ton bowlders three miles, a camp like that of the sulphur workers on White Island would be exposed to the first barrage.

T.A.J.

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No. 67 RELEASED WITHOUT COPYRIGHT RESTRICTION April 8, 1926

KILAUEA REPORT NO. 743

WEEK ENDING APRIL 7, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

On rainy afternoons during the past week there has been much fume and vapor at the vents in the lower walls and bottom debris of Halemaumau. Sulphur odor is occasionally perceptible. At a vent in the south wall increasing yellow coatings indicate sulphur depositing, and at the south talus there is dense blue fume of sulphur gases mixed with the steam. This blue fume is seen also near the center of the pit and at the east edge of the bottom. On April 4 new debris had fallen on the northeast talus, and a new wall scar was in evidence up and down the NNW wall. Rocks were sliding a little at the NW and NE. Such slides must have been slightly bigger about noon April 5 for dust in small amounts rose over the pit. On that afternoon the large northeast sill was steaming at a place near its east end where the rock has recently fallen away and left fresh gray surfaces.

Twenty-three local earthquakes were recorded by the Observatory seismographs during the week, all too small to be noticed. Tilting was slight to the SW.

UNITED STATES SEISMOLOGICAL REPORT

Under the title "Seismological Report" for January, February, March, 1925, by Frank Neumann, mathematician, Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey, there has just been printed the first number of the new quarterly which marks the transfer of seismological investigations in the United States from the Weather Bureau to the Coast Survey. Formerly this matter was printed in the Monthly Weather Review. A special report will be issued to cover the six months ended December 31, 1924, during which time the Weather Bureau ceased publication. Commander N. H. Heck is chief of the Division of Terrestrial Magnetism, now made to include seismology.

The new report is in octavo form, forty-eight pages, and includes all seismological investigation in the United States, the regions under its jurisdiction, and adjacent regions. The statistical data include tables of felt earthquakes, instrumental records and a summary of current earthquakes. A special canvass was made for intensity information concerning the regions affected by the Quebec earthquake of March 1 (February 28, local time) and the Alaska earthquake of February 23. The Quebec earthquake is here considered only in relation to places in the United States. The instrumental reports use the Klotz symbols and all reports are reduced to Greenwich time.

The summary of earthquakes for the three months in lands under the jurisdiction of the United States shows only eleven days without reported shocks and many days with two to seven earthquakes. The well established locations of shocks include forty in the Philippines, twelve foreign, eleven in California, ten in Canada, and nine in Alaska. The local shocks of Hawaii are not here included, but the Bulletin of the Hawaiian Volcano Observatory is referred to. Ninety-seven earthquakes were well located, sixty-seven had positions doubtful, thirty-seven were in unknown locations, and twenty-nine were aftershocks of the Alaska and Quebec earthqaukes, making two hundred and thirty shocks in all.

The principal earthquakes were in New England on January 7, a submarine shock January 18, an earthquake February 23 centering seventy miles north of Valdez on the south coast of Alaska, the Quebec earthquake near the St. Lawrence river, and a disastrous shock March 16 in China which destroyed 5000 lives about the city of Tali in Yunnan.

The list of observatories cited in the summary includes nine in the United States, five in Canada, one in Panama, one in Guam, two in Hawaii, one in the Philippines, and one in Alaska.

Mention is made of the work of the Coast Survey in precise triangulation in California which has determined extraordinary changes in horizontal position of old stations amounting to as much as 24 feet northward near Gaviota in the Santa Barbara district. A new baseline is to be measured in that district with a view to finding out how much of this movement is an actual geographic change and how much may be ascribed to residual errors in the triangulation. A preliminary report on "Earth Movements in California" has appeared as Special Publication No. 106, U. S. Coast and Geodetic Survey. Precise leveling has been run across southern California comparing the data of 1906 and 1924. In seven kilometers distance between Santa Ana and Barstow a change of elevation of 54 millimeters was found, and between Orange and Barstow, a distance of 214 kilometers, the change was 63 millimeters.

These reports may be expected to grow in size and value, and represent the first appropriations specifically made by Congress for collecting seismological information from all parts of the United States. The Coast Survey needs the cooperation of the public. "The humblest citizen can often furnish information as valuable in its field as the technical report of the seismologist with elaborate instrumental equipment." Progress depends on cooperation. All people who keep records of felt earthquakes should send their lists to the U. S. Coast and Geodetic Survey, Washington, D. C. People in remote places are especially fortunate in situation for furnishing valuable data. Firms having organization of representatives in many places could enormously help the work by securing blank forms from the Survey and having them sent in systematically whenever an earthquake is felt. T.A.J.

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No. 68 RELEASED WITHOUT COPYRIGHT RESTRICTION April 15, 1926

KILAUEA REPORT NO. 744

WEEK ENDING APRIL 14, 1926
Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, Temporarily in Charge

A very diffuse blue fume was observed with the steam escaping from one of the many vents inside Halemaumau during the fore part of the week. Accompanying the numerous earthquakes attendant on the outbreak of Mauna Loa there was an increase of avalanching from the walls of Halemaumau. During the forenoon of April 10 two large slides from the wall near where the southwest rift of Kilauea enters Halemaumau were observed. Possibly this rift was in motion.

On April 11 Halemaumau was full of steam most of the afternoon and a faint odor of hydrogen sulphide was noticeable at the south rim. An occasional glimpse into the pit showed abundant floor vapor. On April 12 following the rain of April 11 the walls of Halemaumau were found to be quite red. Steam was escaping in continuous jets from a line of vents in middle of southwest talus slope. Recent movement in cracks back from the rim of Halemaumau were noticed on April 13. During the afternoon diffuse blue fume appeared to be mixed with the steam escaping from a vent in sulphur stained area on south floor of Halemaumau.

376 earthquakes were recorded during the week, 363 of which occurred during the four days following outbreak of Mauna Loa. The majority of the shakes appear to have had their origin along the extension of the southwest rift of Mauna Loa into the lower Kau country, though some appeared to originate under Mokuaweoweo the summit crater of Mauna Loa and along the northeastern rift. The net tilting for the week was very slight to the ENE. On April 13 there was a noticeable spurt of northeast tilt. A northeasterly tilt which means an increase of internal pressure of Kilauea coupled with the known sympathy of action between Kilauea and Mauna Loa indicates that Halemaumau should be watched closely.

THE APRIL 10, 1926 OUTBREAK OF MAUNA LOA

Shortly after 3:00 a. m. April 10, 1926, Mauna Loa became active after having been quiet since November, 1919. The rising fume columns illuminated by fire fountains and lava flows below cast a pinkish glare all over the island of Hawaii. Large print could be read at the Observatory 24 miles away.

The Observatory is greatly indebted to E. G. Wingate, Topographic Engineer, U. S. Geological Survey, for a very complete report of the outbreak. Mr. Wingate, who was camped a few miles from the summit of the mountain at an elevation of 11,400 feet, went immediately to the scene of action. By nightfall he had made copious notes on the activity and very accurately mapped the lava flows, the location of fountains, and active fissures.

Lava spattered from a crack over three miles long and from several places short lived flows started. The highest flow issued from near the edge of Pohaku Hanalei crater—the southern part of Mokuaweoweo. The lava both streamed down the mountain side for about one mile and cascaded over the crater rim. The southeastern half of Pohaku Hanalei crater was covered with the new lava.

Owing to lava flows along its edge observations were not made at the first of the two outer craters about a half a mile below Pohaku Hanalei. At the second of the outer craters about a half a mile below the first there was a wonderful sight. A line of fountains marked the main rift crack which cuts through this crater.

Lava was cascading into the crater from the upper edge and at the lower side there were two lava streams one running into a tunnel and the other over the surface. These two streams with others lower down fed the main lava flows which went down the mountain with branches leading toward both the Kau and Kona sides for a distance of about four miles or more. The lowest vent was at an elevation of about 12,000 feet or above the site of the preliminary outbreaks in 1916 and 1919. One branch of the flow went by the sulphur bank area which appears as a conspicuous scar when viewed from above the timber line far down the southwestern rift zone. (For a description of this rift zone, see Volcano Letter No. 52, Dec. 24, 1925).

Shortly before 8:00 a. m., as viewed from the Observatory, activity at the source vents had nearly ceased. By 8:30 a. m. the large fume cloud that was drifting to the northeast had disappeared.

There was no "swarm" of earthquakes preceding the outbreak, though they have been coming in "swarms" since. The warning quakes which were widely felt over the eastern half of the island of Hawaii occurred at 1:50 a. m. and 2:04 a. m. or about an hour before the appearance of the lava. Before the occurrence of these shakes, however, at 1:36 a. m. "harmonic tremor," a motion that is recorded on the Observatory seismographs only when there is molten lava at either Kilauea or Mauna Loa, was recorded. This type of tremor became very noticeable after the 2:04 a. m. shake and continued so for that day.

Prior to the outbreak Mauna Loa had been watched with considerable interest for three reasons: 1, there was an indication of increase of internal pressure of the volcano system as shown by a slight accumulation of easterly tilt from 1925 to 1926; 2, quite a large number of earthquakes had been occurring on Mauna Loa during the past several months; and 3, Mauna Loa had been quiet for nearly 6½ years which is rather longer than the average interval between periods of activity.

The outbreak followed one of the driest years ever noted on the summit of Mauna Loa. There was scarcely any snowfall during the preceding winter. For the last seven months the entire island of Hawaii has been unusually dry.

R.H.F.

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No. 69 RELEASED WITHOUT COPYRIGHT RESTRICTION April 22, 1926

KILAUEA REPORT NO. 745

WEEK ENDING APRIL 21, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

During the Mauna Loa eruption there has been no increase of steam or avalanche activity noted at Halemaumau. Hydrogen sulphide was smelled there on the 17th. The sulphurous steam at south talus appeared a little hotter and more flocculent.

Numbers of local earthquakes per twelve-hour interval beginning the morning of April 14 were 32, 24, 51, 32, 37, 29, 29, 16, 12, 8, 12, 8, 18, 2, the last being the night of April 20-21. The total is 310. Tilting was moderate SE with unusual daily fluctuation. Intensity of earthquakes increased as numbers diminished. Three of the quakes of the 20th were of Halemaumau origin.

PROGRESS 1926 MAUNA LOA ERUPTION

The writer explored the summit region from camp of E. G. Wingate April 11-14. The new break on the southwest rift is tangent to the two upper small pits on their east sides, and cuts across the third pit. Flows of silvery light weight pahoehoe extend from these fissures several miles south, and others have cascaded into the pits. The upper cracks are hot and vaporing in places but no longer flowing. An unusually sharp earthquake felt on the mountain the evening April 13, along with others, showed that the rift was working. Three cups on the rift east of the divide cones at about 8000 feet elevation were seen April 13 smoking with dense yellow fume, (looking down the southwest rift). April 14 about 8:30 a. m. a big brown fume column arose at that place and then others higher up the rift zone. The lava flows had started on the rift approximately 15 miles from the center of the summit crater, and five miles above Puu o Keokeo as one follows the curved rift line. At night there was red glow there and smoke all along the rift to the summit.

These observations and subsequent ones by R. H. Finch and W. O. Clark the night of April 19 in the source region above Naalehu show that the main new crack of this outbreak is several miles long and on the eastern side of the rift belt divide. In spite of this the floods of lava made their longest flow on the western side to the ocean.

April 15 observation from south of Waiohinu in evening showed the glowing front of an eastern flow in Pele o iki Kipuka high up the mountain above the Waiohinu homesteads. Beyond could be seen the lurid glare and fume column of the source fountains, and vivid glow in a long belt to the west over a flow going towards South Kona. There the cowboys of upper Papaa ranches reported the Kona branch flow as four miles from the belt road near Honomalino and progressing.

April 16 an observatory party reached the new Pele o iki eastern flow but were unable to cross it. It was aa. In the forenoon news came that the Honomalino flow was close to the road; two columns of fume showing great increase of volume and heat convection appeared over the source region. We arrived at Kaanaana's house at Honomalino 10:30 a. m. where the smoke of the burning forest at the front of the flow was visible just above. At 12:22 p m the aa flow there crashed through the guava bushes into a causeway of the road creeping as a red hot landslide of tumbling "snow-ball" block-lava 500 to 600 feet wide. Immense accretion balls or bowlders covered the surface and tumbled forward at the front. Advance across road at 1:10 p. m. was 6 to 8 feet per minute. This place was three miles above the Hoopuloa wharf and south of the Hoopuloa road. The Kaanaana house was crushed and burned.

We descended the trail to Honomalino beach, Milolii, and Hoopuloa.

April 17 at 3:30 a. m. the front overtopped the bluff back of Hoopuloa; at 9 a. m. it reached the lava flat some thousand feet back of village; the interior liquid was rolling over the front by friction with the ground, shoving forward the top layer of blocks, and maintaining a red hot talus at the lower ends of each lobe. The mass was delta shaped, 25 to 50 feet high and increased in width from 1000 to 1500 feet. Its average forward creep was 2.7 feet per minute. The middle of stream on bluff slope broke into cascades every 3 or 4 hours that night.

April 18 the front reached Hoopuloa at 4 a. m., burned houses about 5 a. m., reached sea 6:30 a. m. and in next two hours buried the town and the harbor. Clouds of steam peppered with black sand shot up, small pebbles rose in wavy trajectories, the vapor was sour with muriatic acid, and the noises were hissings and later thudding explosions and prolonged roars of escaping steam. Fish were killed by thousands.

At the road crossing a sluggish orange colored aa river pulsated within hardened lava fields. The Waiohinu flow stopped. Upper ranch buildings of Honomalino were destroyed, by branch flows. Army aviators photographed the district from the air.

April 19 about 9 a. m. the road flow stopped. Finch and Clark reported fountains at about 7600 feet elevation, activity on rift miles long, immense smoking columns and loud roar from one of them, large fountaining areas and a rived from them passing to the north of Puu o Keokeo over to the Kona side. The line of activity appeared to be 5 or 6 miles long. New cones and fountains were 50 to 100 feet high. The line is well to the east of the 1919 line.

T.A.J.

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No. 70 RELEASED WITHOUT COPYRIGHT RESTRICTION April 29, 1926

KILAUEA REPORT NO. 746

WEEK ENDING APRIL 28, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Halemaumau continues quiet after having been inactive for one year and nine months. Today the pit floor and walls were dry and dusty with but little steam escaping.

The Mauna Loa outbreak produced no visible effects in Halemaumau save that caused by the earthquakes. There was an increase in avalanching and some of the blocks around the rim of pit were jostled so that small new cracks appeared. Some such effect is to be expected when one considers the rather unstable 1200 foot walls being jarred by earthquakes the largest of which was strong enough to overturn some objects.

During the week 46 earthquakes were recorded, 32 of which occurred on April 21 and 22. The shake at 4:32 a. m. April 22 was one of the strongest of the series and was widely felt over the island of Hawaii. The seismographs both at Hilo and Volcano were dismantled. A shake at 11:05 p. m. April 22 had an indicated distance to origin of 12 miles, equal to the distance of northeastern rift of Mauna Loa from Observatory.

The net result of tilting for the week was slight to the south-southeast.

DECLINE OF MAUNA LOA ERUPTION

The 1926 outbreaks on Mauna Loa began one year and nine months since lava activity was last seen in the Kilauea-Mauna Loa system. This is not a long interval and it is clear that the explosive eruption of Kilauea 1924 in no way interrupted the normal successsion of lava effusions. The new outburst was accompanied by a sharp change of tilt at Kilauea observatory from westerly to easterly, and a moderate change from southerly to northerly, beginning about April 11, a day after the summit outbreak. The change was from tilt towards the active center to tilt away from it. Along with this came 70 to 90 earthquakes per day, then in the second week 15 to 50, and the numbers per 24-hour day midnight to midnight beginning April 21 have been 17, 17, 6, 4, 2, 1, 1. This decline suggests a finish within three weeks of the beginning; whereas the Alika period of 1919 lasted seven weeks. But more observation of the source region is needed before this conclusion is established for 1926.

From Kilauea, glow was seen over the Kahuku lava source region April 25, also the fume cloud, and faint fume was visible April 27 and later. Fume jets had apparently developed down the rift immediately after the summit outbreaks of the 10th, gradually increasing and concentrating at about the 8000-foot level on the 13th, when the stage was set for the lava flows from the lower levels. The absence of glow at the Kilauea distance 55 miles away does not prove that small fountaining has ceased.

April 21 the cattlemen of Honomalino Ranch reported a second flow alongside of the one that had destroyed Hoopuloa moving not faster than a mile a day, and near the 1916 flow in the forest 2 to 3 miles above the belt road, in Honomalino. This stopped there, and on the 23rd they reported another branch 5 to 6 miles above the road moving 2 feet per minute, in flat country. Valuable upland paddocks in the Koa forest were destroyed.

The writer went to the flow source at about elevation 7400 feet, 3 miles north of Puu o Keokeo, and spent the night April 22-23 there on an old red cone, against the north foot of which lay the flowing streams. These streams flowed to Honomalino from a fissure line dotted with nine active cones. These made the most active part of a line of sixteen new cones visible, the lower three making pahoehoe slag-heaps of the Kilauea type, the upper ones making clouds of smoke so as to hide any others that lay farther up the rift The nine middle vents bounded the east end of the Hoopuloa source belt of fresh lava, here a half-mile wide and trending WSW. Most of this was aa, but through the southern part of it swept a gorgeous meandering river of fiery melt with rapids, and risings and fallings, and floating rafts, and overflows, all within well defined banks. This stream took its rise at the northern cones of the spectacular nine, where the hills piled up, and a spray fountain rose and fell in brilliant orange incandescence, and brooks of molten basalt fed the torrent with lava springs. With very brilliant reflection on the cloud above, the river of fire wandered off three miles across the plateau in a shimmer of western mirage and disappeared over the shoulder of the mountain towards Kona. No glow was seen in the direction of the earlier Kahuku flow towards Waiohinu. A lower cone of the nine was an open cup vomiting sluggish aa, and this went out of action during the night. The other vents were flaming or spitting or fuming fierily, and showed by the cooled field of lava from them and by their built-up flanks that they were dying remnants of what had been fountaining and flooding during the first days of eruption.

The report of a visiting party showed that the source region was still fountaining and golwing April 26th. On that day the Observatory party visited the northern sides of the Hoopuloa flow at the sea-shore and at the road, and found the former steaming feebly and the latter flaming in spots where vegetation was burning beneath. Otherwise the flow was cool and easily walked over. There is ammonia among the gases distilled. The abundant large concretionary balls of lava and the worn, lumpy aa fragments make this flow different from the rusty arborescent aa of 1919. The 1926 stream-flow was more viscous and less hot.

By analogy with former eruptions, if the Kahuku source stops action, Halemaumau may have its bottom disturbed from below, and it will be watched with interest. On the other hand the slag-heap pahoehoe in Kahuku, working sluggishly, might develop flows. T.A.J.

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No. 71 RELEASED WITHOUT COPYRIGHT RESTRICTION May 6, 1926

KILAUEA REPORT NO 747

WEEK ENDING, MAY 5, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, Temporarily in Charge

Though there has been a decline in the number of earthquakes there has been a noticeable increase in the avalanching at Halemaumau. Many avalanches may be observed every day. Nearly all are small however. On May 3 avalanching was nearly continuous from 2:40 to 3:00 p. m. On May 5 with a high humidity there was but little steam escaping from the Halemaumau floor. The most conspicuous steam vent was near the sulphur stained area at the south side. From some places on the rim it appeared that some blue fume was mixed with the steam while at other places the apparent fume was not visible.

Eight very small earthquakes were recorded during the week. Tilting was moderate to the northeast.

THE EARTHQUAKES ACCOMPANYING THE MAUNA LOA ERUPTION OF 1926

From the time of the beginning of the preliminary outbreak of Mauna Loa during the early morning of April 10, to April 28 when shaking had practically ceased 647 earthquakes were recorded on the Observatory seismographs.

The daily distribution of the total number of earthquakes and of the number of shakes perceptible at Observatory are shown in the following table:

Day	Number of shakes	Number of perceptible shakes
April 10	75	4
11	35	1
12	81	5
13	83	8
14	60	9
15	86	13
16	61	17
17	53	7
18	26	10
19	20	4
20	23	2
21	17	1
22	12	4
23	6	0
24	4	0
25	2	0
26	1	0
27	1	0
28	1	0
29	0	0

Of the 85 shakes that were perceptible 24 dismantled the Observatory seismographs. The strongest shakes of the series were at 4:30 a. m. April 18 and 4:32 a. m. April 22. The latter dismantled the seismographs at Hilea, Hilo, and Kealakekua (See Letter No. 2, Jan. 8, 1925), and was strong enough to overturn some unstable objects though no real damage was done. A press dispatch from a Colorado seismograph station on April 10 stated that a distant earthquake was recorded whose origin was probably on Mauna Loa. The same disturbance was recorded as a distant earthquake on the several seismographs in Hawaii.

The 1926 outbreak more closely resembles that of 1916 in regard to the number of earthquakes and the time between the upper preliminary outbreak and the lower one from which the main flow issued than the 1919 one. In 1916 about 632 earthquakes accompanied the eruption or about the same number as in 1926, while in 1919 there were but 185 earthquakes. During an eruption in Mokuaweoweo in 1914 with no flow outside there were but 60 earthquakes. The time interval between the upper and lower outbreaks in 1916 was nearly three days, in 1919 about 2¼ days, and in 1926 nearly four days.

The two large earthquakes that occurred just prior to the first appearance of molten lava apparently occurred along the entire length of the southwestern rift as small tidal waves were reported from Hilo a short time afterwards and by the middle of the day of April 10 thin smoke was already issuing from a crack along the rift at an elevation of about 8,000 feet or at a distance of about 10 miles from the center of the upper outbreak.

The distance to origin as computed from the four seismograph stations located the majority of the earthquakes as occurring near Mokuaweoweo and along the upper end of the southwestern rift. There was no striking change of distance to correspond to a progressive cracking down the mountain side which has been noted at times of other outbreaks both on Mauna Loa and Kilauea.

It is interesting to note that discrepancies in the indicated distance to origin of many of the earthquakes as determined from different seismograph stations could be explained by assuming that the great faults of Mauna Loa are inclined toward the east or have an easterly dip.

R.H.F.

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No. 72 RELEASED WITHOUT COPYRIGHT RESTRICTION May 13, 1926

KILAUEA REPORT NO. 748
WEEK ENDING MAY 12, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The change from a very quiet pit at Halemaumau through April, with the exception of the tenth, the day of the summit outbreak of Mauna Loa, to numerous wall slides beginning May 1, is the only happening of the past fortnight to suggest any sympathy between Kilauea and Mauna Loa. Kilauea motion began when Mauna Loa stopped. During the past week rock falls and avalanches have continued, and steam on the pit bottom has been thin. The northwest rim is shattered so that slides are easily started. On the tenth slides were timed, occurring at 4:30 p. m., 4:41, 4:47, 4:50, and 5:00. They were mostly from the NE and NW walls. After heavy rain this morning there is nearly continuous slipping of rocks there. Steam has ceased to be conspicuous at base of northwest talus; it is sulphurous in the center and at the south.

Thirteen very small local seisms were recorded. A small record of distant earthquake occurred 4:39 a. m. May 12. Ground tilt for the week was moderate SW.

END OF MAUNA LOA ERUPTION

At noon of April 28 T. C. White and Charles Ka of Kona reached the source cones of the Honomalino flows from the northwest by way of Kaohe and Kaapuna in South Kona. They went around the north side of the larger Alika source-cone of 1919, where they could see the whole belt of 1926 heapings along the 1926 crack a half-mile east of them. A mile up the rift were fresh openings fuming with strong sulphur gas, bordered with warm pahoehoe lava in short flows, and coated with bright yellow sulphur needles. Far up the mountain along the crack two steaming places were visible. Opposite and below the Alika vents was a string of new spatter cones for a mile and more. The upper sulphur place was at elevation 7750 feet by aneroid; a high cone in the lower series of 1926 openings gave 7280 feet. From here a small active cone was seen next south along the rift, feeding with lava a small lake a few hundred feet across. The feeding stream was about ten feet wide flowing about five miles an hour. The lake lay in the rift to the south of the feeding cone, and intermittently a big fountain of lava spouted in the southern end of the lake, the action resembling Kilauea lakes. There was no outflow towards Kona seen, and the exceedingly brilliant display which we had seen on the 23rd had greatly dwindled. White's lake appears to have been identical with the big fountain vent, at the source of our lava river. He made the direction of the 1926 rift N. 30 E. changing to approach N.-S. at its southerly end.

In the morning April 30 Honomalino ranch reported dense smoke over the source region. A Kona party of visitors to the upland the next day saw nothing glowing. On May 3 the writer rode up from Kona to the Umi Caverns next the Alika source, and camped there three nights, going by the Kaapuna trail through the On Tai Ranch, and exploring somewhat thoroughly the upper 1926 rift from the new sulphur deposits to the fountain location. All flowing lava activity had stopped, and very hot gas rose from some of the vents, which was spicy sulphur at the upper cracks and sulphur dioxide, making blue smoke, at the lower ones. It was now possible to walk right down the line of new cones, of which there were thirty below the 8000-foot level. Sixteen of these are below the big-fountain location, ending at the slag-heaps west of the 1916 cones, two miles above Puu o Keokeo. There are eight in the zone of maximum output opposite the Alika source. Above this there is a gap of a half-mile with only cracks and sulphur stain. There next occurs a group of small cones and puddled lavas, pahoehoe, and up the mountain farther the new crack occupies a valley amid old hills. The fissure has here vomited pahoehoe cascades, and the openings are coated with beautiful crystals of prismatic sulphur for several hundred feet; this marks the rift brilliantly as seen from a distance, and pale blue fume arises. This whole belt of thirty vents is about four miles long, and lies between elevations 7050 and 8000 feet. The position of the cracked zone is very near that of the 1916 rift, as though extending the latter up the mountain. The 1926 lavas in fact override those of 1916.

The belt of maximum outflow 1926, aboout elevation 7400 feet, has left a half mile of big spatter heaps of frothy pumice forty to fifty feet high in a line trending S25°W, with four or five channels on each side of the ridge leading off at right angles to unite in river beds. These made the Kahuku and Honomalino flows. On the west side the flows bent southward parallel to the spatter ridge and then united to a westerly course. On the east side they pitched down the slope in several separate rivers, and perhaps it was this separation that kept them from making any single big flow. There are large fields of new pahoehoe on both sides; the aa develops after the lava has flowed a quarter mile or more. The fountain lake is now a tumbled smoky channel full of big slabs and semi-aa rubble. This channel meanders in big sweeping curves away towards Kona. An ancient cone is split asunder where the new spatter heaps go through, and the heather bushes show charred stumps. Everything indicates that the rift opened from above downward, and the airplane photographs show that the rift developed southward between the 17th and 19th April. This developed the second Honomalino flow to the south of the Hoopuloa flow.

Looking up Mauna Loa one could see gleaming fields of new lava and two steaming areas along the rift high up. The last puffing effervescence of fume at the lower rift was seen at 9 a. m. May 4. T.A.J.

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No. 73 RELEASED WITHOUT COPYRIGHT RESTRICTION May 20, 1926

KILAUEA REPORT NO. 749

WEEK ENDING MAY 19, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

The frequent avalanching noted in last week's report has ceased. Steam from a vent near south wall and from southwest talus continues abundant. Despite the dry weather several points on the different walls appear quite damp.

Eleven earthquakes were recorded during the week. One at 1:34 a. m., May 14, was plainly felt at Waiohinu and at other points in Kau. Tilting for the week was moderate to the SW.

VOLCANOES AND AIR TEMPERATURES

In the immediate vicinity of volcanoes, fumaroles, and hot springs it is quite common to find air temperatures higher than in places more remote from the vents. Volcanoes exert a warming effect.

The amount of heat given off by Halemaumau when there is a large lake of molten lava present is rather startling. In January and Febraury, 1924, there were times when the heat escape from Halemaumau was equal to the heat produced by the complete combustion of one and a half tons of coal per second. Most of the heat quickly escapes to space but when smoke and steam clouds are present the warming effect may be noticeable for considerable distances from the vent on the windward as well as on the leeward side.

The escape of smoke, steam or water vapor and air even at moderate temperatures from fumaroles, hot springs and hot cracks tends to increase the temperature over small areas. The heating ffect of steam and warm air escaping from the many cracks in the vicinity of the Observatory is the main reason why with a heavy frost only 1500 feet away where there are no steam cracks the lowest temperature at the Observatory may be only 43° Fahr. It is possible to sleep without blankets along steam cracks at an elevation of 13,000 feet on Mauna Loa while only a few feet away freezing temperatures would be encountered.

All lava flows, of course, tend to raise the temperature in their immediate vicinity as long as they remain hot. A lava flow through a forest even after it has cooled off tends to slightly increase the average temperature by reducing evaporation. The rain quickly percolates through the lava and drains away underground and with no vegetation there is but little evaporation.

There is another and much more profound effect of volcanoes on temperatures that is just the opposite from the above—a cooling effect. The lowering of the temperature is often very widespread and in many cases the entire world is affected. The cooling effect of volcanoes is produced by violent explosions hurling great quantities of fine dust into the upper atmosphere where it may persist for several years and shut out incoming solar radiation.

One of the earliest recorded volcanic eruptions believed to have had some effects on world temperatures was that of Vesuvius in A. D. 79. Another eruption of Vesuvius in 1631 that sent up a dust cloud to a height of 30 miles was followed by cool weather in 1632 and 1633. The average of world temperatures makes the year 1785 one of the coldest on record. This cold year as well 1784 and 1786 is attributed to a violent explosion of Asama in Japan in 1783 aided by activity of Skaptar Jokull in Iceland durin gthe same year and of Vesuvius in 1785. Following the great explosion of Tomboro near Java in 1815 the whole world was remarkably cool in 1816. 1816 was frequently called "The year without a summer."

Explosions in more recent years have also produced cooling effects. The Krakatoa explosions in 1883 which sent up a dust cloud to a height of 17 miles was followed by world wide lowering of temperatures in 1884 and 1885. This dust cloud produced visible sky effects for three years. Katmai's explosions in 1912 produced a cooling effect especially noticeable in the northern hemisphere. An extensive volcanic eruption in the Chilean-Argentine Andes in December 1921 not only affected the southern hemisphere but produced noticeable results in the northern hemisphere.

Volcanic explosions may be of tremendous economic importance not only because of resulting rigorous winters in the temperate zones as in 1783-84-85, but also by the lowered temperatures greatly diminishing crop yields as in 1816.

Observed cooling effects have been such as to lower the average world temperature three degrees Fahr or more. If violent explosions from several different volcanoes should nearly coincide in time the effect might be very profound. Volcanic dust has been advanced as one of the causes of the ice ages. It is interesting to note that a lowering of the average temperature over Mauna Kea by but a few degrees would be sufficient to produce glacier conditions on that mountain. Many places now well populated might become glaciated by a lowering of the mean annual temperature only a few degrees for several years.

R.H.F.

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No. 74 **RELEASED WITHOUT COPYRIGHT RESTRICTION** May 27, 1926

KILAUEA REPORT NO. 750

WEEK ENDING MAY 25, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

Halemaumau continues quiet. Small rock falls are heard occasionally. On May 22 the steam vent at the south edge of the pit floor which usually omits more steam than any of the other vents was scarcely noticeable while the vents in the southwest talus and in the north floor were steaming as usual. This indicates that there is a variation in the amount of steam that escapes from the different vents. There is, of course, a large apparent variation due to variations in atmospheric conditions.

Considerable interest was taken in large white clouds that hung over Mauna Loa during the afternoon of May 24. This type of cloud may be seen quite frequently. It is primarily due to the heating of the mountain slopes during a clear non-windy day. Occasionally such clouds may be seen over Mauna Kea. The many steam vents on Mauna Loa naturally aid in the formation of such clouds.

Seven local earthquakes all too small to be perceptible at Volcano House were recorded on Observatory seismographs. This is the smallest weekly total since February.

There was a strong north-northeast tilt during the week.

BULK DISPLACEMENT DUE TO TILTING

In Volcano Letters No. 41, October 8, 1925 and No. 61, February 25, 1926, short discussions of tilting and the resulting changes of level at Kilauea volcano may be found. The exact amount of subsidence is not yet definitely known nor are the limits in distance from Halemaumau to which the subsidence may be detected by precise levelling. Determined values, however, indicate that detectable sinkings may be found 20 miles or more from Halemaumau. Preliminary values which will probably have to be increased when more determinations are made indicate that the subsidence of Kilauea during 1921-1924 inclusive ranged from 13-14 feet at Halemaumau to a tenth of a foot or more 20 miles to the northeast.

Tiltings to produce elevation changes of the above amounts and to such distance from a volcano center are not unknown. The subsidence accompanying the Sakurajima eruption in 1914 amounted to nearly nine feet at the mountain and was still large enough to be measurable over 30 miles away. At Kilauea there was a swelling up of the mountain from 1913 to the beginning of 1921 whose value probably nearly equaled that of the subsidence from 1921 to 1924. Mauna Loa appears to give surface manifestations of changes of internal pressure by tiltings of its great dome but there are no quantitative data at hand for this mountain. Shoreline elevations and subsidences have been noted at many places on the earth's surface. Elevation changes take place in regions without active volcanoes as well as in active volcano regions.

In a region like Kilauea volcano computation of the volume involved in changes of elevation is difficult unless a very elaborate net of levels are run. The value of the elevation change may jump suddenly when a zone of cracks in the earth's surface is crossed while on either side the values may change systematically. Two wide crack zones lead away from Halemaumau, one leading to the southwest and the other to the northeast.

By using the preliminary data determined for a northeasterly direction and assuming a symmetrical subsidence about Halemaumau as a center it may be shown that the volume of land withdrawn by subsidence during 1921-1924 amounted to 20,000,000,000 cu. ft. This is nearly three times the amount engulfed during the collapse of Halemaumau in 1924. If there was no compensation by elevation at other places on the Island of Hawaii it would mean that the volume of the island above sea level was decreased by the above number of cubic feet. The estimated volume displacement at Sakurajima in 1914 is about one-fourth of the above. Owing to the average porosity of the rock involved it is probable that the weight of the 20,000,000,000 cu- ft. was not much over one and one-quarter billion tons.

At times of solar eclipses the moon frequently shows an apparent error of as much as four seconds of time in her computed schedule. Dr. E. W. Brown of Yale University in discussing causes for the apparent erratic behaviour of the moon suggests that the earth my be at fault. He computed that shrinking and tumescing of the earth to the extent of a few feet in a comparative short period of years would be sufficient cause to account for the apparent failure of the moon to travel by schedule. In the foregoing discussion tumescing and subsiding have been shown to take place over small areas and it would seem to be easily possible for some such movement to take place over large areas. R.H.F.

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No. 75 RELEASED WITHOUT COPYRIGHT RESTRICTION June 3, 1926

KILAUEA REPORT NO. 751

WEEK ENDING JUNE 2, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

In all its recorded history Halemaumau was never more quiet than it is at present. There has been a noticeable decrease in the steaming from the vent on the south floor of Halemaumau and a slight increase at the north. Avalanching still takes places though not very frequently. Aside from anything due to the recent activity of Mauna Loa that mountain for months has been emitting more actual smoke than has Kilauea.

Six earthquakes were recorded during the week. One at 7:10 p. m. May 31 was perceptible and had an indicated distance to origin of 22 miles. Tilting was slight to the southwest.

ANCIENT VOLCANOES

In the earliest known geological ages volcanism or other forms of igneous action was very general. From these early times on there appears to have been fluctuations in volcanic activity. There were periods of great volcanic activity all over the world followed by periods of quiet. During the relative quiet periods, however, it is probable that many volcanoes showed activity. It is probable that there will be periodic fluctuations in activity in the future.

There are but few places in the world where one would have to travel far to see effects of ancient volcanism. Were there no active volcanoes in the world today one could get good impressions of how lava flows behaved and of the formation of volcanic cones by studying ancient volcanic regions.

Not conspicuous to everyone but obvious to all when the formations are pointed out is the fact that at one time there was a volcano near the site of New York city. In Auvergne—south-central France—there are many cones produced by volcanic activity thousands of years ago. These cones, as a rule, are in well defined zones showing that they were located over active fissure belts. They are among the best preserved forms of ancient volcanic activity to be found anywhere. A photograph showing several of these cones, excepting for the vegetation, looks very much like a photograph on some of the higher parts along one of the great rifts of Mauna Loa.

In Great Britain there are many remains of ancient volcanism. The subject is so extensive that Sir Archibald Geikie in writing on the subject, "Ancient Volcanoes of Great Britain," found it necessary to fill two large volumes in order to make the discussion at all comprehensive.

Pisolitic ash similar to that produced at Kilauea in 1790 and to some extent in 1924 may be found in certain strata in western Germany. This shows that explosive volcanic eruptions took place in Germany. This type of ash is produced by rain drops falling through dust laden atmosphere collecting so much dust that they fall as mud pellets. Owing to natural cementing qualities of the ash they more or less retain their round shape. There is some justification in calling pisolites, "fossil rain drops."

Probably the largest lava flow of old geologic times that may be traced quite clearly took place in India. It is known as the Deccan Trap and is still exposed over an area of 200,000 square miles. The original area was probably much greater. Its thickness varies from 4,000 to 6,000 feet.

More recent than the Deccan flows were the ones in Oregon, Washington, and Idaho which extended over an area of about 200,000 square miles. The accumulation in thickness of these flows vary from a few feet to over 2,000 feet.

Still earlier than the Deccan flows there was a flooding over a vast area in the Lake Superior region. This flow took place so long ago that its evidence is not striking. It is remarkable in having produced fills as much as 15,000 feet in thickness.

In prehistoric times but very recent there was activity in the southern part of Californa and Arizona. Beautiful volcanic cones nearly as fresh as though they were formed but yesterday may be seen. In northern California, western Oregon and Washington it appears that there was a gradual decline of volcanic activity to present day conditions.

In the San Jose valley in New Mexico there is a very fresh looking pahoehoe lava flow. There is an Indian legend handed down for several generations of a river of fire in this valley. This legend would make the flow one of comparatively recent times. The freshness of the lava adds to the plausibility of the legend.

In recent times the most active producers of lava have been the volcanoes of Iceland. In 1783 from one volcano system, Laki, lava poured forth to the extent of 420 cubic miles.

R.H.F.

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No. 76 RELEASED WITHOUT COPYRIGHT RESTRICTION June 10, 1926

KILAUEA REPORT NO. 752

WEEK ENDING JUNE 9, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

During the week 11 local earthquakes were recorded on the Observatory seismographs. On June 4 at 1:53 a. m. one of the shakes was slightly felt in Hilo. Another shake at 9:35 a. m. June 9 was rather widely felt over the island of Hawaii. It was strong enough to shake objects off shelves at Kapapala and dismantled the seismographs at Volcano Observatory. The indicated distance to origin from Volcano House was 16 miles southwest. A slight record of a distant shake was written at 9:35 a. m. June 5. Tilting for the week was moderate to the south-southwest.

Halemaumau continues quiet with but few avalanches. Following the recent rains the walls are quite red.

Snow was observed on Mauna Kea during the afternoon of the 7th but none was visible on Mauna Loa.

MUD VOLCANOES

A rather comprehensive definition of volcanoes has been given about as follows: It is an orifice in the crust of the earth commonly terminating in depression or crater whose sides mark the summit of a mountain or hill. From the crater are ejected—sometimes continuously, sometimes with long intervals of quiscence—hot water, steam, gases, dust, gravel, broken stone, or molten lava. The ejection of the different kinds of materials depends upon the condition of the volcano and its age. According to the above definition lava flows, explosions, steam and gas vents, geysers, mud volcanoes, and some hot springs are but surface manifestations of more deep seated volcanic processes.

The Italians have given names to several types of decadent volcanic activity. The name solfatara is applied to vents emitting chiefly steam and sulphurous vapors. Examples are found in many active volcano regions. Soffioni is a term used to designate volcanic vents which emit steam, hydrogen sulphide and carbon dioxide. These may occur in regions of recent volcanic activity but away from present day active regions. Mofetta is a name given to volcanic discharge consisting chiefly of carbon dioxide. Examples of the latter are rather widespread, and some are quite well known such as Death Gulch in Yellowstone Park and Valley of Death in Java. In the Valley of Death not only may the bones of birds and beasts be found but also the bones of men.

The conditions necessary for the formation of a mud volcano depends largely upon the nature of the ground through which hot water and steam escapes. If the ground is of unconsolidated material like clay or tufa mud volcanoes may result and build up cones varying in height from a few feet to 500 feet or more.

Frequently, as at the Vesuvian eruption of A. D. 79, large explosive eruptions are accompanied by mud flows. Such mud streams result from heavy rains occurring at the time of the explosion mixing with the ejected dust in the air or on the ground or in both places and are not the product of true mud volcanoes.

Mud volcanoes often discharge streams of mud frequently exhibit fountaining when the vents are surrounded by a mud lake. In the northern part of Lower California near the California border rather spectacular fountaining may frequently be seen. Cheduba and other small islands in the northeastern part of the Bay of Bengal near the Burma coast contain a chain of mud volcanoes. In this chain in 1906 a new island of mud was thrown up that had an area above the water line of 600,000 sq. ft. A mud volcano, Gorela, near Kertch in Crimea with a cone 264 feet high has sent forth several streams of mud. The volume of one of these flows was estimated to have a volume of over 22,000,000 cu. ft.

Mud volcanoes are commonly located in extinct volcano regions (extinct, meaning not producing molten lava nor ash) or over rather quelt fissures in active regions. The "paint pots" in Yellowstone National Park are mud volcanoes in a region where volcanism has been extinct for thousands of years. Mud volcanoes are found on Mount Etna an active volcano region. Tikitere, a valley in New Zealand, containing many mud volcanoes is near active volcanoes.

That mud volcanoes may afford an interesting sight may be gleamed from the following description of mud volcanoes of the north of Iceland: "From the plain of mud vast clouds of steam rise into the air, while a low drumming sound proceeds from many sources. Vents are numerous but there are especially 12 large one in which the slime is boiling. In some the mud is as thick as molasses while in others it is smiply ink-black water. The thundering and throbbing of these boilers, the thud of hot waves striking banks, the scream of escaping steam at the edge of a blue-slime pond produce a horrible effect. In some places the mud is boiling furiously in others bells of black ooze rise and explode into scalding sprinklings. The whole is a frenzied roaring pool of slush. R.H.F.

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THE VOLCANO LETTER

A Weekly news leaflet of the Hawaiian Volcano Research Association

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No. 77 RELEASED WITHOUT COPYRIGHT RESTRICTION June 17, 1926

KILAUEA REPORT NO. 753

WEEK ENDING JUNE 16, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

At daylight the morning of May 11 and for over an hour thereafter Halemaumau was a spectacular sight. The pit was full of steam and from the rim a continuous, rather dense, steam cloud extended upward to a height of about 1500 feet. With no other cloud around and the entire column well illuminated by the sun it looked as though Halemaumau were in eruption.

The vent at the south edge of the pit floor is again emitting much more steam than any other vent inside the pit. Avalanching is rather in frequent though small rock falls at least can nearly always be heard.

During the week 10 earthquakes were recorded. All were too small to be perceptible at Observatory.

The net result of tilting was slight to the northwest. This is the usual direction of tilting for this time of the year. Tilting so far this year has been greater than during 1925. The direction of tilting during the first half of the year is normally to the south. During 1925 the accumulation of southerly tilting amounted to 7.5 seconds of arc and in 1926 it amounted to 12.6 seconds. The westerly tilt now going on will probably continue for two more months but already the 1926 westerly tilt exceeds the total of 1925 by over one second.

BORINGS IN KILAUEA CRATER

Some progress is being made in the boring on the floor of Kilauea crater. (See Volcano Letter No. 66, April 1, 1926.) One hole was drilled through rock that at the surface showed only ordinary temperatures though only 75 or so feet away there were steam cracks. After reaching a depth of about a foot a temperature of 194° Fahr was encountered. This temperature was constant for about four feet and is a few degrees higher than the natural steam vents in the neighborhood. Upon going deeper a lower temperature was encountered. At a depth of 10 feet the temperature was 172° Fahr or 20° less than at one foot below the surface. When the temperature of the hole was again measured a few days later it was found that the bottom of the hole had become slightly hotter. The amount of steam escaping from the hole when it is uncapped is very slight and the velocity of escape is low.

R.H.F.

ACTIVITY ON ISLAND OF REUNION

A. Lacroix recently reported to the Paris Academy of Sciences that a lava flow from the volcano Piton de la Fournaise, Reunion, started on December 30, 1925. The volcano is apparently in a period of active output as there was another flow in September 1924. This volcano resembles Kilauea in being classified as continuously active. It has been mentioned in Volcano Letters No. 4 January 22, 1925 and No. 24 June 11, 1925. The active cone rises to a height of 8600 feet above sea level. Glow can be seen over the mountain nearly every night. Frequently the flows that pour down the side of the mountain are of pahoehoe nature and develop lava tubes in which lava stalactites may be found.

R.H.F.

JAPAN'S LATEST VOLCANIC ERUPTION

Tokachi-dake and its companion peak Mount Iwo became active suddenly on May 24 after having been quiet for a long period. Mount Tokachi is the next to the highest peak on the island of Yezo. It rises to a height of 6541 feet above sea level.

The outbreak was heralded by preliminary rumblings so that many people in especially dangerous areas escaped. It was fortunate for those who were forced to flee and for rescue work that the outbreak occurred in the day time. A railroad train that was entering the dangerous district was turned back just in time to escape its being overwhelmed. Both lava flows and explosions accompanied the eruption. The roar from the explosions were reported audible 20 miles away. One river was damned by a lava flow and another by explosion debris. The water impounded in these damns later on broke loose and caused floods in the valleys below. The worst flood was caused by the rupture of a mountain lake which let loose a flood that rushed forward as a wall of water 30 feet high. The outbreak quickly diminished in vigor though ashes and smoke were intermittently emitted for some time after.

It is thought that about 400 lives were lost; lava flows, floods, and explosions each taking a share. Newspaper reports, from which most of the above facts were taken, state that 144 bodies were recovered within two days.

R.H.F.

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No. 78 | **RELEASED WITHOUT COPYRIGHT RESTRICTION** | June 24, 1926

KILAUEA REPORT NO. 754

WEEK ENDING JUNE 23, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

Halemaumau continues to be very quiet. Large avalanches have been rather infrequent though rock falls continue. Judging from the numerous cracks and shattered rock at many places on the rim, Halemaumau walls are still quite unstable. With the increased day temperatures during the past week the amount of visible steam escaping from the vents in the pit has lessened. A sulphur stained patch on the south-southwest wall is becoming more conspicuous.

20 earthquakes were recorded during the week. This is the largest weekly total since the eruption of Mauna Loa ceased. Only two of the shakes were perceptible at Observatory. One of these, at 4:56 p. m., June 19 with an idicated distance to origin of two miles, was preceded by a rumble. The other, at 12:46 p. m., June 22, had an indicated distance to origin of 15 miles.

Daily tilt values were small, the net result for the week being slight to the north-northeast.

VOLCANIC FLAMES

Where the recent lava flow from Mauna Loa crossed the road at Honomalino, banners of flames issued from numerous vents on each side of the flow. The flame jets varied in height from a few inches to over six feet. They were pale blue in color and at night brilliantly illuminated the approach to the flow. Through a pocket spectroscope the flames showed only the lines that are characteristic of sodium. Some of the vents from which the flames issued were 50 feet or more from the edge of the flow. The distance of the flames from the flow and the fact that they continued for hours led some people to conclude that they were of true volcanic origin arising from gases issuing from the lava. Speculations of the lava burrowing its way underground were even heard. The flow here went through a forest and, of course, the flames were of burning gases produced by distillation of vegetal matter underground. The ground is very porous and the amount of vegetal matter in it is very large. The flow crossed the road at a fill where the amount of underground vegetal matter was much more than normal. When the flames began they often issued as explosive puffs, but after a large part of the air in the underground cavities was expelled an explosive mixture was no longer formed and they issued as nearly continuous banners.

Farther up the mountain where the flames did not continue so long there were often true explosions. Occasionally small trees were blown bodily into the air and larger ones uprooted. The explosions were frequently large enough to be heard 3-4 miles away. Flames were seen to follow many of the explosions. Alongside the flow in higher and drier country near the timber line, fires ran underground as much as 300 feet from the edge of the flow and small explosions were noted at that distance.

In a flow from Kilauea in 1919 over pahoehoe lava with scanty vegetal covering, gases accumulated in small caverns and when exploded would blow the roofs of the caverns to pieces.

Along all lava flows in a region where there is any vegetation there is a distinct odor of burning hydrocarbons produced by destructive distillation of vegetal matter in addtion to the usual odor of burning wood. The odor of burning hydrocarbons near the source of the 1916 lava flow from Mauna Loa led to the conclusion that hydrocarbons in considerable quantities were a natural exhalation of Mauna Loa. Such a conclusion is probably not true as there is considerable vegetation along the southwest rift of Mauna Loa as high as 8,500 feet, or several miles above the 1916 source. The source of the main flows from Mauna Loa in 1919 and 1926 were in the same region as that of 1916 and the peculiar hydrocarbon odor was noticed in these years also. At the upper outbreak in 1926 in the neighborhood of 13,000 feet where there is no vegetation, the odor was lacking.

Flames of strictly volcanic nature have been observed on numerous occasions and at many different volcanoes. At Kilauea the flames are usually of a bluish tint, though occasionally they are of a yellowish color and often play over a vent for hours at a time. Intermittent jets of flame frequently issue from cracks in the crust on a molten lava lake. Great banners of flame a hundred feet or more in height, indistinctly seen on account of fume, have been noted accompanying Mauna Loa fountains.

Gases collected over true volcanic flames are chiefly water vapor, together with sulphur dioxide, carbon dioxide and lesser quantities of other constituents. This indicates that hydrogen may be the chief source of volcanic flames.

R.H.F.

Correction: The date "May 11" in Kilauea Report of Volcano Letter No. 77, should be "June 11."

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No. 79 RELEASED WITHOUT COPYRIGHT RESTRICTION July 1, 1926

KILAUEA REPORT NO. 755

WEEK ENDING JUNE 30, 1926
Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

Halemaumau shows no signs of activity. The most conspicuous steaming vent in the pit is at the northwest. Faint sulphurous odors may be distinguished on the rim.

The number of earthquakes recorded during the week was 16. Four of the earthquakes were slightly perceptible at Observatory. Two that occurred at 9:20 p. m., June 23 and at 11:18 a. m., June 27 respectively, caused pheasants to squawk and had indicated distances to origin of one mile. The strongest shake of the week occurred at 3:27 a. m. June 30 and had an indicated distance of 14 miles.

A distant earthquake was recorded at 4:08 a. m. June 29 with an indicated distance of 4750 miles. A shake was reported from near Singapore about this time.

Tilting for the week was moderate to the East-northeast.

SUBMARINE VOLCANOES

It is not uncommon for sea captains to report passing through seas of pumice or turbulent waters, the result of submarine volcanoes. When one considers the number of land volcanoes and the fact that three fourths of the earth's surface is covered with water it is easy to imagine a rather large number of volcanic vents on the ocean floor.

Before a great many of the present day active volcanoes developed in height so that their throats remained permanently above water they would have been classified as submarine volcanoes. Many known extinct volcanoes passed through the submarine stage. Both Vesuvius and Etna as well as Stromboli started from the floor of the Mediterranean.

Numerous islands in the Pacific ocean are of volcanic origin. Others that are classified as coral islands may be rally volcanic with a coral cap. Islands might be covered with a coral growth either if their summits never quite reached to sea level before the volcano became extinct or if they were once higher and were eroded to below sea level. The great depth of the ocean around many of the coral atolls in the Pacific ocean points to a volcanic foundation.

The elevation of entire islands or parts of them may have been greatly reduced by subsidence. Penguin Bank west of Molokai in the Hawaiian group may have been much higher once and its elevation reduced more by subsidence as a whole than by erosion. The outline of the Bank is marked by submerged cliffs where the depth of the water abruptly changes from an average of 240 feet to an average of 1320 feet. Magnetic observations as well as topography indicates that the base of the coral atoll of Funafuti in the Ellice group is of volcanic origin. A boring in this island to a depth of 1114 feet, however, failed to reach the igneous base. The island may have been sinking coincidental with the coral growth.

The Hawaiian Island group have been elevated from a depth of 15,000 to 18,000 feet below sea level, unless we assume the rather untenable theory that the group is but a remnant of a large land mass now submerged. The volume of land of the Hawaiian Islands above water is but a small percentage of the great volume below sea level. This volume relation is true of the majority of volcanic islands because there is a great ocean deep adjacent to nearly all volcanic regions.

Occasionally at the present time new islands are born. Some live for but a short time while others make permanent additions to the land mass above sea level. An effect of the short-lived volcanic island may be the production of a shoal where once there was deep water. Graham Island was born in the Mediterranean about 30 miles southwest of Sicily in July 1831. The birth was heralded by a column of water 800 feet in diameter and 60 feet high quite suddenly appearing at a place where the Mediterranean was 600 feet deep. The water column was shortly followed by steam clouds and presently an island of pumiceous material appeared. It quickly reached a height of 200 feet with a circumstance of three miles. Within six months the island had quite disappeared though the top of its submerged remnant is but 9 or 10 feet below sea level. In 1891 there was a submarine eruption in this same general region but no island appeared. Near Bogosloff volcano in the Bering Sea an island, New Bogosloff, appeared in 1883. It appears to be a permanent addition to the land in Bering Sea. Near the Azores a short-lived volcanic island was formed in 1811. A submerged volcano near Saint Miguel in the Azores appears to be active occasionally. Several temporary islands have been reported in the Pacific. Some that persisted for a few years and were several times observed were placed on maps but later on utterly disappeared. R.H.F.

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No. 80 RELEASED WITHOUT COPYRIGHT RESTRICTION July 8, 1926

KILAUEA REPORT NO. 756

WEEK ENDING JULY 7, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

During the past week there has been a revival of avalanching from the walls of Halemaumau. Frequently the avalanches are large enough to send dust clouds well above the pit rim. Most of the slides have been from the north wall, usually from near the top of the wall. The echoes of the roar produced by the largest avalanches produce wierd noises.

During the recent dry spell the deposit of white salts, sulphates, have been quite conspicuous around Halemaumau pit especially on the southwest side.

The strong wind that blew on July 5 stirred up great dust clouds in the desert to the southwest of the volcano. Whirlwinds in the dust clouds greatly increased the dark appearance of the cloud. Small clouds were stirred up in the middle and southwest parts of Kilauea crater. The north end of the crater where the total dust fall of the explosions in 1924 amounted to only an inch or two is now quite free from dust. Owing to the trade winds there has been a quite constant progressive movement of the dust toward the southwest. Though it has been over two years since the explosions the appearance of the desert on July 5 closely resembled its appearance following many of the explosions.

The 12 earthquakes recorded during the week were all too small to be perceptible at Observatory. About half of them appeared to be of Mauna Loa origin.

Tilting for the week was moderate to the north-northeast. The greatest amount of the tilt occurred on the 5th and 6th of July.

THE RATE OF DISSEMINATION OF VOLCANIC DUST

The eruption of Krakatoa in 1883 not only caused widespread dust clouds in the lower atmosphere but also sent great quantities of dust into the upper atmosphere well above the level of the highest clouds. Dust was collected over 1100 miles from the vent and the dust that reached the upper atmosphere spread all over the world. Such a dust cloud in the upper atmosphere throws light on the air currents in that region. Other great explosions have occurred but few have been so widely observed. From known air currents over equatorial regions it is to be expected that the dust would spread around the world over the equator quicker than over places nearer the poles.

Professor Stentzel of Hamburg has collected data on the rate of travel of these high dust clouds and estimates the average speed of propagation to be from 85 to 125 miles per day. The actual velocity is, of course, much greater as the dust does not travel out in straight lines to all places from the explosive vent but pursues greatly curved paths before it appears over most stations.

A newspaper account reviewing Professor Stentzel's work states that the dust from the Mauna Loa outbreak on April 14, 1926 may be expected over Europe some time in July. As no dust cloud was produced by Mauna Loa this year such an expectation will not be fulfilled. R.H.F.

THE IMMANUEL FRIEDLANDER VOLCANO INSTITUTION

A discussion of The Volcanological Review and notes on some of the articles published in it were given in Volcano Letter No. 15, April 9, 1925. This review is the official organ of the Volcano Institution of Immanuel Friedlander. The institution is organized under Swiss laws and is now located at Zurich. Its work is encouraged in Italy, Swizerland, Germany, and elsewhere. The chief concern of the institution is the observatory building at Naples. Active in addition to Dr. Friedlander, the director of the institution, there is an assistant editor for the Volcanological Review, a chemist, a petrographer, a seismologist, and others. The institution is very much like the Hawaiian Volcano Research Association in its scope and supports scientific publications, trips for making scientific investigations, compilation of material, and loans instruments. R.H.F.

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No. 81 RELEASED WITHOUT COPYRIGHT RESTRICTION July 15, 1926

KILAUEA REPORT NO. 757

WEEK ENDING JULY 14, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

The avalanching from the walls of Halemaumau reported last week has continued during this week. Most of the avalanching is still from the north wall. On several days the avalanches, both large and small, were so frequent that when the pit was not filled with dust it was quite hazy. The scars on the walls from which avalanches broke loose are much brighter than the rest of the walls and often show considerable deposits of salts. The sulphur stained patches in southern part of the pit have been greatly dimmed by dust from avalanches. The amount of steam escaping from the pit floor does not seem to vary greatly. The steam vents may be roughly grouped into three lines that cross the bottom of Halemaumau from north to south.

Despite the large number of avalanches the number of earthquakes has not greatly increased. Of the 18 shakes recorded during the week four appeared to be of the type that accompany avalanches. The only earthquakes large enough to be at all perceptible during the week occurred at 8:15 a. m. July 12. It, apparently, caused a rather large avalanche as a dust cloud that rose well above pit rim was observed shortly after the earthquake.

Tilting for the week was slight to the south-southeast.

In answer to the question, "Is Kilauea dead?" it can be said that not only is there no evidence pointing to the fact that Kilauea is a dead volcano but also there is evidence that it is still active internally. When lava is present in the pit there is often a variation in the internal pressure of the volcano system that causes the top of the visible lava column to vary in height from 600 feet below the rim up to the rim level. An internal and unseen variation in the height of the lava column may also be possible. Records at the observatory show that the internal pressure of the Kilauea-Mauna Loa volcano system has been increasing since June 18, 1926. The increase of pressure is manifested by a swelling of Kilauea mountain that is recorded as a northeast tilt at the Observatory. There is a normal westerly tilt closely following the seasonal temperature curve from the last of winter until August. When the seasonal temperature starts to decrease in August the direction of tilting normally changes from west to east. This year not only has the westerly tilting been arrested nearly two months prior to the normal time but there has been an accumulation of easterly tilt since June 18. The 1926 tilt curve is closely parallel to the 1924 tilt curve that preceded the return of lava to Halemaumau in July of that year.

THE RETENTION OF HEAT IN LAVA FLOWS

Two and a half months after the 1926 lava flow from Mauna Loa crossed the road at Honomalino it is still quite hot. At some places even the rocks that are well exposed, as at the edges of the flow, are so hot that they hiss when water is thrown on them. Where the flow entered the sea the water is still warm. In some of the small protected arms of the sea the water is so hot that it is unbearable to the touch.

Some cracks in the Mauna Iki lava flow that poured onto the Kau desert from Kilauea in 1920 are still hot enough to ignite a stick of wood. It seems probable that a part of the heat found in lava flows long after the time of issue may be due to chemical action. R.H.F.

THE KEAIWA FLOW OF 1823, HAWAII

In Volcano Letter No. 18, April 30, 1925, attention was called to the fact that since 1920 the Keaiwa lava flow to the southwest of Kilauea which had been assumed to be of the 1868 has been correctly called an 1823 flow.

This flow is the subject of a paper by J. B. Stone in the American Journal of Science for May 1926. The flow, of typical olivine basalt, poured out along the southern half of a fissure 11 miles long. It flowed out so rapidly that a canoe was burned at Mahuku. One of the most interesting features of this flow is the "ball-lava" which may be seen at a few places in the upper portion of the walls of the crack from which the flow issued. It is assumed that the lava balls were formed by cool fragments of lava falling into the crack where molten lava was surging and after growing by acquiring coatings of molten lava during the churning action were hurled out as smooth rounded balls. Two small explosions with possibly some smaller ones marked the closing stage of the flow.

An excellent description of this flow, among other things, is contained in a paper on the above subject by H. T. Stearns in the Journal of Geology, for May-June 1926. In the abstract by Stearns he states that there is evidence that the usual fire fountains of Hawaii did not play during the eruption. Spatter that is found at the edge of the flow shows that there were rather tall fountains accompanying the eruption. Excepting for the fact that this spatter is not pumiceous the action along this crack in 1823 must have been quite similar to the preliminary Mauna Loa eruptions near the summit in 1916, 1919, and 1926. R.H.F.

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NO 82 RELEASED WITHOUT COPYRIGHT RESTRICTION July 22, 1926

KILAUEA REPORT NO. 758

WEEK ENDINIG JULY 21, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

There has been a considerable dimunition in the number of avalanches from the walls of Halemaumau that became especially frequent about the first of July, and continued for over two weeks. Rock falls and small avalanches may be seen and heard neraly every day however. There was a large slide from the southwest wall though the north wall still appears to be more unstable than the others.

Following moderate rains the walls of Halemaumau were quite red on July 19. The red color makes ats appearance as a series of horizontal parallel bands separated by layers of quite dense gray strata whose color changes but little. These pleasing color contrasts give Halemaumau a very striking appearance.

It has now been two years since the lava returned to Halemaumau, after an absence of about three months, to stay for only 12 days and therefore nearly two years that there has been no lava in the pit. Halemaumau was without lava duruing a large part of the thirteen year period from 1894 to 1907. During most of this period considerable smoke issued from the pit, while in the last two years there has been but very little smoking and at present practically no smoke escapes.

There has been practically no change in the location of steam vents during the past several months though the place of maximum steaming is at the northwest instead of at the south as formerly.

Earthquakes continue to be quite frequent. Twenty-two were recorded during the week. All were too small to be perceptible at Volcano House. Several appeared to have indicated distances equal to that of Mauna Loa.

Tilting for the week was slight to the north northwest. There was a strong spurt of north-northeast tilt on July 20.

LAVA TUBES

One of the most interesting and picturesque of volcanic formations are lava tubes or tunnels. Nearly every pahoehoe lava flow produces tubes, large or small.

The most common type of tube is produced by a crust forming over a lava river that initially flowed over the surface of the ground laterally confined by banks of its own making. After the crust is formed over the river the lava continues to flow underneath much as a water river does when it freezes over. When the activity ceases, the lava drains away, leaving an empty tube.

There is another type of tube that is not so frequently observed. This type is formed by lava pouring through a crack or fissure often several hundred feet below the surface. The presence of such tubes in subterranean lava flows can usually only be surmised. In the southwest wall of Halemaumau, 275 feet below the rim this type of tube is exposed. Initially this tube was but a narrow crack into which lava started pouring in 1919. A tube of considerable dimensions and over six miles long was quickly developed. The "Devil's Throat" and some similar holes, 250 to 300 feet deep in the Kau Desert southwest of Halemaumau are but breakdowns in the roofs of such tubes.

Lava rivers follow the topography just as water streams do but in several respects they are just the reverse of water rivers. The greatest volume of lava is at the source. The discharge is often through small tubes that spread out like the delta of a river. Lava tubes have been observed to be nearly horizontal, steeply inclined, and even practically vertical. The later occur where lava cascades over a cliff.

The picturesqueness of lava tubes is often increased by stalactitis and stalagmites. Two widely different types of stalactites are often present. The more common type is composed of lava and is formed by the melting action of burning gas that escapes from the lava river as it flows through the tube. In some places the roof of a tube may be quite thickly covered with these stalactites. The length of the stalactites vary from an inch or less to over three feet. Lava stalactites three feet in length with an average diameter of only half an inch have been found. Probably a large portion of the drip from stalactites fall into the lava river below but where the drip falls onto a ledge above the lava level stalagmites may be found. The stalagmite formation often resembles a bunch of petrified grapes.

The other type of stalactite occasionally found in tubes is composed of sulphates. They are formed after the tube has started to cool off but when it is still quite hot by rain water percolating through the roof of the tube and dissolving the sulphates that have been formed in the material of the roof. They often show a variety of colors and make a tube quite beautiful. Being, for the most part, quite soluble they quickly disappear when the tube cools off.

Lava tubes are found at many places in both recent and ancient lava flows. There is a lava tube on Mt. Shasta, Calif., with a roof 60 to 80 feet high. One can not travel any distance on either Kilauea or Mauna Loa without encountering lava tubes.

R.H.F.

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No. 82 RELEASED WITHOUT COPYRIGHT RESTRICTION July 29, 1926

KILAUEA REPORT No. 759

WEEK ENDING JULY 28, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

While there has been no surface manifestation of unusual activity at either Kilauea or Mauna Loa during the past two weeks, the Kilauea-Mauna Loa volcano system is passing through a crisis as real, from the Observatory standpoint, as though molten lava had been present. The northeast tilt that started on June 18 appears to have stopped and during the past week there was a slight northwest tilt. With the change in the direction of tilting there has been an increase in earthquake frequency. Thirty-three separate, small earthquakes were recorded. In addition to the thirty-three shakes there was a nearly continuous tremor from 9:30 a. m. to 1:30 p. m. July 22. A similar tremor was noticed for four hours during the afternoon of July 26.

During the last two or three days there has been a slight increase in avalanching from the walls of Halemaumau. All walls appear to be in motion though the greatest number of avalanches appear to have fallen from the west wall.

The fume column that can usually be seen over Mauna Loa in late clear afternoons was especially conspicuous in the afternoon of July 28. It rose as a rather narrow column at least two or three thousand feet above the outline of the mountain.

SEISMIC EFFECTS OF A SOLAR ECLIPSE

The solar eclipse of July 9, 1926, was not annular at the Hawaiian Volcano Observatory but the maximum obscuration of the sun was roughly estimated to be above 80 per cent. Such an interruption of radiant energy with its consequent lowering of ground temperatures, might well be expected to cause measurable tilts of the earth's surface. The relation between tilts and ordinary daily and seasonal temperature variations has already been mentioned in Volcano Letter No. 41, Oct. 8, 1925.

In an attempt to detect such eclipse effects the seismograms written at the Observatory during the week including the day of the eclipse were subjected to a thorough examination, and an especially sensitive optical tilt-recording instrument was put into operation for the occasion.

After some study the optical records were put aside as being too much influenced by known and suppositious accidental disturbances. From the seismograms however a good tilt curve was deduced, extending over an interval of six days. Any special tilt changes so large as one second of arc would have been unmistakable on this curve, and it is most probable that magnitudes half so great would have been correctly identified. Nothing of the kind appeared, however, which could be associated with the eclipse. One can say, then, that if eclipse tilts existed they must have been of the order of a small fraction of a second of arc.

No earthquakes were detected which could be changed in any way to the eclipse. P. H. Kirkpatrick.

ARE MAUNA LOA AND MAUNA KEA HOLLOW MOUNTAINS

Occasionally one hears the statement that Mauna Loa and Mauna Kea are essentially hollow mountains. This idea arises from the fact that when gravity observations were taken years ago on the two mountains it was found that the actual attractions of the mountains masses were less than the computed amounts based on their bulks and average specific gravits of the rock of which they are composed.

One explanation of this seeming hollow condition that has been offered is that subterranean tunnels abound in the two mountains. While such tunnels might be a contributing factor to hollowness it is probably relatively unimportant. An important factor contributing to the deficiency in the mass of the mountains is the natural voids in the lava flows of which they are largely composed. The voids in an aa lava flow may be over 35 to 40 per cent. The voids in pahoehoe flows while commonly less than in aa may still be quite high especially when the imperfect contact of one flow on another is considered. The presence of intrusive bodies of high specific gravity would tend to decrease the effects of the voids.

The crushing strength of the lava is so high that one would not expect to find the percentage of voids very greatly reduced until a depth in excess of 5,000 or 6,000 feet is reached. This becomes evident when one sees a layer of very friable pumice around Kilauea supporting compacted ash beds that in places are six feet or so in thickness. R.H.F.

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No. 84 RELEASED WITHOUT COPYRIGHT RESTRICTION August 6, 1926

KILAUEA REPORT NO. 760

WEEK ENDING AUGUST 4, 1926

Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, temporarily in charge.

Earth shakings continue to be quite frequent, 34 being recorded on the Observatory seismographs during the current week. Only one of the shakes was perceptible at Observatory. It occurred at 11:02 a. m. August 3 and had an indicated distance to origin of 10 miles. This earthquake was the first perceptible one at Volcano House since the last of June. None of the 102 earthquakes recorded during July was perceptible. Usually six or seven per cent of the total number of earthquakes recorded are perceptible.

On July 30, at 2:33 p. m., there was a large avalanche from one of the walls of Halemaumau. It was the largest avalanche that has been observed for some time and sent a dust cloud well above the crater rim. Despite the large number of earthquakes avalanches have not been frequent and Halemaumau is again very quiet.

The lull in tilting noted last week continues. The net result for the week was a very slight tilt to the east-southeast.

AN EASTERN MEDITERRANEAN EARTHQUAKE

An earthquake occurred in the eastern Mediterranean Sea on June 26, 1926, that was of world shaking proportions. Three world shaking earthquakes, quite widely separated, occurred within a short time. In addition to the eastern Mediterranean shake there was a quite destructive earthquake on or near the island of Sumatra on June 27 and one in the China Sea on June 29.

The Mediterranean shake appears to have been especially severe near the island of Crete. The area over which the disturbance was perceptible was rather widespread. Minor damages were reported from Egypt, houses collapsed and at least one person was killed on the island of Rhodes, and alarm and panic was caused as far west as Malta. Ceilings were shaken down in the Archeological Museum at Candia, Crete, and considerable damage was done to valuable collections.

It is interesting to note that this shake had its origin in an active volcano region. The principal manifestation of volcanic activity in this region is Santorin. Mention of Santorin, which became active in August 1925, was made in Volcano Letter No. 43, October 22, 1925. The exact location of the fault where the earthquake occurred is not yet known but it may well pass under Santorin for, according to press dispatches, an outburst of Santorin coincided in time with the occurrence of the principal earthquake shock. Crete is but 50 or 60 miles from Santorin and the island of Rhodes but little farther.

It has been said, even by students of earthquakes, that there is but little connection between strong, widely felt earthquakes and volcanoes; that all volcanic earthquakes are small. The last statement undoubtedly does apply to the majority of volcanic earthquakes but certainly not to all of them. There are many examples of strong world shaking earthquakes accompanying volcanic eruptions, among such is the 1868 earthquake that accompanied an outbreak of Mauna Loa and the earthquakes accompanying the Katmai eruption in 1912. The June 26, 1926 shake may be another example. R.H.F.

HUALALAI

Hualalai is principally known to the majority of people who know anything at all about this mountain as the source of a very spectacular lava flow in 1801. According to O. H. Emerson who recently returned from spending a few days on this mountain there is much of interest to be seen near the summit. It is covered with cones of various types, some like those of Mauna Kea or Haleakala and some like those to be found on Mauna Loa. Cones composed of mixed lava and volcanic ash may also be found. Pit craters like those on the northeast rift of Kilauea are not uncommon. Evidence of small explosions is given by angular blocks of dense material and by layers of ash overlain by more recent lava. One gains the impression that there is a great range of age between the different formations on the summit of Hualalai. R.H.F.

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No. 85 RELEASED WITHOUT COPYRIGHT RESTRICTION August 12, 1926

KILAUEA REPORT NO. 761

WEEK ENDING AUGUST 11, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The numerous earthquakes that marked the last three weeks still continue. During the current week 50 earthquakes were recorded. In addition to this number there were spells of very small tremors that lasted for several minutes. The only earthquake that was strong enough to be perceptible occurred at 8:24 a. m. August 6.

Tilting for the week was slight to the north northwest.

Small avalanches are frequent from the walls of Halemaumau. The walls at the north and west appear to be the most active. The odor of hydrogen sulphide can frequently be detected at south rim of pit. A crack about 250 feet back from the south rim showed signs of recent movement on August 10.

SECTION OF VOLCANOLOGY, U. S. GEOLOGICAL SURVEY

There was established on July 1, 1926, a Section of Volcanology in the Geologic Branch of the Survey. Mr. W. C. Mendenhall is Chief Geologist directing the activities of the Geologic Branch in Washington. Mr. T. A. Jaggar at the Hawaiian Volcano Observatory is Volcanologist in charge of the new Section. The Section of Volcanology is empowered by act of Congress to operate volcanologic surveys, measurements and observatories in Hawaii, including subordinate stations elsewhere, and to provide and maintain laboratories and quarters for the work, and to print reports.

This establishes a government service for continuous observation of volcanic action in the United States and its dependencies, with headquarters on Kilauea volcano. In immediate effect it enlarges the scope of the Hawaiian observatory so as to create experiment stations to study volcanism in California and Alaska, these making their reports to the Hawaiian headquarters for publication and comparison. Hitherto the Hawaiian station has been the only permanent American volcano observatory.

Lassen National Park, where was staged in 1914-15 an eruption in the northern California mountains at Mount Lassen, and where there were other eruptions from 100 to 250 years ago, has been selected for the second. This second volcano observatory will be in charge of Mr. R. H. Finch, Associate Volcanologist, who has been first assistant at the Kilauea station since 1919. His task is to establish an earthquake laboratory modelled on the one in Hawaii, equip it with seismographs, man it winter and summer, and make studies also of slow movements of the mountain, of weather controls, and of underground temperatures as shown by the springs and gas vents.

The seismographic laboratory at the Hawaiian station is placed in charge of Mr. Ronald M. Wilson, topographic and geodetic engineer. Mr. Wilson becomes geodesist and mathematician to the Section of Volcanology, as aide to Mr. Jaggar in physical investigations, and will specialize in tilt measurements and change of ground levels in relation to tide-water, and in horizontal movement determined by precise triangulation. Of late years work in Japan, California and Hawaii has proved that these slow movements are of enormous importance in relation to earthquakes and volcanoes, and that they have forecasting value.

Another officer in charge of the clerical and disbursing work of the Section of Volcanology is Mr. Richmond B. Hodges, stationed at the Hawaiian laboratories. Mr. Hodges has served through the grades of junior and assistant clerk in the Washington office of the U. S. Geological Survey. He will have charge of the records, files and accounts at the Hawaiian observatory, and of part of the drafting and editing.

Mr. Jaggar has made reconnaissance of the Lassen district in 1925 and 1926. The Topographic Branch of the U. S. Geological Survey, Colonel C. H. Birdseye in charge, is now at work making a topographic administrative map of the Lassen Park and surrounding country of the National Forests. This map will be of great importance to the volcanologists. Furthermore a monograph on the recent eruption of Lassen, by Doctors Day and Allen of the Geophysical Laboratory, excellently prepares the field for permanent studies of volcanic energy there.

For the present the program of publication of the Section of Volcanology is to issue weekly reports of earth shakings, tilts, temperatures, and other volcanic phenomena observed at all stations occupied. These are given the local press in the vicinity of each observatory, and are collected every week in the Volcano Letter for wider distribution. In the Monthly Bulletin of the Hawaiian Volcano Observatory will be published the fuller illustrated reports from each station, in this as in other things the Hawaiian laboratory becoming the mother station.

The third observatory of volcanic action planned is naturally in that wonderful region almost unknown, the Aleutian mountains and islands of Alaska. That land will be reconnoitred for the purpose in 1927, and among the many volcanoes there belonging to the United States, one will be selected for laboratory study winter and summer. Financial aid to supplement the small work that the government funds can do will be essential to any thorough research in that country. T.A.J.

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No. 86 RELEASED WITHOUT COPYRIGHT RESTRICTION August 19, 1926

KILAUEA REPORT NO. 762

WEEK ENDING AUGUST 18, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Changes at Halemaumau pit have been slight. Six places at the bottom of the talus slopes, one of them in the rock wall itself, have developed yellow sulphur stain. These places are all east, south and southwest from the bottom area, and are distinct from the places of maximum steaming. The steaming is higher on the debris slopes, and the vapor at present is not dense.

Action is confined to small slides of rock from the walls. A wait on the rim of a half-hour is usually rewarded by the sight or sound of two or three small avalanches. Usually a bunch of debris from the middle of the cliff parts suddenly from its place, without evidence of what starts it. The northern walls are the favorite places. The dust of a slide rose above the rim about noon August 17.

Twenty-six earthquakes were registered for the week, all too small to be perceptible; a weekly total much less than that of the three preceding weeks. Tilting was slight NNE.

HORIZONTAL GROUND MOVEMENT IN CALIFORNIA

An interesting report by William Bowie was published in 1924 (Special Publication No. 106, U. S. Coast and Geodetic Survey, Earth Movements in California) describing results of precise triangulation in 1922 and 1923 by reoccupation of old stations in the sections Sierra Nevada to San Francisco, San Francisco to Santa Barbara, and Santa Barbara to San Diego. The immediate vicinity of Santa Barbara itself was left to be done in 1924. The Santa Barbara earthquake occurred June 29, 1925. The published report covers the southern belt from Ventura to the base line in the mountains southeast of Riverside, and the northern belt from Gaviota just west of Santa Barbara to the vicinity of the Lick Observatory. This northern belt is referred to the base line Mount Lola—Round Top in the Sierras.

As the discussion of the author of the report was written in 1924, it does not cover the Santa Barbara earthquake and was unbiased by knowledge of that earthquake. The results of the resurvey show that in the forty years following 1880 (about), the stations of the Coast Range from Monterey to Santa Barbara moved northward respectively, taking them in order southward, 4, 7, 11, 15, 20, 22, and 24 feet, the last being Gaviota station. The results for the southern belt beginning to the southeast of Los Angeles, show that the stations progressively westward from Santiago to Ventura County, after about 1890, moved southwestward and southward 1, 2, 2, 4, 5, 6, and 7 feet, the last being Chaffee station, just east of Santa Barbara, with its motion almost exactly in the opposite direction from that of Gaviota. The changes in geographic position indicated by the resurveys are based on assumptions that the base-lines in the distant mountains stood still.

It seems to the reviewer that the various writers who have described the Santa Barbara earthquake have been unduly prejudiced by the presence of east-west faults in that region, and that they have neglected this astounding trigonometric forecast of the disaster in Dr. Bowie's survey. Professor A. C. Lawson, when he heard of the 24-foot movement at Gaviota at the meeting of the American Geophysical Union in Washington about May 1, 1924, rose and asserted that this meant a coming earthquake. A year later the earthquake came.

What was the stress acting on the under-earth at Santa Barbara in the spring of 1925? Chaffee, 22 miles to the east, had migrated south; Gaviota, 28 miles to the west, had migrated enormously north. The earth crust under Santa Barbara was strained to the breaking point, and the whole mosaic of mountain blocks suddenly yielded, with jarring, on June 29. It was not necessary that any north-south fault should show. Twenty fault-blocks may have twisted a little, a deep slab may have snapped, or deep magma may have been released intrusively.

It would appear that this work of the Coast Survey has brought earthquake forecasting into the range of quantitative measurement. T.A.J.

THE FORMATION OF AA AND PAHOEHOE LAVA

The question of how aa or clinkery lava is formed occupies considerable space in scientific literature. Nearly all of the discussions have been largely of a philosophical nature and but limited portions have been based on chemical analysis, close observations in the field, or on experiments.

A paper on "The Formation of Aa and Pahoehoe" by O. H Emerson, American Journal of Science, Vol. 12, Aug. 1926, gives a discussion of the artificial formation of aa lava. In an effort to produce aa artificially Mr. Emerson melted some powdered pahoehoe in a crucible and stirred it constantly while it was slowly cooling. While the interior remained fluid for several minutes a pahoehoe skin quickly formed on the surface. When the solidified mass was broken open it was found that the interior was essentially crystalline and that the hole formed by the stirring was lined with typical aa arborescence. Repetition of the experiment gave the same result- In one case pulverized aa was used and there was no essential difference in the result. Crystallization taking place while the flow is in motion seems to be a real factor in the production of aa. The question of the limiting conditions of temperature, gas content, and degree of crystallization in controlling types of lava flows needs more investigation.

Mr. Emerson omitted part of the history of his experiments. The method was suggested by the undersigned to see if the natural mechanical stirring in a flow was a factor in the production of aa. A first test at Hawaiian Volcano Observatory gave only pahoehoe lava because the lack of sufficient heat made it impossible to stir the melt. R.H.F.

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No. 87 RELEASED WITHOUT COPYRIGHT RESTRICTION August 26, 1926

KILAUEA REPORT NO. 763

WEEK ENDING AUGUST 25, 1926

Issued by the Observatory, U S. Geological Survey:
T. A. Jaggar, Official in charge

Changes have been very slight at Halemaumau pit of Kilauea volcano during the past week. The very heavy rain of the 20th and 21st, amounting to 8.42 inches at Kilauea Observatory, washed away much of the sulphur stain at the solfataras in the bottom, and deepened the red of the walls.

Again the seismograph shows great numbers of very feeble tremors. The total number for the week was 58. A feeble shock at 2:19 a. m. August 24 had origin at distance indicated as 18 miles. Tremors were frequent the forenoon of the 20th. Tilt was light NNW. A weak teleseism at 7:22 p. m. August 24 had distance to center indicated as 3600 miles.

LAVA DOME AT SANTA MARIA 1922-25

Santa Maria volcano in western Guatemala, after an interval of twenty years, has followed its explosive and engulfment eruption of 1902, with a lava-plug eruption of three years' duration beginning June 29, 1922. (K. Sapper, Zeitschrift fur Vulkanologie, 1926, Vol. IX, pp. 156-200, 14 plates. Die vulkanische Tatigkeit in Mittel-Amerika im 20. Jahrhundert. I Teil).

The 1902 outburst left a great hole in the southwest flank of the mountain at about 6500 feet elevation. This engulfment crater was left 3300 feet across and 800 feet deep to the geyser like lake of boiling water spouting and making sulphurous fumes until after 1906. Thereafter the volcano became quiet.

In 1922 at the end of June the same crater sent up cauliflower clouds of dust and made rumblings and small localized earthquakes and electric storms. Mr. G. Hurter of Quetzaltenango on August 13th photographed the new rounded dome of aa lava which had risen from a fissure in the bottom debris of the crater, and already had reached a height 300 feet above its lower lip. There was much growing of the heap during four months, with rumblings, fume jets, crashing of debris down slopes, and sulphurous coatings. There was glow at night illumining dust jets that were mistaken for flames. Explosive eruptions making light ash falls were frequent. October brought temporary decline.

This Cumulo-dome was of the same type as the Pelee heap of 1903, that of Bogoslof of 1907, that of Tarumai in 1909, and similar to that of Kilauea in 1888. The Lassen plug of 1915 appears to have been much the same These domes have all the features of stiff lava flows, forced by the topography to pile upward instead of streaming downhill. When the Hoopuloa flow on Mauna Loa in April, 1926 accumulated at the shore below a steep slope above, it formed a circular heap with spiny top and red hot slide slopes closely resembling the photographs from Santa Maria.

The Hurter photographs present a series of eighteen taken on successive dates for three years, wonderful pictures showing the growth of this Santa Maria lava hill, all from the same viewpoint. These are the plates in Dr. Sapper's monograph. In 1923 the flow took a fresh spurt enlarging the dome, which preserved a finely serrate profile. It had made a great growth by May. At the beginning of 1923 it was 800 feet high and 3300 feet across. It swelled further and overlapped the old crater edge. It became craggy, square-topped and massive, always fuming and glowing, in 1924. On June 1, 1924 a spine 200 feet above the top of the heap had pushed itself up through a chasm in the crest. This was quite like the Pelee tower or the Bogoslof fin. The growth stopped in 1925, leaving the new structure 1600 feet high above its base and 4000 feet across. Its top was now a wide cluster of castles, turrets, spires, domes and buttresses, surrounded by sweeping talus slopes. T.A.J.

VOLCANIC HISTORY OF OREGON

A remarkably interesting and beautifully illustrated book entitled "Mount Multnomah, ancient ancestor of the Three Sisters, by Edwin T. Hodge," has been published by the University of Oregon, Eugene, Oregon (Aug. 1, 1925). This book is for the use of geologists, mountain climbers and nature lovers, is illustrated by superb photographs and excellent block diagrams and maps, discusses the history of the Cascade Plateau, the climate, flora and fauna of the volcanoes called "the Three Sisters," and is a model of good scientific book-making, condensation, colorful writing and clear explanation. I have never seen block perspectives of landscape used to better purpose in association with photographs of the landscapes themselves.

Professor Hodge concludes that a 15,000-foot volcano once lay over the site of the Three Sisters, built above the post-Eocene Cascade fault that extends north and south along what is now the "break" between the Cascade Plateau and the rugged gorges to the west. In Oregon eighteen volcanoes lie along this fault today. In "Multnomah" a Mauna Loa of basalt was built up in Miocene time. Thereafter it collapsed or blew up or both, and enormous engulfment occurred. A circular fault eight miles in diameter bordered the sink. Streams cut back into the sink, but in Middle Pliocene two sister volcanoes were built up within it. Then more volcanoes arose, followed by glaciation. The Oregon block sank again after the Ice Age, and revivified the volcanism, which continues to the present day. T.A.J.

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No. 88 RELEASED WITHOUT COPYRIGHT RESTRICTION September 2, 1926

KILAUEA REPORT NO. 764

WEEK ENDING SEPTEMBER 1, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Small avalanches have continued in Halemaumau pit and are notably conspicuous at present at northeast wall. These slides have undermined so as to reveal fresh rock for several hundred feet below the rim, and the ground above is heavily cracked and threatens to wreck the northeast trig station in the near future. During temporary visits about four avalanches are seen in a half hour and many falls of small stones. Some of these were observed this morning, September 1, also from the western wall, and there also the dirt is freshly cracked along fissures back from the rim of the pit. A dyke of light-colored rock was observed in the middle portion of the northeast wall. At the foot of this wall the talus heap has been growing higher during several months past, and now tends to rival the southwest heap in height. These two are just opposite each other, which suggests that the major caving away is along a line trending toward Kilauea Iki.

Recent rains have increased the volume of visible steam in the bottom of the pit, and the fuming patch at the base of the south talus appears very hot and sulphurous. Another at the base of the east talus is making yellow sulphur.

Unusually large numbers of very small local earthquakes have been registered on the seismograph. The total number counted for the week was 107. Tremors in addition to the measured movements were frequent on August 27, 28, and 29, particularly during the forenoon of the 27th. At 2:21 p. m. August 31 a faint teleseism was registered without distinct phases. The tilt for the week was slight to the SSW.

The increase in tremors may possibly forecast new activity in either Mauna Loa or Kilauea. There was a remarkable cloud over Mauna Loa at 6 p. m. August 30 that suggested volcanic fume. Some of the local earthquakes appear on the seismograms like avalanche tremors from Kilauea, others seem to indicate a Mauna Loa distance of origin.

PHOTOGRAPHIC RECORD OF LASSEN VOLCANO

In May of 1914, when Lassen Volcano, on the borderland between the Sierra Nevada and Cascade Ranges, broke into eruption, the newspapers were incredulous. It was known that at the Cinder Cone, in the eastern part of what is now Lassen National Park, there had been a lava flow some 250 years ago. Nothing is known of what then happened at Lassen Peak, a big volcano of the same class as Mount Shasta, with a shallow crater depression and pool of water in its top. It has been the custom to connect Lassen Peak with the Cinder Cone and its lava flow, but the two are 12 miles apart and there is no obvious relation between them.

In 1914, the old crater depression in the top of Lassen Peak began to eject dust and steam through small caved-in depressions of the summit. These depressions engulfed the rock of their margins until they had united into a single crater hole apparently at the junction point of several cracks in the mountain mass. The forester's Lookout House became gradually destroyed by falling stones in a sucession of explosions which increased in vigor and in numbers. The eruptions occurred every few days and rarely lasted more than 20 minutes. In the two years 1914 and 1915 the month of May appears to have been the critical one for Lassen, for the first outbreak was May 30, 1914, and the maximum explosion was on May 22, 1915.

Mr. B. F. Loomis, proprietor of the hotel at Viola, is an energetic photographer who has compiled a "Pictorial History of Lassen Volcano" (published by Anderson Valley News Press, Anderson, Cal., 1926). This book is not only a useful guide to Lassen National Park, but contains a critical review, illustrated by many photographs of the activity of 1914-15. Mr. Loomis cites the opinions of Messrs. Diller, Day, Allen, and Holway in their published statements about the Lassen eruption, and reaches some conclusions of his own, backed up by photographic evidence, that are of interest.

The chief of these is to the effect that the eruption of May 19, 1915, produced merely a flood of water and ash which devastated the northeastern creeks without throwing down trees. With this eruption there was no down-rushing blast of steam capable of melting snow to cause the flood. The much bigger eruption of May 22, on the other hand, produced a down-rushing steam blast which is photographically shown to have overturned trees and cut a V-shaped swath through the forest to the northeast for four or five miles. The action in both cases was quite like that of the volcano Pelee in Martinique, which also began with a flood and ended with a blast.

Loomis believes that both Lassen eruptions gave vent to liquid water from the mountain itself, followed by steam, and his pictures of mud torrents from the very summit appear to bear out his belief. The photographs also suggest very strongly that the plug of lava breccia which rose to fill the new crater, overflowed the west lip in a definite aa lava flow, which according to him was seen flowing and glowing. T.A.J.

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No. 89 RELEASED WITHOUT COPYRIGHT RESTRICTION September 9, 1926

KILAUEA REPORT No. 765

WEEK ENDING SEPTEMBER 8, 1926

Issued by the Observatory, U S. Geological Survey:
T. A. Jaggar, Official in charge

Few changes have taken place in the pit of Kilauea Volcano during the past week. Occasional small rock slides and avalanches occur at intervals, causing thin dust to rise from the pit. Dust from these slides was observed several times during the day on September 6. Dust from a slide was observed a few minutes before 8 a. m. on the 7th, at which time a spasmodic tremor was recorded by the seismographs, suggesting correlation between the two occurences.

The seismographs record 81 tremors for the week, for the most part very feeble. One exception was a local feeble earthquake at 5:38 p. m. September 1, which was perceptible to many people at the Volcano House and others in the vicinity. During the afternoon and evening of September 2 the very feeble tremors were most frequent, 27 being recorded during that time, being a third of the number recorded for the entire week. Of these, several exhibited phases indicating the distance to their origin to be about 35 miles. In contrast to this period of time with many tremors, it is of interest to note that during the 24 hours from 8 a. m. September 7, to 8 a m. September 8, only one very feeble tremor is recorded. The records show two faint teleseisms, having phases so indistinct as to prohibit the calculation of the distance to their origins, one at 5:17 a. m. September 4, and the other at 2:03 a. m. September 7.

A slight tilt to the north has accumulated during the week. R.M.W.

BORING AT CALIFORNIA GEYSERS

An article in the Oil Weekly (February 2, 1926) describes drilling for steam at the "Geysers," Sonoma County, California. A number of wells have been opened with a view to harnessing steam power to furnish electricity. J. D. Grant drilled two wells with churn rig and cable tools in something over two years. The rock is sandstone and hard serpentine. The Geysers Development Company are using a rotary drill with hydraulic feed, which permits putting extra pressure on the Hughes cone bit. A system of valves to protect the workmen and control the wind is used. Mud is pumped through the drill rod and returns through a special valve. The serpentine cap rock is said to be from 200 to 400 feet thick.

The temperature of the hole reached a dull red heat, 998 degrees Fahrenheit. Seven wells were drilled with Hughes bit to some 500 feet each in less than two months to each well, and the cone bits stood this temperature. In one well, four sets of hardened steel cones were dulled in drilling 277 feet of 9¾-inch hole in hard rock. At a depth of 451 feet such a steam pressure was encountered that the uprush of rocks, mud, and steam at the casing head wrecked the timbers.

To deal with these forces, casing is cemented from top to bottom; in the latest wells the upper casing is 15 inches in diameter, and the lower 10 inches. Steam pressure increases with the depth. The well cited above developed 67 pounds pressure at 228 feet, 169 pounds at 416 feet, and another well developed 240 pounds at 486 feet. A runway is built from the upper derrick off to the hillside, to save the derrick man in case of a steam blowout. T.A.J.

TOKYO SHORELINE ELEVATION

The Kwanto District around Tokyo and Yokohama not only had blocks of the bottom of Sagami Bay dropped and elevated hundreds of feet, at the time of the 1923 earthquake, but the land tilted This tilt was from southeast to northwest, with a depression in the interior country, and elevation of some two meters at the peninsulas. These two peninsulas, moreover, at the entrance to Tokyo Bay, have moved horizontally towards the southwest four (Boshu) and two (Miura) meters. The coasts had been sinking a half meter or so in the half century preceding the disaster. (On the Recurrence of Destructive Earthquakes in Southeast Japan during 2,000 years, A. Imamura, Proc Imp. Acad. Jap. 1926, Vol. 2, No. 6).

The tide gauges showed gradual lowering of the shore for 38 years, and sudden elevation at time of earthquake They also show nine-year and eighteen-year periodic oscillations of several centimeters.

Professor Imamura has traced old shorelines suddenly uplifted during earlier big earthquakes at Misaki on the Miura peninsula. These earthquakes occurred A. D. 33, 818, 1703, and 1923. The different benches have been allocated to their proper earthquake date by relative erosion of the standard holes in the cliff of the boring shell **Lithophaga nasuta** The shell works at sea-level. The cliff has been etched back since elevation at the rate six millimeters in 220 years. The shell holes make sea-level belts which are identifiable History records great earthquakes that check with the shell-hole-erosion data.

On this basis the bench of the 1703 earthquake was elevated 5.5 meters at the tip of Boshu peninsula, and that of the year 818 A. D., 4.7 meters—both of these more than double the uplift of 1923. T.A.J.

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Sent free to libraries and to members. Dues of Association $5 per annum. Members receive in addition the Illustrated Monthly Bulletin of the Hawaiian Volcano Observatory. Anyone may join the Association and thereby support Pacific volcano research. The society has also patrons—individuals, firms and institutions.

No. 90 RELEASED WITHOUT COPYRIGHT RESTRICTION September 16, 1926

KILAUEA REPORT No. 766

WEEK ENDING SEPTEMBER 15, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Halemaumau pit at Kilauea Volcano is always different from the other pits, such as Kilauea Iki and the Chain of Craters, in that the walls are sliding and the rim enlarging. The avalanches eating away the northeast rim, as noted September 1, have accomplished their threat of destroying the northeast flag station. This monument was installed last April, and was found to have gone on September 12. It was probably carried away by the morning slide of the 7th.

On September 12 slides were frequent. Today they were not observed during a half hour. There is fresh, red dust on the slopes, and a new bowlder on the floor has left a gray trail. The south talus solfatara makes blue fume in hot puffs. In many places the rock wall of the pit steams on the inner faces.

Seventy-three earthquakes were registered in the seven days prior to the morning of September 15. The frequency and intensity of instrumental earthquakes has increased since September 8. On that day there were four; on September 14 there were 17, of which three were almost big enough to be felt. Additional spells of volcanic tremor appeared on September 14 and 15. Tilt for the week was slight SSE.

NEW ZEALAND VOLCANIC ACTIVITY

Recent files of the New Zealand Herald (Auckland) beginning in April, 1926, report earthquakes and volcanic activities along the Taupo belt of the North Island from Ngauruhoe Volcano to White Island Volcano in the Bay of Plenty.

A local earthquake was felt at Christchurch March 31. April 8 there was comment on submarine disturbance near White Island causing disappearance of the fish. A cutter in 1886, during the great Tarawera eruption, in the same waters, ran into muddied sea, floating weed, and dead and dying fish. Near Mercury Bay there are hot water springs. Ngauruhoe opened a new vent with explosion and detonations April 16. The shores of the Bay of Plenty felt a sharp earthquake April 18, time said to be 10:45 p. m. at White Island. All of this was simultaneous with the outbreak of Mauna Loa in Hawaii.

From Waimarino April 24 enormous clouds of black dust along with bowlders were seen rising from Ngauruhoe for two hours. Detonations and severe vibrations were reported from other places, and brilliant glow at the crater in the evening. Campers near the mountain described shots like cannon, the noise of stones falling, rumblings, and one tremendous report after daybreak April 25 which sent up black smoke 1,500 feet. One message described "tongues of flame."

April 12 (after the activity of Mauna Loa in Hawaii had begun) earthquakes were reported from Fiji and the Marshall Islands. About May 1 the rumblings from Ngauruhoe were heard in the Gisborne district. The Tongariro National Park reported vibrations and volumes of explosion clouds from Ngauruhoe May 12. May 15 the activity increased, with loud reports, glow, and red-hot bowlders. At 7:45 p. m. a wide streak of fire extended down the mountainside. Bowlders rolling down the slopes prevented approach.

The maximum paroxysms were evidently at this time. From the railway to the west, May 17, "great gusts of light burst up from the crater." The fume column was estimated 6,000 feet in height, and was seen from Wanganui 60 miles away. Taupo reported frequent "shots" from the crater, jets of black smoke 2,000 feet high, with concussion that rattled windows, earth tremors, and "flame" visible from there.

A photographer reported May 18 a great roar, prolonged shaking, and a tremendous shot: the lips of the crater were a vivid red with flame, while bowlders of 10 to 20 tons crashed red-hot down all sides of the mountain with regular monotony. These were discernible in daytime five miles away. The snow of Tongariro was buried under the ash of Ngauruhoe. A sharp earthquake occurred May 20. Two notices of this period describe "a stream of lava through a hole in the lip of the crater," probably glowing slides of debris.

May 28 the volcano was sending white steam straight up, and was quieter. May 31 glow was still seen. June 1 a sharp earthquake was felt at Gisborne, and at the Bay of Plenty. Another occurred in the South Island June 6.

June 5 an ascent of Ngauruhoe was made; varicolored fume rose, first white, then black; there was a notch in the north lip, the crater appeared 600 feet deep, and down below what appeared to be "dark-red and blue flame" rose in glimpses 40 to 50 feet above the surface of "molten lava." The former crater floor was covered with sand and split by huge fissures which suggested coming engulfment. There was roaring noise.

July 2 a sharp local earthquake was felt at Taupo and a succession of shocks occurred July 5 in the north end of the South Island. July 8 White Island appeared to make unusual clouds of steam. July 30 a tremor was felt at Taupo and both Ngauruhoe and Tongariro showed symptoms of increased "activity" of steaming.

Such is what can be made out of press notices. It is to be hoped that the volcano observer of the Government will soon be sending us official reports; clearly there has been abundant work for a New Zealand volcanologist during the past six months. T.A.J.

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No. 91 RELEASED WITHOUT COPYRIGHT RESTRICTION September 23, 1926

KILAUEA REPORT No. 767

WEEK ENDING SEPTEMBER 22, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

On September 19 the only developments of the last week noticed at Halemaumau pit were stains of yellow sulphur and white alum on the rock slope at foot of southeast wall. On September 21 fresh gray rock fragments lay at foot of northeast wall. A line of sulphur stain at base of east talus has increased. Rock slides have not been seen lately.

Forty-four local earthquakes were registered for the week, and tilt was moderate to the NE. A distant earthquakequake was well registered at 7:38 a. m., September 16. Its preliminary phase indicated distance of origin 3,630 miles and direction southwesterly, suggesting New Caledonia. Its time of occurrence at the origin by this should have been Greenwich civil time 17 h. 59 m. 08 s. Science Service and the U. S. Coast and Geodetic Survey from records of seven stations made the origin west of the New Hebrides and the time 17 h. 59 m. G. C. T. Another weak teleseism occurred September 17, 12:59 p. m.

EARTHQUAKE IN ENGLAND

Just as the United States in 1925 was stirred by earthquake peril, so now England is in the throes of a paroxysm. The Channel Islands started the excitement August 1, with a shock in Jersey about 2 p. m. which wrecked chimney stacks and broke gas pipes. This was felt on the coasts of England and France. There were rumbling noises and rocking at Jersey that lasted several seconds, throwing over wall cases of merchandise and bringing down ceiling plaster and pictures. The vicinity of the Channel Isles is a recognized seismic center.

On August 15, 1926, a shock in the Hereford district of England, to the east of Wales, shook some 40,000 square miles of the most densely populated parts of England. Davison reviewed the happening in the Birmingham **Post** August 20. A similar but more extensive earthquake had shaken Birmingham and centered near Hereford in December, 1896, with 98,000 square miles as the area shaken, including the Isle of Man and Southeastern Ireland.

The 1926 shock produced great alarm but little damage. Chimneys fell between Ludlow and Hereford. This was the principal epicenter, and a radius of 150 miles from there probably includes all places of felt quaking. The 1896 quake and earlier ones in the same district had two centers, near Hereford and Ross, respectively, the double earthquake in each case producing maxima almost simultaneously in the two places, but stronger sometimes at the Ross center, sometimes at the Hereford. Hereford is said to be a place of faulting.

Morrell in the "Graphic" suggests that Hereford and South Wales are not far from volcanic matter below. Fifty miles to the south is Bath, where "the water constantly wells up from those superheated depths at a temperature of 120 degrees Fahrenheit. A volume of some 180,000 galloons of warm water is thus literally erupted daily, and this process has been going on for ages." Judd pointed out that this "is a slight manifestation of volcanic activity." Thirty miles west of Hereford are sulphurous wells in old volcanic rocks.

Oldham (Nature, August 28, 1926), on the basis of a formula dependent on area of felt shock, maximum intensity, and meaning of the word "perceptible," estimates the depth of origin at 30 miles; but he makes the diameter of the region of felt shock less than Davison, so that the depth may be nearer 40 miles. He makes the maximum violence number six of Mercalli's scale (Rossi-Forel seven).

The greatest of the English earthquakes was probably the Colchester shock at the east coast. 50 miles northeast of London, April 22, 1884, with twin centers near Rowhedge and Peldon, where most of the houses were damaged. Houses in 24 towns to the number of 1,213, including 31 churches, required repair. The maximum intensity was Rossi-Forel 9. The damage was greatest in low river grounds.

The area shaken was more than 100,000 square miles, and the shock was felt in France and Belgium. Sounds were heard 198 miles from the center. At London and Cambridge the intensity was R-F 6. T.A.J.

NATURAL HORSEPOWER

The horsepower in industry of the United States is 190 million ,of which 111 million is coal-produced, 67 million petroleum, and 12.3 million falling water. Great Britian uses 45 million horsepower, Germany 41.5 million, France 17.8 million, and Canada 10 million. (Compressed Air Magazine, September 1926.)

The total world horsepower resource in falling water is about 450 million, of which only 30 million is used. There is thus in sight enough water power to replace all present-day fuel when the latter is exhausted. This is without counting volcanic steam power and future development of direct solar energy and the tides. T.A.J.

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No. 92 RELEASED WITHOUT COPYRIGHT RESTRICTION September 30, 1926

KILAUEA REPORT No. 768

WEEK ENDING SEPTEMBER 29, 1926

Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The period leading up to the equinox showed a notable growth in numbers of small local earthquakes and tremors at Kilauea, but no volcanic activity has yet appeared. Beginning with the week-end August 18, the weekly numbers of shocks at the Observatory recorded by seismographs were sucessively 26, 58, 107, 81, 73, 44; and this week the number is 27. Such a curve of waxing and waning frequency has some volcanic meaning, and the weeks of large numbers showed many small avalanches at Halemaumau, which however seemed to be effects rather than causes of the shakings.

The past week has produced no slides that have been seen and no marked changes at the pit.

Besides the 27 earthquakes, microtremors were a little stronger than usual the first part of the week. There were other very minute volcanic tremors on the 22nd and the 23rd. The tilt was slight to the NNE, and during the past two weeks about two seconds of angular tilt to the east has accumulated. This is the third pronounced bend in the tilt curve away from westerly in the past six months. The first accompanied the Mauna Loa eruption. The second occurred about the June solstice. And the present one is the usual seasonal eastward tilt of the autumn.

CONCLUSIONS CONCERNING VESUVIUS

Reviewing observation of Vesuvius for twenty years as recorded in Perret's monograph (The Vesuvius Eruption of 1906; Study of a Volcanic Cycle. Frank A. Perret. Publication 339, Carnegie Institution of Washington, 151 pages, 25 plates, 1924), Dr. A. L. Day cites conclusions drawn from Vesuvius by the volcano workers of the Geophysical Laboratory. (Annual Report Director Geophysical Laboratory, 1925, Carnegie Institution Year-Book).

The pre-eruption period was 1903-06, the great paroxysm April 1906, the repose period 1906-1913, and the new eruptive period 1913-1921. Fumaroles were formed during the repose period, and the enlarged crater was gradually filled in by break-down of the walls, and after 1913 by effusion of lavas on the pit floor. The post-1913 period constitutes the beginning of a new cycle that will lead to another paroxysm.

"It is of interest to note that although lava flows developed during the eruption, the most intense activity appeared to center in the discharge of the volatile components, carried in solution in the magma in enormous quantity; and in particular with increasing concentration as greater depths within the lava column became exposed by the release of overlying pressure. It is pointed out that some, perhaps a considerable portion, of this tremendous volume of volatile material may have come from the sea nearby, and it is intimated that the gradual filling up of the crater between one extravasation and the next represents reactions in which infiltrating sea-water plays a major part, though what manner of connection exists between the sea and the volcano hearth is still unknown."

"Some years ago it was demonstrated by Johnston and his associates in the Geophysical Laboratory, that capillary forces could not properly be invoked to account for accessions of water into regions containing fluid magma; but no such limitation prevents the circulation, in appropriate channels, of (gaseous) water above its critical temperature or indeed of liquid water through supercapillary openings, such as may very well be supposed to exist near a center of explosive activity."

"It was observed further that other volatile ingredients of a chemically active kind, such as chlorine, fluorine and sulphur, were conspicuously in evidence in the preliminary stages of the eruption, but as the period of maximum intensity approached, there appears to be no evidence of any of them in quantities sufficient to affect the sense of smell. The great outpouring of volatile matter at the height of the eruption appears therefore to be water vapor, as it has also been shown to be at Lassen Peak."

Two facts emerge in this analysis, of great interest to those who studied the explosive eruption of Kilauea in 1924. One is that underground water is unreservedly appealed to as the source of volatile matter in the explosive phase of the eruption of 1906 at Vesuvius. The other is that the lava gases of the earlier phases are admittedly different, strong chemical acids. The pre-eruption period of lava flows and a full terminal crater occurred in the three years preceding the Kilauea eruption just as at Vesuvius. The forceful agent in the Kilauea explosions was pure steam, quite different from the acid gas of the great lava lake of only three months before. All of this parallels Vesuvius. But Vesuvius differed from Kilauea in that it mingled a luminous liquid-lava phase with explosion at first. Then came the paroxysmal emission of gas like Kilauea May 17-18). Then the Vesuvian "dark, ash phase" corresponding to the avalanching and earthquake maxima of Kilauea May 21 and 24.

It appears to the reviewer that this phase was a tremendous engulfment of crater rock at Vesuvius just as at Kilauea. T.A.J.

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No. 93 RELEASED WITHOUT COPYRIGHT RESTRICTION October 7, 1926

KILAUEA REPORT No. 769

WEEK ENDING OCTOBER 6, 1926

Issued by the Observatory, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

During the past week there has been no appreciable change in the pit of Halemaumau. There have been no slides or avalanches noted, nor any change in the amount of vapor. The total number of earthquakes for the week is only 25, showing that the number of earthquakes is still diminishing. The week's earthquakes have all been very feeble, of the local spasmodic tremor type, with the exception of a feeble trace of a teleseism which occurred at about 8:45 a. m. Hawaiian time on October 3. The fact that eartbquakes have been so few and feeble is probably connected with the lack of slides and avalanches. Tilt has been very slight during the week, to the NNE, but of insufficient amount to continue the eastward trend of the tilt curve that has been exhibited during the last two weeks.

THE TIDAL WAVE ON PALMERSTON ISLAND

The Sheffield "Telegraph" (Great Britain) of August 10, 1920, tells of a tidal wave on Palmerston Island, about 300 miles northwest of Raratonga, probably on May 12, 1926. Only one life was lost, but all the buildings excepting the church were swept away, and the population, about 100 in number, were left without homes and property, and with ony very scant means of sustenance. Hand-caught fish, and cocoanuts enabled them to live till relief came.

The "Telegraph" says: "The destitute condition of the inhabitants was revealed only when Sir Maui Pomare, the New Zealand Minister of Health and a Maori, on the New Zealand government steamer Hinemoa, touched there on an inspection tour. Supplies were landed and a relief ship ordered immediately from Raratonga."

The coming of tidal waves has many times been heralded by the more speedily propagated earthquake waves recorded on seismographs. Nature has thus arranged to send a message of warning, that only requires interpretation to make it possible, by preparation, to minimize the damage done by a tidal wave. The interpretation and preparation require time, and the message would hardly have been of assistance to the people on Palmerston Island without wireless. But it is conceivable that such a seismic message might still have been put to use, in suggesting to the outside world that these people were in trouble, and so have shortened their period of privation.

EARTHQJUAKE WAVES

In the Proceedings of the Imperial Academy (Japan March, 1926), A. Imamura shows that in some cases a long wave motion may preceed or travel along with the usual "P" wave in the propagation of seismic disturbances. In this paper Mr. Imamura indicates the difficulty encountered in separating on the seismograms the effect of slow motions horizontally to and fro and of tilting back and forth without horizontal motion. The trace of some of these early long waves strongly suggested the curve resulting on the seismogram when the instrument was known to have undergone sudden tilt. Mr. Imamura therefore analyzed these waves from the tilt point of view, and states that the results of his investigation appear to favor the idea of explaining them in this manner. Whether these waves of tilting are propagated in that particular form from the origin, or locally induced by the regular "P" wave, is left as an open question R.M.W.

PRECISE LEVELS ON MAUNA LOA

Lieutenant Simmons, of the U. S. Coast and Geodetic Survey, is this week begining work on the line of precise levels to be run from Hilo, via the Volcano of Kilauea, to the summit of Mauna Loa. This line of levels, in addition to making a determination of the elevation of the summit of Mauna Loa, will also provide means of establishing bench marks upon which later leveling may be done. to secure evidences of possible changes of elevation. This work should yield very interesting results when considered in connection with the tilting of the ground as recorded by the seismographs at the Hawaiian Volcano Observatory. R.M.W.

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No. 94 RELEASED WITHOUT COPYRIGHT RESTRICTION October 14, 1926

KILAUEA REPORT No. 770

WEEK ENDING OCTOBER 13, 1926

Issued by the Observatory, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

At the pit of Halemaumau there has been no activity of note during the past week, with the exception of an occasional avalanche, of which the most striking was one noted at about 9 a. m. on October 12 by a number of people at the Volcano House. The number of earthquakes for the week is only 12, being a very considerable decrease from the number of last week. This continual decrease in the number of earthquakes per week has been continuing for the past two months. There were three days this week upon which no earthquakes were recorded during the 24 hours, October 7, 11, and 12. Of the 12 earthquakes recorded there were two worthy of note. One local shock which occurred at 5:41 p. m. on October 9 was almost intense enough to be felt and lasted for nearly two minutes. The other quake is a teleseism of which the "P" wave began at 8:45:04 a. m. October 13, Hawaiian standard time. The indicated distance is 2,370 miles. Owing to the weakness of the initial motion of the "P" wave, it is difficult to estimate the direction. The entire disturbance as recorded on the seismographs lasted over an hour before the waves completely faded out.

Microseisms during the first part of the week were somewhat stronger than usual. The accumulated tilt has been only very slightly towards the west.

EARTHQUAKES AND EARTH ROTATION

In the "Transactions of the Astronomical Observatory of Yale University," Volume 3, Part VI, Dr. E. W. Brown has set forth his investigation of the constancy of the earth's rate of rotation. This is especially interesting from the point of view of Seismology and Volcanology in that the cause of these changes in rate of rotation is ascribed to geophysical changes within the earth itself. To change the rotational momentum of the earth, some gain or loss of either its mass or its impounded kinetic energy of rotation must take place. Its rotational kinetic energy is drained slightly by tidal friction. This effect is well understood and has been corrected for in the investigation. But apparently there still remain unexplained changes in the rate of rotation, in addition to the retardation explainable by tidal friction. Rate of rotation, mass and distribution of mass (moment of inertia) are factors making up rotational momentum. It is therefore possible to alter the rate of rotation, and yet retain rotational momentum and mass unchanged, by altering the distribution of the mass. Thus if the earth expands, its mass is distributed on the whole somewhat farther from the axis of rotation, its moment of inertia is greater, and therefore its rate of rotation may be slower, without loss or gain of mass or energy. An example of this effect may be had by swinging a weight on a string in a complete circle, allowing the string to wind up on the finger—the shortening of the radius will speed up rotation without the input of any more energy.

Dr. Brown suggests periodic expansion and contraction of the earth, in amount between five inches and twelve feet change of mean radius, as an explanation of the apparent fluctuations in rate of the earth's rotation. These fluctuations in rate are detected astronomically in the discrepancies developed between the computed and observed places of the moon and sun. That is, using time as derived from orbital motions and the gravitational theory the earth appears to run ahead or behind its mean rate of rotation by a slight amount, so that in the course of years a few seconds may be gained, then lost, and gained again.

If this is to be explained by the shrinking and expanding of the earth, one might expect to find evidences of it here beneath our feet. Dr. Brown reasons that this amount of change would by no means be enough, in itself, to stretch or shrink the crust of the earth to the point of fracture. But these periodic strains in the crust of the earth may be enough to liberate or shake loose greater strains accumulated almost to the breaking point through other causes—isostatic compensation for example. The investigation shows, in fact, that there is apparently a rough correlation between frequency of earthquakes and change of rate of rotation. Astronomy has, therefore, brought a direct challenge into the realm of geophysics.

R.M.W.

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No. 95 RELEASED WITHOUT COPYRIGHT RESTRICTION October 21, 1926

KILAUEA REPORT No. 771

WEEK ENDING OCTOBER 20, 1926

Issued by the Observatory, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

During the past week there have been no notable changes at the pit of Halemaumau. The seismographs show very few earthquakes, there being only 12 very feeble ones recorded for the week. On the 14th and 15th microseisms were somewhat stronger than usual, and on the 16th there were very faint evidences of occasional spasmodic tremors which have not been included in the count above. There has been moderate tilt towards the east accumulating during the week.

Last week, just as the Volcano Letter was being prepared, a strong teleseism was received which was described at that time. The records from the seismographs at Hilo, Kealakekua, and Hilea, which have since been received, also recorded this earthquake.

A letter from Mr. R. H. Finch, who is in charge of establishing the Geological Survey volcano observatory at Mount Lassen, California, has just been received. Mr. Finch states that the excavation for the seismograph cellar is well under way and he expects to have the seismographs in operation by the end of this month.

Lieutenant L. G. Simmons of the Coast and Geodetic Survey is now camped at the Rest House at an elevation of about 10,000 feet on Mauna Loa. He is endeavoring to complete the upper end of the precise level line before the coming of winter weather. This level line, as stated in a previous Volcano Letter, is to be run between sea level and the summit of Mauna Loa. The work is being done with the high degree of accuracy usual in precise levels, being run independently in both directions with a standard prism level, and level rods having the graduations on invar metal. The U. S. Coast and Geodetic Survey is also planning this winter to make observations for gravity at the summit of Mauna Loa and also to establish a standard tide gauge at Hilo. These precise geodetic surveys will be of invaluable assistance in learning more of the activities within Mauna Loa.

The University World Cruise, a floating college comprising a full faculty and students to the number of about 570 persons, visited the volcano on the 18th. On the 19th the Los Angeles Chamber of Commerce visited the volcano with 107 persons in its party. These two days, therefore, brought a flood of visitors, many of whom were much interested in seismology and volcanology.

EARTHQUAKES DUE TO COLLAPSE

An extract from the Johannesburg "Star" (Transvaal) tells of the establishment 16 years ago of a seismograph at the Union Observatory in that city. This instrument was established to study the earthquakes felt in the vicinity of extensive mines at that place, to determine whether the quakes were of natural origin or were caused by settling and collapse due to mining excavations. In the early days, before the ground had been honeycombed by mining operations, no earthquakes had been noticeable, but in 1905 earthquakes began to occur with increasing frequency. In 14 years, following the establishment of the seismograph in 1910, there were recorded 5,427 local shocks of which about one-seventh were classed as strong. These earthquakes tend to occur in series or batches, being most frequent in the dry season, perhaps due to lack of the binding effect of moisture in soil and rock. The fact is noted that the greater number of these earthquakes, and those having the greatest intensity, occurred during the early morning hours.

Realizing that these earthquakes were probably caused by the settling of the workings of the mines, more care was exercised in timbering and in refilling abandoned tunnels with waste material, to guard against collapse. A response to this care has been shown in the diminishing number of local earthquakes registered on the seismograph.

If earthquakes can be caused by artificial excavation, may it not be that some of our ordinary earthquakes are caused by the collapse of internal voids in the earth, such as might be left by retiring magma?

This idea is perhaps supported by evidence furnished in both of the recent eruptions on Hawaii; the explosive eruption of Kilauea on May 11, 1924, and the lava flow on Mauna Loa on April 10, 1926. In both of these cases it was during the waning phases of the eruptions that the maximum number and violence of earthquakes occurred. This may mean that the subsiding pressure or retiring magma, allowing the upper layers of the earth's crust to settle back, has caused earthquakes due to this readjustment.

R.M.W.

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No. 96 RELEASED WITHOUT COPYRIGHT RESTRICTION October 28, 1926

KILAUEA REPORT No. 772

WEEK ENDING OCTOBER 27, 1926

Issued by the Observatory, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

A few slides and avalanches in the pit of Halemaumau represent all the activity noted during the week. There have been 15 local earthquakes, all very feeble, and three teleseisms. On October 23 there were a few very minute spasmodic tremors that have not been included in the above count of earthquakes.

Two of the teleseisms were recorded on the 22nd and occurred almost precisely an hour apart, their maxima coming at 2:21 a. m. and 3:21 a. m., respectively, Honolulu time. These earthquakes, according to Associated Press report from San Francisco, were sharply felt in San Francisco at 4:35 and 5:36 a. m., Pacific Standard Time, which, allowing for the time difference, would be 15 minutes before they were recorded here. A peculiar circumstance is that two local earthquakes occurred almost exactly an hour apart, the first one following 16 minutes after the first teleseism, and the second local shock following the second teleseism by the same amount of time. This is perhaps no more than an interesting coincidence.

The third teleseism was on the 25th, the preliminary wave arriving at 5:26 p. m. and the main wave at 5:46 p. m., Honolulu time. The estimated distance to the origin of this earthquake is 4,440 miles. A United Press report states that this earthquake was recorded at Ewa, near Honolulu, at about 5:55 p. m., Honolulu time, the distance indicated by the record at that observatory being 4,590 miles. The accumulated tilt during the week is slightly to the SW.

AN ACHIEVEMENT

In "Science," the issue of October 1, 1926, the resolutions adopted by the American Geophysical Union are of considerable interest. That resolution concerning the determination of the value of gravity at sea is of especial interest from the point of view of seismology. It almost seems that Dr. F. A. Vening Meinesz, of the Dutch Geodetic Commission, has accomplished the impossible.

To accurately determine the value of the attraction due to gravity is a delicate operation even on land. A pendulum, swinging in a partial vacuum, is timed very carefully. The value of the attraction due to gravity is computed from the time taken for a complete swing of the pendulum, by the usual formula of phsics. But in order to attain the great accuracy necessary to discover the minute variations in gravity, there are many precautions and corrections to be applied. Rigidity of support for the pendulum, elevation above sea level, and accurate time are matters of prime importance which on land can be satisfactorily attended to. But at sea complications are introduced that seem almost insurmountable. There can be no rigid support for the pendulum—a ship at sea must always have motion that will disturb the natural swing of the pendulum. The elevation of the instrument at sea, due to tide and wave, is difficult to determine. In fact, all the complexity that attends the determination on land is many times multiplied in a determination at sea.

Dr. Meinesz conducts his observations in very cramped space in a submarine, which in itself is an accomplishment. He uses a submarine in order to get into the comparatively quiet water below that agitated by wave action. Instead of swinging one pendulum only, as in land observations, Dr. Meinesz swings three, in planes making 120° with one another. These furnish sufficient data so that the effect of the motion of the submarine can be computed and eliminated.

In the face of all the difficulties presented, the accuracy attained is comparable to that resulting from land observations. Most certainly this is an achievement of high order.

Seas and oceans cover nearly three-fourths of the earth's total area. Land gravity stations can only cover a limited part of the earth, and this method will enable studies of gravity to be made systematically over the whole earth. Dr. Meinesz hints that certain areas may show values of gravity that are not in accord with completed isostatic compensation, which would probably have a definite bearing on seismic activity.

Dr. Meinesz visited the Volcano of Kilauea about a month ago, and was very generous in telling many of his interesting experiences. R.M.W.

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No. 97 RELEASED WITHOUT COPYRIGHT RESTRICTION November 5, 1926

KILAUEA REPORT NO. 773

WEEK ENDING NOVEMBER 3, 1926

Issued by the Observatory, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

A couple of large avalanches were noted on Saturday and Sunday in the pit of Halemaumau. There have been no other notable changes or activity at the pit. Eight local earthquakes and two teleseisms occurred during the week. The local earthquakes were all very feeble, with the exception of that which came at 12:16 a. m. on October 31. This shock, apparently about 14 miles from the observatory and probably on the rift line of Mauna Loa, was of sufficient intensity so that one of the seismographs was partly dismantled. There have been no reports of its having been felt, probably due to the time of its occurrence, although its maximum acceleration indicates that it should have been perceptible.

One teleseism, which occurred at 9:20 a. m. on the 30th, was rather feeble, and no estimation as to distance and direction could be made. The other teleseism, at 3:27 p. m. on the 31st, had a maximum amplitude of 0.61 millimeters actual movement of the ground. This produced on the seismogram a record about six inches wide. In spite of the apparent size and intensity of this earthquake, no preliminary wave could be distinguished, probably being obscured by microseisms. The seismograph operated by Captain R. D. Woods in Kealakekua, Hawaii, also recorded this earthquake. A telephone message from him was the first news of the quake at the observatory, as the seismographs had not been inspected during the afternoon.

Tilt has been accumulating slightly to the east during the week.

USE OF VOLCANIC ENERGY

Manifestations of such liberal amounts of energy as occur in volcanoes, earthquakes and geysers, naturally lead to thoughts of harnessing and making use of this energy. The tides have been to a certain extent made use of in generating power, and large projects of further developments are in view. Volcanic energy is more difficult to harness, but has been successfully done.

Prince Piero Ginori-Conti, President of the Italian Society of General and Industrial Chemistry, tells (New York "Times," September 15) of using volcanic steam in the region of Vesuvius. The steam escaping from the ground is under low pressure—about 30 pounds per square inch at best, and it has been successfully utilized even when the effective pressure is as low as five pounds per square inch. It was at first an experiment. In 1903 a small engine was run at Larderello by steam escaping from a natural vent. Since that time wells have been drilled tapping larger supplies under better pressure, so that in 1914 a plant of three turbo-alternators was running with a net power output of 2,500 kilowatts.

The wells drilled are 16 inches in diameter, and vary in depth from 180 feet to 750 feet, ordinarily by using a rotary drill. In the Larderello district the steam brings with it various gases that have commercial value, as carbon dioxide, helium, and argon. Also sulphurous gas is separated from the steam before it reaches the engines.

Geysers have also been tapped, and made to deliver power. Prince Ginori-Conti says that there are in our western states geysers that are comparable to the ones that have been utilized in Italy.

In order to find natural volcano steam under pressure it is probably essential to have the surface strata sufficiently impervious to confine the steam. In the vicinity of the Volcano of Kilauea the structure of the upper layers, at least, is not only composed of a rather porous lava, but is also broken by many earthquake cracks. Thus steam that is formed underground has so many natural vents that it has practically no effective pressure when it reaches the surface. But there is aparently an inexhaustible supply, and pressure might be found by deeper drilling.

Apparently hopeful ambition is not lacking in the matter of harnessing the volcano noted in an extract from the "Madras Mail" of September 9, 1926, though in this case it seems to be to muzzling, rather than utilizing, the volcano's output. The extract is as follows:

"Farmers living near the Masaya volcano, in Nicaragua, who have clung to their homesteads in spite of damage frequently done to their crops by poisonous gases given off by the mountain, have apparently decided to muzzle their enemy.

"According to the latest report they have employed a group of German engineers, who propose to build a cap over the crater, and by the injection of certain chemicals, to neutralize the gases, which, if necessary, will be allowed to escape through a safety valve." R.M.W.

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NO. 98 RELEASED WITHOUT COPYRIGHT RESTRICTION November 12

KILAUEA REPORT NO. 774

WEEK ENDING NOVEMBER 10, 1926

Issued by the Observatory, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Conditions at the pit of Halemaumau remain unchanged. The steaming at the southwest talus continues, and there are still occasional avalanches.

During the week there have been eleven local earthquakes, all very feeble, and one teleseism, which occurred at 9:45 p. m. Hawaiian Standard Time on November 4. This was apparently a minor earthquake with indicated distance of 2,160 miles. During the week microseisms have been unusually strong. Accumulated tilt has been slightly to the east.

PRECISE LEVELS ON MAUNA LOA

Lieutenant L. G. Simmons, of the U. S. Coast and Geodetic Survey, now has the Mauna Loa level line completed about halfway from the summit of the mountain to the Volcano House. The difference of elevation between the summit and the Volcano House is a little less than 10,000 feet, and the distance is approximately 30 miles. In running spirit levels, level sights only are taken, and rods of 10 or 12 feet in length are used, therefore for each time the instrument is set up, only about nine feet in elevation can be gained, as an average. To make a single measurement of this difference of elevation thus requires, roughly, 1,100 "set-ups" of the instrument. But as this work is being double run—that is, each part is run in both directions—it is actually being run twice, as a check. Lieutenant Simmons will therefore have to set up, level, and read his instrument about 2,200 times to complete this section of the work. One hundred "set-ups" are considered a very fair day's work.

So far, during the progress of the work, the weather has been favorable. Rain is not so frequent on the higher part of Mauna Loa, and wind has not bothered excessively.

The party camped at the Rest House, beside Red Hill, for a while, at about 10,000 feet elevation, and then moved to the "Hotel de Jaggar" not far from the summit and at the northeast end of the Crater of Mokuaweoweo, where they stayed about 10 days. This camp is no more than a lava tube, which affords meager shelter if one is inclined to get down on hands and knees and crawl for it. A caved-in portion of the tube is the front door, which, covered with a sheet of canvas, also served as kitchen and commissary. Water in the crevices of the lava supplied the camp, though it was necessary each morning to break through an inch of fresh ice. It is a surprising fact that mice were found at this camp, easily 5,000 feet above the highest outpost of vegetation.

The party is now camped below the Rest House, at an elevation of about 6,500 feet, in comparative comfort below timber line.

THE SEISMOGRAPH STATION AT KEALAKEKUA

The Hawaiian Volcano Observatory is located on the east flank of Mauna Loa. On the west flank, in Kealakekua, is the branch station operated by Captain R. V. Woods, consisting of a single horizontal pendulum mounted in a N—S plane, being thus most sensitive to E—W motion. This instrument is of simple construction, yet during the few years of its operation has been very successful in detecting both local shocks and teleseisms. Many earthquakes have been recorded both on this instrument and on the instruments at the Hawaiian Volcano Observatory. Comparison of the records is especially interesting on account of the fact that the line between the two stations passes practically through the middle of the great mass of Mauna Loa. The two stations are also almost equidistant from the center of this volcano, and are therefore strategically placed as observation posts to study the interior workings of the mountain. Comparative study has heretofore been somewhat hampered by the difficulty of accurate time comparison. For a long time the clocks at the observatory have been corrected by the radio time signals, but at Kealakekua dependence was placed upon time secured by telephone, sometimes more than a minute in error. A radio set for receiving time signals has just been installed at the Kealakekua station. A key placed beside the radio set is connected into the station clock circuit, so that at the instant the time signal is received the key is depressed, thus recording it on the current seismogram along with the minute marks made by the station clock. To obtain the clock correction it is therefore necessary to simply measure on the seismogram the time interval between the radio time and the clock time. It is believed that time can thus be secured to within half a second or better. This will make possible the comparison of the time of arrival of shocks at the two stations with a fair degree of accuracy. R. M. W.

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No. 99 RELEASED WITHOUT COPYRIGHT RESTRICTION November 18, 1926

KILAUEA REPORT No. 775

WEEK ENDING NOVEMBER 17, 1926

Issued by the Observatory, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

The pit of Halemaumau is still confining its apparent activity to occasional small avalanches, and continued steaming at various points on the floor of the pit and through the talus slopes. Conditions remain practically unchanged.

Rumors and reports have occasionally been heard of a glow, or smoke, being seen on Mauna Loa. Lieutenant Simmons, camped near the summit, has seen no sign of activity, nor have the seismographs indicated any unusual activity. The 1926 flow is probably still warm enough to convert into steam any rain that falls upon it, thus perhaps giving rise to rumors of smoke on Mauna Loa. The same thing happens in the pit of Halemaumau—during and after a rain the steaming is much more pronounced.

There have been but eight very feeble local earthquakes recorded this week, and no teleseisms. On the 14th of November microseisms were exceptionally strong, perhaps due to the high wind that prevailed upon that day. Tilt accumulated during the week has been moderate to the N.E., coming mostly on the 14th.

THE FIELD OF THE SEISMOGRAPH

The seismograph, as its name implies, was primarily designed to study earthquakes. That is of course its major application, but its other practical usefulness is sometimes not realized. Practically all modern knowledge of the mechanics of earthquakes and the propogation of earthquake waves has come from data furnished by the seismograph in its various forms. It is now being used not only for general study, but for obtaining information upon certain definite points of commercial and industrial interest.

In the Volcano Letter of October 21, mention was made of the use of a seismograph installed to detect local and artificial shocks due to mining operations.

Oil companies have been making successful use of seismographs to help locate oil formations. This is done by setting off charges of explosive, thus causing an artificial earthquake of which the time and place may be accurately determined. The record made on a seismograph at some distance away is then studied. The earth waves originating with the explosion are reflected back from the underground strata, and careful timing yields data from which the depth of these strata may sometimes be computed.

An instrument, operating upon the same principle as a seismograph, has been used mounted upon a railroad car, recording during the car's progress the sway caused by unevenness of roadbed.

In engineering, seismographs are adapted for use in studying the nature and amount of vibration in structures. Mounted on bridges or buildings, deflections and sway due to passage of vehicles, to variation of loading, and to wind pressure might be recorded, if these motions are of sudden or periodic nature. Slight tipping, such as might occur due to unequal settlement of foundations, would also be recorded. The effect of earthquakes on tall buildings might so be studied.

Many may be written on the use of seismographs as an aid in detecting danger to structures due to earthquakes. In the April-June, 1926, issue of the "Materiaux pour l'Etude des Calamites" (Societe de Geographie de Geneve) Dr. G. Agamennone, Directeur de l'Observatoire royal de geophysique de Rocca di Papa, writes on the menace of dams built for hydroelectric developments. There have been several calamities due to the failure of such dams, resulting in loss of life and damaged property in the flooded areas. Dr. Agamennone suggests various reasons for such failures—unusually heavy rains, poor design, undermining due to leaks under the foundations, and so on. He states that earthquakes may easily cause such failures in various ways. An earthquake may not cause an immediate failure, but may so crack the structure as to allow water to seep through and complete the destruction. Dr. Agamennone suggests that since the success of a project depends upon the care with which it is planned, that a study of the seismic conditions might well be made at a site chosen for a dam. Engineers consider rainfall, geologic structure, and many other things, but sometimes neglect seismic activity as a factor in determining the design of the dam. Frequency and intensity of local shocks should be considered, both through historical information and by setting up seismographs at the chosen site. When the dam is built, as a measure of protection seismographs should be installed at the dam.

Dr. Agamennone suggests that laws should be passed enforcing this precaution, as it would be but a small amount of insurance invested towards the safety of those living below the dam. Such instruments might give early warning of earthquakes of sufficient magnitude to endanger the dam. If mounted on the dam itself they would give warning by recording any undue vibration, settling or "giving" of the structure. Certainly these instruments would be excellent sentinels to report the coming of danger, and might easily minimize the loss of life, through warning, that would probably result should the dam fail. Sometimes legal suits result from such a failure. Seismograph records would be important evidence in ascertaining cause and blame.

R.M.W.

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No. 100 RELEASED WITHOUT COPYRIGHT RESTRICTION November 26, 1926

KILAUEA REPORT No. 776

WEEK ENDING NOVEMBER 24, 1926

Issued by the Observatory, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

At the pit of Halemaumau continued steaming has increased the yellow sulphur deposits at various places, and dust from avalanches has begun to settle on the black lava portion of the floor to such an extent as to be noticeable, causing the floor to be of a dusty, reddish tint, rather than the shiny black of the fresh lava. On November 22, at 1:20 p. m., a very considerable avalanche was noted, the dust continuing to rise in heavy clouds from the pit for five or ten minutes. An inspection of the seismogram shows a very slight tremor at that time, probably caused by this avalanche. This slide appears to have been a sloughing-off of the lower part of the wall on the north side of the pit.

There have been eighteen local earthquakes this week. All of these were much too feeble to be felt, but two of them were large enough to show definite preliminary phases indicating the distance of each to be about 28 miles. On November 20, during the middle of the day, a few very minute spasmodic tremors were noted, which have not been included in the above count. For the past several weeks the frequency of earthquakes has been very low. The number this week marks a very considerable increase. It is perhaps possible that the low ebb of seismic activity is at an end and that more frequent earthquakes may be expected.

Tilt during the week has accumulated slightly to the northwest. Tilt accumulated since the middle of September is about seven and one-half seconds of arc towards the east, and about five seconds of arc towards the north.

OCTOBER TELESEISMS

During the month of October there were seven teleseisms recorded at the Hawaiian Volcano Observatory. These were noted briefly in the current Volcano Letters. Information from other stations, not available at the time these Letters were published, has since been received. This makes possible the comparison of the various data from other parts of the world with the data recorded here.

In Volcano Letter No. 93 of October 7 a teleseism is mentioned as having been recorded at 8:45 a. m. Hawaiian Standard Time on October 3. This corresponds to 19:15 Greenwich Time. The trace of this earthquake was a feeble one and the disturbance noted at the time was probably not the preliminary wave as was then supposed. The preliminary wave probably arrived at 19:50 Greenwich Time. This earthquake apparently caused some doubt at other stations as to the position of the epicenter, and no conclusion seems to have been reached concerning it. A very uncertain estimate of the distance from this station is 5,670 miles.

On October 13, as noted in Volcano Letter No. 94, an earthquake was recorded, beginning at 8:45:04 a. m., corresponding to Greenwich Time 19:15:04. An estimate of 2,370 miles was made for the distance to the epicenter of this earthquake. From other stations come reports of three earthquakes on that day, all in the same region, near the Aleutian Islands, the one recorded here being the third. Its epicenter as computed by the central station of the Jesuit Seismological Association, St. Louis, is 51 degrees north latitude and 178 degrees west longitude. This checks with the distance from this station as estimated above. The first earthquake of this day was also recorded on the seismograph at this station, but was so faint as to have been overlooked at the time. The preliminary wave of this first earthquake was recorded at about 6:10 Greenwich Time.

The earthquakes felt in San Francisco on the 22nd of October, noted in Volcano Letter No. 96, attracted considerable notice from the press. The preliminary bulletin of the central station of the Jesuit Seismological Association makes no computation of the position of the epicenter except to say that these two shocks were apparently at approximately the same place and about 640 miles from the station at Tucson, Arizona. These earthquakes perhaps occurred two or three hundred miles off the south-central portion of the coast of California.

Another earthquake was also mentioned in Volcano Letter No. 96, recorded on the 25th day of October at 5:26 p. m., Honolulu Time, corresponding to 3:56 October 26 Greenwich Time. This earthquake apparently took place about five or six hundred miles south of the southwest end of Japan.

The earthquake which was recorded here at 9:20 a. m., Honolulu Time, on the 30th, occurred at 19:41:28 Greenwich Time, near the Queen Charlotte Islands, British Columbia, Canada. The latitude and longitude of the epicenter as given by the U. S. Coast and Geodetic Survey from combined data is 53 degrees north and 129 degrees west.

The earthquake which was recorded here at 3:27 p. m. on the 31st, Hawaiian Time, is reported as having occurred at 1:39:10 Greenwich Time on November 1 in latitude 50 degrees north, longitude 130 degrees west. This is only two or three hundred miles south of the earthquake just described above on the 30th. R.M.W.

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No. 101 RELEASED WITHOUT COPYRIGHT RESTRICTION December 2, 1926

KILAUEA REPORT No. 777

WEEK ENDING DECEMBER 1, 1926

Issued by the Observatory, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

The pit of Halemaumau is still quiet. The steaming continues and has made a yellow deposit of sulphur at one point on the southeast talus. A new deposit of sulphur has also appeared near the foot of tbe northwest talus. Avalanches are infrequent.

The total number of earthquakes for the week has been nine, of which four occurred on the afternoon of the 29th of November. All of these were very feeble with the exception of one which came at 4:09 p. m. on the 29th. This was strong enough to be felt by a few persons in the vicinity, being a local shock with a maximum acceleration of about 8.0 millimeters per second per second. During the afternoon of the 29th there are evidences of occasional very slight spasmodic tremors, in addtion to the earthqaukes noted above.

Tilt has been accumulating during the week slightly towards the southwest.

SEISMOLOGY AND GEODESY

Seismology is intimately involved with many other branches of science, geodesy being one of the most important. Geodesy, dealing as it does with measurements over large areas of the earth's surface, is available as a means of discovering movements of the earth's crust due to seismic and tectonic forces. Trinagulation is used to measure the horizontal surface displacement resulting from earthquakes; precise levels to discover change in slope, or tilt, and differences in elevation due to vertical displacement. Tide gauges may record sudden or gradual elevation or depression of a shore line. Astronomical latitude and longitude observations may show change of position of great areas of the earth's surface, as in the theory of the "Drift of Continents."

Surveys of the earth's surface in general have been made to determine dimensions of areas for various civil uses, without thought that these areas may be measureably changing. The ever-increased accuracy with which geodetic surveys are being made is developing the fact that our apparently solid earth is actually undergoing surface movements that may be directly measured. Geology easily shows that the earth's surface has many times been made over. But geology deals in such vast periods of time to accomplish these changes, that an individual, in the few years given him in which to observe, must observe very closely to see the changes actually progress.

Successive surveys over the same area will always show discrepancies, even if no actual change in the area exists, as curveys and measurements can never be exact. Thus two surveys will differ, due simply to errors and inaccuracies in measurement which cannot be reduced to zero, even by the most careful work. The actual ground movements are usually small, and it is therefore difficult as a rule to separate, in the discrepancies developed by two successive surveys, the amounts that are due to measurement errors and to actual movement or change of dimensions of the measured area. If the probable errors of measurement are known, through knowledge of the methods employed, and if the discrepancies developed are considerably in excess of such probable errors, then it may be said that very likely actual movement exists.

Triangulation, by the U. S. Coast and Geodetic Survey, has successfully shown earth movement over large areas in California (U. S. Coast and Geodetic Survey Special Publication No. 106, "Earth Movements in California"), and a very comprehensive compilation of old triangulations has been made by R. H. Tucker in the September, 1926, issue of the Bulletin of the Seismological Society of America, wherein is shown the definite measurement of the relative displacement accumulated along the San Andreas fault between 1885 and 1907.

Spirit levels in Japan, re-run after the eruptions of Sakurajima and Usu, showed cases where relative differences of elevation had changed many feet in the regions around these volcanoes. Levels run in 1912 around the Volcano of Kilauea showed the presence of tilt, and more elaborate running in 1920 and 1921 apparently confirmed the idea that tbe elevations at this volcano are changeable, causing slight tilting or altering of grade in the slopes of the mountain.

Observations are now in progress to simultaneously establish accurate astronomic latitude and longitude stations in various parts of the world. In future years these stations may be again occupied, thus perhaps making a direct measurement of changes in latitude and longitude of a given point on the earth's surface due to its horizontal movement under the impluse of isostatic adjustment, faulting or other causes.

Therefore, in many ways are the surface motions of the earth being watched. Geology shows the results of past changes. Many of the earthquakes studied in seismology are the indication of present changes in progress—they are in fact the creaking and groaning and cracking of the earth's crust under the forces that are remodelling it. Such surveys as are here mentioned may help in the future to show where, and in what amount, this remodelling is taking place. R.M.W.

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No. 102 RELEASED WITHOUT COPYRIGHT RESTRICTION December 9, 1926

KILAUEA REPORT No. 778

WEEK ENDING DECEMBER 8, 1926

Issued by the Observatory, U. S. Geological Survey:

T. A. Jaggar, Official in Charge

During the past week Halemaumau pit has developed no volcanic activity and the Mauna Loa-Kilauea system continues quiet, though some earthquakes slightly perceptible have occurred. The earthquake reported last week, of 4:09 p. m. November 29, gave evidence on the seismographs of Kona, Hilea and the Observatory of an inward tilt towards the Mauna Loa center at these stations, exhibited as a sudden swing of the pendulums, causing off-set of the seismogram lines, from which there was no recovery afterward. This sudden tilt accorded with the accumulated southwest tilt at the observatory. This would all seem to indicate that the Mauna Loa rift belt, after the eruption of April, 1926, is still subsiding.

Halemaumau has on the south talus a bright yellow sulphur patch about 25 feet in diameter, with blackened stones in its midst. This was formerly a superheated, whitish, dry area in the midst of steam wetted talus. Prolonged dry weather has developed six other paler sulphurous patches. During 20 minutes today rocks fell twice at the NNE wall. Sixteen steam jets occur about the bottom of the pit.

Only six earthquakes for the week were registered. One of these at 1:29 a. m. December 2 was of intensity sufficient to be perceptible, and the seismogram indicated an origin 10 miles away in the line of direction N 68° W. Tilt for the week was slight to the east.

SCIENCE CONGRESS IN TOKYO

The Third Pan-Pacific Science Congress opened in the great hall of the Imperial University of Tokyo on October 30 and closed its session November 11. More than 200 delegates from overseas were present and some 400 delegates from Japan. The Congress was organized with extraordinary efficiency under the able leadership of Dr. Sakurai, and the foreign delegates were entertained lavishly by the Imperial Government and by distinguished citizens of the Empire. Excursions were provided, before the Congress opened, to the Ainu villages of Hokkaido (the northern island of Japan), to the Cretaceous and Tertiary deposits of that island, and to Tarumai volcano, which staged a small explosive eruption just at the time of the Congressional visit. Other excursions prior to Congress were to Nikko and Hakone, and these beautiful mountain districts were in the full glory of autumnal foliage. Numerous short excursions occupied the week-end of November 6 and 7, and after the Congress there were long excursions to central Japan, the Inland Sea, and the mines, hot springs, and volcanoes of Kyushu. All of this travel was furnished to the overseas delegates at the expense of the Imperial Government, and was even extended to Korea for those delegates who were headed toward China.

The countries represented in the Congress were Japan, the United States, Australia, Canada, China, France, Great Britain, Hawaii, Hongkong, Holland, the Dutch East Indies, New Zealand, Papua, the Philippines, the Strait Settlements and Federated Malay States, Russia, Sweden, Peru and Chile.

More than 400 papers were presented in English, the official language, and geophysical sciences were represented by a large number of delegates. Oceanography was accented, and the geological sciences had more representatives than any other group. Japan exhibited instruments and methods, bearing on seismology and earthquake-proof construction, greatly in advance of former practice. At Kyoto there are seismographs with magnification of 50,000, electrical transmission of the motion, and vacuum-tube amplification for registration. Remarkable new accelerographs and vertical-component instruments are under test in the University of Sendai and at the Imperial University of Tokyo. Dr. Imamura has new horizontal pendulums, designed for registering great earthquakes by reducing the amplitude instead of magnifying it, and others of extraordinarily long period by means of special adjusting screws and great height to the supporting columns.

The discussions of the Congress developed the need for more extensive translation of scientific works written in obscure languages. Resolutions were passed on motion of those interested in volcanology and local seismology, recommending (1) more published notes at short intervals, (2) more cooperation by radio, (3) more interchange of research workers, and (4) translation of far-eastern scientific books through such interchange.

It was provided that the Congress of 1929 shall be held in Java. T.A.J.

VOLCANO EXHIBIT PROJECT

The Hawaiian Volcano Research Association has now provided for an exhibition room to be built adjacent to the volcano observatory at Kilauea. For many years travelers who have visited the pit and the active lava flows have come to the observatory keenly interested to ask questions about volcanology. The new establishment is designed to meet this demand with what may be called a "live museum," that is, a place for short lectures, demonstration of maps and charts, projection of motion pictures and lantern slides and an exhibition seismograph. Plans for the building have been drawn, a curator will be appointed to care for this work, and the exhibit will be opened during the first half of 1927. T.A.J.

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No. 103 RELEASED WITHOUT COPYRIGHT RESTRICTION December 16, 1926

KILAUEA REPORT No. 779

WEEK ENDING DECEMBER 15, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

No new activity has appeared in the volcanoes Kilauea and Mauna Loa. A visit during the past week to Mauna Iki shows that the rusty spots in the top of that hill are hotter than ever. A stick thrust in a crack ignited instantly at one of these spots. Halemaumau, the lava pit of Kilauea, exhibits still further increase in the sulphur stain of the south talus. A new patch of yellow has developed at the margin of that talus, while the large yellow patch in its midst still shows strong solfataric activity. There is very little avalanching.

Fourteen earthquakes have been registered on the seismographs, all small and local except one. This last was a faintly recorded teleseism reaching a maximum at 10:25 p. m. December 9. The U. S. Coast and Geodetic Survey reports the time of occurence at the source 8 h. 37 m. 59 s. Greenwich Time December 10, and the place on the bottom of the ocean about 1,000 kilometers west of Cape Mendocino, California, at 41° N. Lat. and 136° W. Long. Tilt for the week at the Observatory was very slight to the east.

LASSEN REPORT NO. 2

The first note from Lassen Volcano Observatory in California was printed in the VOLCANO LETTER of October 21. Mr. R. H. Finch, Asscciate Volcanologist, now reports that the seismograph pendulums have been operating about a month (November 24), are still in process of adjustment, and have shown no earthquakes. Mid-November produced heavy rains at Mineral, where the volcano station is located. For several days the rainfall was three or four inches per day, and high winds blew down the big yellow pine trees with crashes like the rumble of earthquakes. The road to Mineral was blocked by fallen trees. Snow developed in the latter part of the storm.

"A man who has been cattle-ranching in the Lassen countrty for twenty1five years, told of hearing distinct rumbling from the volcano about 18 years ago. (The eruption was in 1915). The water that went down Hat and Lost creeks during the mud flows of 1914-15 was still warm 18 miles down their valleys. The Lassen edifice has certainly been getting a soaking this month."

"November 29. Winter conditions here are quite primitive. I am all by myself with the nearest neighbor about a mile away. All water has to be carried. Fortunately there is a brook about 500 feet away. So far there has been practically nothing recorded on the seismographs. They are not yet in final shape. The road to Susanville is still open, while some of the Sierra roads farther south are closed on account of heavy snow."

The Lassen Station at present consists of an office and seismograph cellar at Mineral near the Lassen Park headquarters, and a cottage for the volcanologist has been kindly supplied by the U. S. Forest Service. The seismograph cellar was started September 20 and finished October 5. The office building was finished October 19. The seismographs are of the horizontal pendulum type, built on the spot, but the time-piece is an excellent Howard seconds pendulum clock, electrically fitted. T.A.J.

EARTHQUAKE OF SEPTEMBER 16

In the Volcano Letter of September 23 we reported a big earthquake west of the New Hebrides, Greenwich time 17h. 59m., September 16, and another about five hours later. The center was located by the U. S. Coast and Geodetic Survey.

The Sydney Morning Herald of 28 September reports that the ship Mataram on that day (September 17 in Australia), was docked at Yandina, Solomon Islands. The shock was felt all over those islands, and much furniture was knocked about on the ship. On Tulagi the earthquake was very severe. Twelve distinct shocks were felt during the day, the most powerful about noon and five p. m. local time. The wharf was damaged at Makambo, and natives were panic-stricken at Viduna, a cattle ranch, where the principal shock lasted about one minute.

T.A.J.

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THE VOLCANO LETTER

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No. 104 RELEASED WITHOUT COPYRIGHT RESTRICTION December 23, 1926

KILAUEA REPORT No. 780
WEEK ENDING DECEMBER 22, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

The past week has been excessively rainy at Kilauea, and the only changes noted at Halemaumau pit were wetting of the walls, consequent washing-away of some of the soluble salts stained with sulphur at the solfataric areas, and a little sliding from the northern walls of the pit. As usual, the rain has increased the volume of visible vapor at the steam jets.

Sixteen very feeble local earthquakes have been registered. One at 8 p. m. December 18 indicated distance of origin as 12 miles. A prolonged tremor at 11:15 a. m. December 15, of very slight amplitude, may have been occasioned by an avalanche in the pit. No tilt was accumulated during the week.

ELASTIC-REBOUND THEORY OF EARTHQUAKES

The California earthquake of 1906 was characterized by a long, vertical rift extending northwest and southeast for several hundred miles through California. The crack passes San Francisco on the west and lies just within the coast line north of the Golden Gate, until it disappears beneath the waters of the Pacific off Cape Mendocino. The earthquake is believed to have been caused by accumulated strain on opposite sides of this crack, whereby the land to the east was moving southward, and that to the west of the crack was moving nortward, the two motions opposing each other on the rift line and demanding relief there in the course of time. When the earthquake occurred there was sudden, violent motion northwestward of the land west of the crack, and similar motion southeastward of the land east of the crack. The country on the crack itself was torn and shattered, trails, roads and fences crossing the rift zone were offset, and sod was torn athwart hills and fields and bottom lands that chanced to lie in the rift zone. The maximum was near Point Reyes, north of San Francisco, and consisted of horizontal offset of more than 20 feet. The vertical displacement on opposit sides of the gashed ground was small, only a foot or two, and the horizontal movement became progressively less along the fault zone for scores of miles to the southward. The severity of shaking was in general greatest along the rift itself, and died out away from the rift, although here were some parallel belts to the eastward which behaved like independent centers of seismic activity.

This earthquake has been reviewed. along with other great shocks, in an interesting illustrated volume entitled "Our Mobile Earth," by R. A. Daly (Scribner, 1926). In explanation of the great earthquakes of the world Professor Daly accepts Reid's theory of elastic rebound. The growing strain was resisted by the strong crust. At last at a certain moment in the year 1906, the forces reached the elastic limit of the crust. The crust broke at a point. With the speed of sound in rock, that is, at the rate of over three miles a second, this incipient fracture spread along the line of the San Andreas rift. In a minute or two of time the long fault was formed. The crust was relieved of strain which had long been growing. The crust bounded back towards its original position, and that so suddenly as to jar the whole State of California and, in fact, the whole earth. Proofs cited to confirm this theory of elastic rebound are that the belt of destruction was elongated parallel to the rift, the isoseismals or lines of equal shaking were elongated symetrically around the rift, and the shock was greatest along the rift. Eleven other great earthquakes are mentioned having faults from 12 to 190 miles long associated with them, and these faults suffered displacement both vertically and horizontally of from three to 47 feet.

A second confirmation of the theory is found in the fact that broad belts of country alongside the fault trace are permanently displaced, up and down or horizontally, at the time of the earthquake. In California this was tested by a net of triangulation stations which should have indicated a lengthening of lines where the country expanded and a shortening of lines where the country has been dilated before, and suddenly contracted at the time of the earthquake. Just such effects were discovered between triangulation stations which had been established in the 19th century, and were reoccupied after the earthquake. Moreover, the permanent displacements were approximately parallel to the fault zone, with total shifts reaching more than 15 feet and the average displacement nearly twice as much on the west as on the east with reference to a distant base line.

A fourth test of the elastic rebound theory depends on the location of the depth of the point of fracture. The principal shock is supposedly due to a sudden snapping apart of two fracture surfaces at some distance underground. Various instrumental methods have been devised for determining how deep is this point of origin, which is called the focus of the earthquake. "In general the most trustworthy determinations give depths no greater than 25 miles; their weighted average is not far from half that." This agrees with the notion that the earth's crust is only 25 to 50 miles thick and that within that thickness the fractures occur which produce big earthquakes.

The four tests proposed by Dr. Daly seem then to agree with the elastic rebound theory. They are (1) that the shock is greatest along the fault, (2) that wide areas are displaced next the fault, (3) that the land measurably contracts and expands, and (4) that the depth of focus is consistent with the notion of sudden fracturing of the crust deep underground.

With reference to volcanoes Daly concludes that they are best explained on the supposition that such deep fractures allow gas-charged lava to rise, and very often, therefore, earthquakes and volcanoes are associated. Daly considers that both quake and volcano are effects of a common cause, the sudden fracture of a strained crust. He writes: "In all this we are dealing with earthquakes of the kind that causes great destruction. The much feebler shocks, caused by volcanic explosions or by sudden injections of liquid lava into the crust, belong in a quite different category—the class of true volcanic earthquakes."

This definition of volcanic earthquakes appears dubious to the reviewer. At Kilauea neither injection nor explosion produces earthquake. Volcanic earthquakes in Hawaii are due to slipping on fault planes. These slips are of all intensities from tiny to very large. It would seem that the shift of underground magma under change of surface loading may be quite as competent to produce a big earthquake as elastic rebound. T.A.J.

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No. 105 RELEASED WITHOUT COPYRIGHT RESTRICTION December 30, 1926

KILAUEA REPORT No. 781
WEEK ENDING DECEMBER 29, 1926
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

Nothing new except the dribble of small rock falls from the walls, has been noticed at Halemaumau, the lava pit of Kilauea. Kilauea and Mauna Loa remain inactive.

The total number of earthquakes recorded for the week is 17. These were all very feeble with the exception of one which occurred at 9:26 p. m. on December 25. This earthquake was a perceptible one, and evidently shook a large section of the island, having been felt in Hilo and Waiohinu. This earthquake was recorded on the Hilo seismograph as being 46 miles from that place. It was distant 25 miles from the Volcano Observatory, probably near the summit of Mauna Loa. A few hours after this earthquake, on the 26th, between 3:57 and 4:20 a. m., the seismographs show a very feeble, but almost continuous tremor.

Tilt accumulated during the week has been moderate to the north-northeast.

THE MYSTERY OF MAUNA LOA

The terrific earthquakes and tidal wave of 1868, with landslip in Kau, lava flow in Kahuku, and collapse of the whole crater of Kilauea, seems very remote to us of the peaceful present.

On the Hilo side, we have only to quote from letters of 1881:

"Six months glided on, and still the fiery streams continued to grind on their seaward way, burning the forest through which they passed, filling up ravines, and making for themselves a vast level highway, and in places huge tunnels, through which the liquid lava flowed. It became evident that, should the awful streams unite, there would soon remain no trace of Hilo or its harbor."

"All Hilo may be said to have visited the flow during the last few days (July 6, 1881). Men, women and children, some on foot and some on horseback, have made the pilgrimage. Many in Hilo have been packing, so as to be ready to make a sudden start."

"It is almost impossible now to say when the flow will reach the sea; but all things considered, the probability is that it will take the Kukuau gulch. It is now not over one and three-quarters miles from the sea. Probably, before you hear from us again, all the lower part of the town will be destroyed."

"The lava is now only two and one-half miles from Volcano Street, and it is very liquid. It has, some part of the time, run at the rate of half a mile a day."

"Large parties of fifty to one hundred visit it daily, and some go up early in the morning and return, and again go up in the afternoon. Mr. Kennedy and Mr. Richardson are alarmed for the mills, and they have begun to pack and remove their valuable articles. Our town is greatly moved, and some have suspended all other business to watch the fires. The puffs of smoke and steam along the channel appear like the smoke of steamers descending a river. The main body of the fire is moving slowly down upon us in sufficient breadth to sweep our whole town, while the small stream is like advanced pickets on a skirmish line. Probably a few days hence we shall see its triumphant entrance into our town, about half a mile east of Church Street. It will be a grand spectacle, though full of terror.'

Finally August 14th, Mrs. Luther Severance wrote:

"I know you are longing to hear about our lava flow. You will thank the Lord, as we do, that it has ceased action. It had advanced to within a mile from the beach, having travelled fully forty miles from the summit of Mauna Loa."

"We hardly can think or talk of anything else. This fiery flood, whose steady advance we have watched since last November,—that is, for nine long months—has occupied all our thoughts, and for the last two months we have spent much of our time near this terrible, fascinating monster: night and day have called us to its side." (Fire Fountains, by Lady Gordon Cumming, Blackwood, 1883.)

These human documents of forty-five years ago have very human meaning for those of us who watched the flow of 1926 invade and crush, to pulp and cinder, the village of Hoopuloa. The machinery of Mauna Loa is more than a mystery: it is an inaccessible mystery. It extends down through 18,000 feet of sea water. Skilled physicists are at this moment weighing it at a camp on the summit: is the central rock lighter than the shoreline rock? The Kilauea fountains are heavier than the Mauna Loa fountains. Cracks, mysterious cracks, extend toward Hilo and toward Kau. Where is the liquid lava now? Why do the groups of eruptions time themselves to a systematic interval? Why did the eruptions shift from the Hilo side to the southwest side; 1843, 1852, 1855, 1859, and 1881 were at the north. Now they are all at the south—1907, 1916, 1919, 1926.

The Government last year honored Hawaii by making Kilauea headquarters for widespread work in volcanology. A private corporation, the Hawaiian Volcano Research Association, has recognized the honor by financing most generously a new exhibition and lecture system for tourists at Kilauea National Park.

The Territory of Hawaii now has its chance to recognize what the Federal Government has done by building an emergency 7-foot trail up Mauna Loa in Alika. This trail, passable for low gear truck, is needed for protection of the ranches, for a scientific observatory, and to let travellers see the source fountains in that marvellou Kahuku country.

There was a summit eruption in Mauna Loa in 1903 and 1914, and damaging flows poured into the cattle lands in 1907, 1916, 1919 and 1926. There was a flow on the Hilo side in 1899. The intervals were 4, 4, 7, 2, 3, 7 years. Will the next eruption be in 1928, 1929 or 1930? Two, three or four years? Is the south side shaking now? Are the cracks growing cooler or hotter? Is the ground bending down or up?

The Alika flow did one good thing. It came against the Koa Camp road, and opened a way, only five miles long, to extend that as a 7-foot trail to the summit of the Kahuku ridge, 7,500 feet above sea-level. With that trail we will keep an observatory on the most active part of Mauna Loa. With that trail everybody can see the 400-foot fountains. With that trail we can warn the cowboys. With a telephone at the Kahuku observatory we can keep the public informed. An emergency trail need only cost about $25,000. We are going before the Territorial Legislature asking for this trail.

Mauna Loa is mysterious like the Antarctic continent. Every trail, however rough, into Mauna Loa, helps to lift the curtain and explain a mystery T.A.J.