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 1927

(Nos. 106 to 158

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(Nos. 106 to 158)

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No. 106 RELEASED WITHOUT COPYRIGHT RESTRICTION January 6, 1927

KILAUEA REPORT No. 782
WEEK ENDING JANUARY 5, 1927
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

At Halemaumau on December 29, at 3 p. m., there were dribbling falls of rock at the northwest wall and the southwest rift caverns. New red sand on the talus slopes showed that this had been going on for some time. The rock falls continued throughout the week, and January 5 showed a new notch at the northeast rim and new debris below. The bright-yellow sulphur at the south talus was not washed away by the heavy rains of the new year. It is noticeable that the blue sulphurous fume does not show at this place as it did formerly.

Sixteen local earthquakes were registered during the week, all very feeble Owing to northeast wind, microseisms were large after January 2. West tilt increased slightly the first part of the week, but January 3 and 4 nearly four seconds of east tilt suddenly set in, making the net tilt moderately eastward for the week.

THE INTENSITY OF GRAVITY

Lieutenants Brown and Bainbridge of the U S. Coast and Geodetic Survey have just completed "swinging a pendulum" at Kilauea and Mauna Loa. This is to determine the differences of the force of gravity at those places. Older determinations were made near Mauna Kea, and another station is to be made at Hilo.

Gravity is the resultant of the earth's attraction and the centrifugal force of its rotation. These forces change with height and distance from the equator. The same object, at sea-level, weighs one two-hundredth less at the equator than at the poles, and one two-thousandth less for each mile of elevation. If a spring balance could be made reliably sensitive to measure the tiny changes, these differences of weight of the same mass, and so the gravity variations, might be directly measured. At present, however, more delicate methods are needed.

The time of a complete swing of a pendulum (period) is dependent on its length and the force of gravity. If we measure the period and length, the force of gravity for the place of swinging becomes known. To determine the absolute force of gravity in dynes (force necessary to move a gram weight one second with the velocity of one centimeter per second) at a standard location, a double-ended pendulum is used. Adjustments that produce the same period of swing when hung from either end give precise measure of length. Counting the beats gives the other requirement, period.

Determinations of absolute gravity are made carefully at a few base stations. The force is 980.112 dynes at Washington, D. C. Field observations are made by a comparative method. The length of the field pendulum is determined by swinging and timing it at a base station of known gravity. The field pendulum is thenceforth regarded as retaining the same length, with due regard to temperature variation. A dummy pendulum exactly like the one swung, with a thermometer bulb inside its bob, is kept inside the apparatus and the thermometer is always read and temperature is recorded. From time to time the field pendulums are recalibrated at the base station.

The comparative method thus necessitates the use of only a single suspension instead of a double-ended pendulum, and the other end is a lens-shaped bob as big as a large watch. The pendulum is about a quarter meter (nine and seven-eighths inches) long with a period of a half-second. Two or more pendulums are used alternately and the results averaged. They are made of invar metal, a nickel-steel alloy that hardly expands at all with heat. An agate plane in a stirrup at the upper end of the pendulum bears upon an agate knife-edge support. An air-tight metal box holds the pendulum, which swings in a partial vacuum, having a pressure of 60 mm. of mercury, registered by means of a manometer. The box has glass windows and levers for starting the swing, and is exhausted by a hand pump. The pendulum is started through an arc of only two or three degrees, yet it will keep swinging twelve hours. Even the rigid support sways a little: an interferometer measures this swaying, and a proper correction for the period of the pendulum is computed. The pendulums are most carefully handled, as corrosion, dirt, or deformation would so alter the distribution of mass as to change their mathematical lengths.

With corrections made for amplitude of swing, vacuum pressure, temperature, and flexure of supports, the major measurements consist of swinging the pendulums through six twelve-hour intervals. Accurate time for the beginning and ending of these intervals is necessary,and may be secured by telegraph or radio, or from star observations.

An electric light flashes through a slit. A chronometer controls the flash of light every two seconds. Only when the pendulum passes the vertical a small attached mirror reflects back the light to the observer's eye. By direct observation and noting standard time, a comparison of coincident flashes is made between pendulum and chronometer. The beats of the chronometer and the wireless time-signals are recorded on a chronograph. Thus the swings of the pendulum for a few minutes, at the beginning and ending of the twelve-hour interval, are compared with standard time to within a few hundredths of a second, and this gives the number of swings. In the meantime the pendulum beats out its twelve hours unobserved.

This interval, divided by the number of swings, gives the period of the pendulum. A mathematical formula gives the force. The allowable probable error is .004 dyne. The period determination must be within one millionth second. Radio time signals are amplified and recorded on the chronograph. In Hawaii they are received from Washington, D. C., by short-wave wireless. All of this physical apparatus was set up on the top of Mauna Loa, for a week in winter, in a cavern covered by a tent.

The gravity determinations measure the earth's radius, and so determine its shape. They are used in studying isostasy, and in measuring local densities of the earth's crust. The latter use will show, here on Hawaii, what are the interior densities of our volcanoes, Kilauea, Mauna Loa and Mauna Kea. R.M.W.

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No. 107 RELEASED WITHOUT COPYRIGHT RESTRICTION January 13, 1927

KILAUEA REPORT No. 783

WEEK ENDING JANUARY 12, 1927

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

There is nothing new to report concerning the conditions of Kilauea and Mauna Loa volcanoes. Both are dormant, Kilauea with a vast pit 3,000 feet across, inactive since August 1, 1924; Mauna Loa with a summit crater and hot rift athwart it, inactive since May 1, 1926.

For the week at Kilauea 14 very feeble tremblings were registered seismographically. Tilt has been moderate westward, about four seconds. Microseisms, after high easterly winds, were still strong January 6, but have diminished to normal.

REPORT No. 3
LASSEN VOLCANO OBSERVATORY

Mineral, California, December 29, 1926
R. H. Finch, Associate Volcanologist

About the middle of December there were press reports stating that Lassen Peak was in an eruptive stage. The reports were quite certainly based on peculiar cloud formations. On December 18 and 19 a trip was made to the National Park boundary and good views of the peak were obtained. There were no signs of unusual activity. The only clouds seen were of the cirrus type high above the level of the peak. Updrafts produced snow clouds that shot up to a height of 300 to 400 feet above Lassen Peak and adjacent peaks. Such clouds when viewed at some distance, especially by transmitted light, might easily be mistaken for small eruption clouds. The updrafts were observed to start as much as a mile below the summits. The seismographs showed nothing unusual at this time.

On December 28 the seismographs of Lassen Volcano Observatory registered their first "swarm" of earthquakes, 22 quakes being recorded on that day. The strongest shake occurred at 6:12 p. m. It was preceded by a rumble and dismantled the E-W component of the seismograph. The only other one that was perceptible occurred about an hour earlier. The majority of the earthquakes preceded the strongest one. The indicated direction was northeast at Mineral, which is southwest of Lassen Peak.

MAUNA LOA TRAIL

On January 3, 1927, Mr. Allen Burdick, Engineer of the Department of Public Works, Territory of Hawaii, accompanied by Dr. T. A. Jaggar, examined the region above the Koa Camp in Alika with a view to a trail survey. It was found that there are two possible routes from the Koa Camp to the source of the Alika flow, the one leading through the forest and old pahoehoe, between the Alika and the 1919 flows. The other route leads directly over the Alika flow, straight towards its source. The objective for the proposed seven-foot trail is the camp ground at the Umi altar, a few hundred feet north of the largest Alika source cone. There is a third possible route following the contour of the mountain about the 5,100-foot level along the trail that passes the Kaapuna Ranch house. This would lead to the north side of all the branches of the Alika flow, whence a way could be followed due east up the pahoehoe, to the top region.

It is believed that the proposed trail would serve five purposes: (1) It would assist the Board of Agriculture and Forestry in reaching the South Kona Forest Reservations with automobile trucks; (2) it would assist the County of Hawaii in time of danger from lava flow in protection and for warning given to the forest rangers and the cattle ranchers; (3) it would enable the Geological Survey to keep a seismograph station on Mauna Loa, equipped with telephones, near the sources of all the lava flows of the twentieth century; (4) it would assist the ranchers of the western slope of Mauna Loa; and (5) it would make more accessible to travelers the mountaineering and camping on Mauna Loa at all times and especially in times of splendid eruption.

Mr. Burdick is at work on an estimate for this emergency trail, and it is hoped that an act providing for its construction will be introduced for consideration of the Hawaiian Territorial Legislature through the Commissioner of Public Lands. T.A.J.

GEODETIC MEASUREMENTS ON HAWAII

To the Island of Hawaii for precise measurement by levelling came Lieutenant L. G. Simmons of the U. S. Coast and Geodetic Survey October 4, 1926. His work started from Hilo on the Hilo-Kilauea road October 4 to 14. From October 15 to November 17, with the assistance of packers and animals from Keauhou Ranch, he ran levels from Volcano House to the highest summit of Mauna Loa by way of the National Park trail and Puu Ulaula. Bench marks were placed about two miles apart. About December 18 the upper part of the Hilo-Kilauea road was levelled, completing the entire stretch from Hilo to the Mauna Loa summit. Preliminary computation indicates that the old Hawaiian survey of W. D. Alexander, which determined the height of Mauna Loa by vertical angles, differs by only about two feet from the result of precise levelling.

Lieutenants Brown and Bainbridge arrived December 15, and swung gravity pendulums at the Hawaiian Volcano Observatory, Kilauea Crater rim, December 17 to 23. By preliminary computation, not reduced to sea-level, the value of gravity at Kilauea is 978.667 dynes. These observers camped at the north lip of Mokuaweoweo, the crater of Mauna Loa, December 28 to January 7, and obtained preliminary value of gravity, not reduced to sea-level, for the Mauna Loa summit region 979.091 dynes. January 10 they began gravity observations at Hilo.

They will install at Hilo a standard recording tide gauge, to be used under the supervision of R. M. Wilson, geodetic engineer at Hawaiian Volcano Observatory, in determining a datum for the new precise levels. The gauge will also detect tidal waves. It will be operated under the U. S. Coast and Geodetic Survey by Brother J. B. Albert, Hilo seismograph observer. All this new geodetic work has been made possible by cooperation between the Coast Survey and the Geological Survey.

R.M.W.

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No. 108 RELEASED WITHOUT COPYRIGHT RESTRICTION January 20, 1927

KILAUEA REPORT No. 784

WEEK ENDING JANUARY 19, 1927

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

There are three things happening in Halemaumau pit of Kilauea Volcano that show increase during the past week. There is a movement registering earthquakes on the seismographs: there is marked increase of avalanches in the pit; and there are yellow sulphrous patches on the debris slopes which are increasing in area. The combination means disturbance both chemical and physical, and lava eruption may follow, but the effects are not yet unusual enough to justify a forecast.

On January 13 dust from a small slide rose at 1:40 p. m. There were many small slides the next day. On the 15th dust hung over the pit after 11 a. m., and at 11:43 a. m. avalanche roar was audible at the Observatory. Small avalanches continued, dwindling in afternoon. The pit was left with northern walls scarred, and at 4 p. m. northern, western and southern walls were uneasily scaling off. Fresh debris lay on the talus slopes. The seismographs did not respond to avalanching this forenoon, but local quakes were registered the previous day, this afternoon and the day following. About 3 p. m. January 16 came a small earthquake, a big avalanche roar and a cloud of gray dust. Again the pit walls were steadily working, and a mass of red debris had fallen on the north slope. Spicy sulphur was smelled at the south rim, and the yellow solfatara below had increased in area. The slipping of rocks in the pit from the walls continued on the 18th, particularly near the Kau Desert rift tunnel.

During the week the seismographs recorded 29 local earthquakes, all very feeble. On the 13th, 14th and 15th the seismographs showed the greatest activity as on these three days most of the earthquakes for the week occurred. These three days as noted above were also the most active days for slides in the pit. One of the earthquakes, larger than the others but still not large enough to be perceptible, occurred at 5:07 p. m. on the 14th and lasted over two minutes. No avalanche was observed coincident with this quake, although it was somewhat larger than the shock above noted at 3 p. m. on January 16. There was, however, red avalanche debris produced at about this time.

Tilt accumulated during the week has been very slight to the east.

THREE PRESS REPORTS

Confirmation, denial, or explanation of the following, from those who have been there, is invited by the **Volcano Letter:**

(1) At Ballybunicn, on the west coast of Ireland, the Atlantic rollers, making great fissures by breaking down the cliffs, finally reached masses of iron pyrite and alum. Rapid oxidation took place by contact of water with these, which produced a heat fierce enough to set the whole cliff on fire. For weeks the rocks burned like a volcano, and great clouds of smoke and vapor rose high in the air.

(2) A dispatch from Dutch Harbor of December 31, 1926, states that Mount Makushin, on Unalaska in the Aleutian Islands, erupted the evening of December 30 with "fountains of fire and masses of vapor," making a spectacular display. A slight earthquake accompanied the eruption and there was fear for the safety of Makushin village.

(3) The boiling springs of Iceland are piped underground and used, not only to heat the houses, but to warm and water greenhouses and gardens. The warm water hastens the growth of flowers, vegetables, and fruits. "Near the largest geyser at Reykjavic a large greenhouse has been built." Iceland can compete with the Channel Islands in growing early potatoes, vegetables, and flowers.

We did not know the Icelandic geysers were at Reykjavic, no added facts have been seen about the Makushin eruption, and we would like to know the date and details of the Ireland story. T.A.J.

FIGHTING IN LASSEN AA

A remarkable story of the Modoc Indians is told in a popular book on Lassen National Park (The Kingship of Mount Lassen, by Mrs. F. H. Colburn; Nemo Publishing Company, 628 Mills Building, San Francisco). These Indians lived in a lava country. Captain Jack, a young Modoc chief, secreted in a lava cavern which still has a bad name, made headquarters in an inaccessible ridge of aa, flanked by deep ravines, fissures and masses of bowlders. Here with one hundred and fifty followers he conducted depredations against the whites.

Lieutenant Colonel Wheaton fought 52 Indian braves with 400 U. S. troopers January 17, 1873. He reported to the War Department that "the bowlders ranged in size from a matchbox to a church. Captain Jack's stronghold was in the center of miles of rocks, fissures, caves, crevices, gorges and ravines—some fully 100 feet deep. In my twenty-three years of service, mostly fighting Indians. I have near before encountered an enemy, civilized or savage, occupying a position of such natural strength as the Modoc stronghold. Nor have I ever seen troops engage a better armed or more skillful foe."

The fight lasted from 8 a. m. to 10:30 p. m. when the troops retreated to their camp 15 miles away. They had fought all day without seeing an Indian! Little puffs of smoke through a hole in the lava was all they had to guide their attack. Added to the difficulties was a fog so dense that the parties could not communicate. It was bitter cold. Because of the incredibly rough lava surfaces the soldiers were obliged to advance crawling on their hands and knees. It was utterly impossible to recover the dead, and they had great difficulty in removing the wounded. The attack was a complete failure.

This Lassen book contains very beautiful photographic illustrations of the volcano's eruptions and boiling springs, a life of Peter Lassen, descriptions of the country and its pioneers, and a map of the Park. Its pretensions are rather literary and poetic than geological. T.A.J.

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No. 109 RELEASED WITHOUT COPYRIGHT RESTRICTION January 27, 1927

KILAUEA REPORT No. 785

WEEK ENDING JANUARY 26, 1927

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

The avalanching activity at Halemaumau pit reported last week did not continue. At 6 p. m. January 20 there were a few falls of stones northeast and west, some dust had been seen over the pit during the day, fresh debris lay on the northern taluses, and at 6 p. m. rocks were heard falling in the pit.

The afternoon of January 22 a few isolated rocks fell from the walls, and during a circuit of the pit it was noticed that the eastern sulphur stain is about 100 feet above the floor, and the southern larger one is at least 200 feet up the talus. No fresh cracking of the soil near the pit edge was anywhere observed. On January 26 very heavy rains had not washed away the bright yellow crystals of the south talus, though the other sulphurous spots were paler than before.

During the week 25 earthquakes were registered, mostly very feeble. On January 24 at 6:49 a. m. a shock was strongly felt in Kona, and registered at the Kilauea Observatory feebly, indicating a distance of 44 miles by its preliminary tremor, which is almost the distance to Kealakekua, Kona. At 6:54 a. m. January 25 a slight earthquake was felt at Volcano House, with maximum acceleration E-W.

A distant earthquake was registered January 23, beginning 2:45 p. m., and showing phases that indicated distance to origin 3,585 miles. Greenwich time at origin (0) should have been 1 h., 05 m., 46 s., January 24. Tilt was slight to the SE.

PROGRESS OF SANTORIN ERUPTION

Professor C. A. Ktenas of Athens describes the growth of the new lava dome surmounted by an ejection cone in the Grecian Archipelago. (Bulletin Volcanologique, Nos. 7 and 8, 1926, pp. 3-64, Naples. See also Volcano Letter Nos. 43 and 58.) His account extends to January, 1926, and the eruption had begun August 11, 1925, with the piling up of dacitic andesite lava in a sea-water channel among ancient lava cones. Santorin Volcano is in a crater lagoon enclosed by the crescent islands of Thera. August 23 a dome 73 meters high had formed, and afterwards kept about this height. Temperatures from 700° to 900° C. were measured in luminous cracks. Explosions through the dome went hand in hand with lava-flow extensions. The explosive products were of contemporaneous lava, and the gas rushes made cauliflower clouds charged with sand, pebbles and bombs.

The lava flows spread through and filled up two water channels, progressing 700 and 1,000 meters by January, 1926. The lavas expanded under a glassy carapace, and showed increase of inclination toward their fronts. The water was 10 to 50 meters deep, and the lava flows thickened to 25 to 30 meters above it. The water was heated to 65 degrees C. The lava front domed up.

The lava is glassy with plagioclase, angite and hypersthene crystals, and subordiante titano-magnetite and olivine. The composition is excessively siliceous, without quartz; silica 65%, alumina 16, iron 5, alkalies 7, and lime exceeds magnesia.

Yellowish and bluish flames were abundant on the dome, and spectroscopically showed hydrogen, sodium, chlorine and no helium. The salts showed lime, magnesium, chlorine, sulphuric acid and ammonia dominant. The fumarole gases showed dominant sulphurous acid, hydrogen, and carbon dioxide, at temperatures from 65° to 380° C. Water vapor was abundant, as shown by many explosive jets of white steam, but the gases from the lava proper showed signs of dryness. Litmus paper gave no acid reaction until it was wetted. The ashes that fell showed no acid effects until they were wetted by rain. Some of the fumaroles were anyhdrous, and some were humid. Flames during principal eruptions were several meters high. Sea salt was not deposited by the fumaroles. Sulphuretted hydrogen was notably inconspicuous, but was detected in the sea-water reactions.

The lavas were not properly aa, but formed stiff carapaces that cracked and dragged showing transverse crevasses like glacial seracs. The whole islet of the active volcano in the middle of the Thera lagoon is increased and unified on its eastern side. The lava dome developed cinder cone slopes about the central vent as the eruptions went on, the whole being called a "conodome." The explosive phenomena have increased during the development of Santorin since 1707.

The explosive activity of the period, very strong at first, reached a maximum the first half of September, and declined thereafter. There were paroxysmal explosions occasionally, and spells of waxing and waning moderate effervescence. A very interesting observation, by measurement with a micrometer scale in a field glass, records that the central portion of the dome, during a series of expulsions of gas, would rise visibly three or four meters continuously and rapidly; after the explosion this area, 50 meters across, would sink back. This oscillation repeated itself six to ten times an hour. The net result was continual change in the form of the dome. T.A.J.

CHLORINE AND VOLCANISM

Attention is called by Dr. Sidney Powers, of Tulsa, Oklahoma, to the fact that Malladra, Volcanologist of Vesuvius, and Ponte of Etna, both consider increase of chlorine in the solfataric cracks at the craters a sign of coming eruption.

The collections of gas from live Hawaiian lavas have never shown such excess of chlorine as the Italian volcanoes. Shepherd says (Bull, Hawn. Volc. Obsy. May, 1921, p. 88) "Chlorine occurs, but in relatively small amount." His analyses generally show only a few hundredths of a percent, and chlorides are rare among Kilauea salts. Muriatic acid, very conspicuous in odor and effects where the Hawaiian lava flows enter salt seawater, is comparatively unknown at the source vents. T.A.J.

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No. 110 RELEASED WITHOUT COPYRIGHT RESTRICTION February 3, 1927

KILAUEA REPORT No. 786

WEEK ENDING FEBRUARY 2, 1927

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

An inspection of Halemaumau pit of Kilauea Volcano between 3 and 4 p. m. January 28, revealed nothing new in the condition of the bottom. There was a marked jet of steam arising from a bowlder in the midst of a dry, hot patch that extends up and down the moist middle region of the southwest talus. No slides of any size occurred at this time.

On February 1, avalanching from the northern walls of the pit was noticed, somewhat like that of a fortnight before. In the middle of the afternoon, dust from slides arose from the pit, and at 5:45 p. m. singularly white dust rose in a thin cloud from the whole pit gradually, beginning at the northeast corner. This left the air over the orifice of the pit suffused with dust for 30 minutes or more. The next day, February 2, dust rose from the north corner of Halemaumau about 7:30 a. m.

Fifteen very feeble local earthquakes, and one teleseism, have been registered during the week. Two of these indicated distances to origin of 22 and 37 miles. The preliminary wave of the distant earthquake arrived at 7 h., 36 m., 10 s., a. m., February 1. There was practically no accumulated tilt.

LASSEN REPORT No. 4

Mineral, California, January 14, 1927
R. H. Finch, Associate Volcanologist

L. W. Collins, Superintendent of Lassen National Park, and R. H. Finch, made a round trip to the summit of Lassen Peak during the three days January 11, 12, and 13. The first day was taken up in reaching camp by Supan's Hot Spring region and on the 12th the trip from camp to summit and back was made. The depth of the snow averaged between five and six feet. The places where horses are usually tied in summer ascents, about 1,400 feet below the summit, was reached at 11 a. m. Here snowshoes were left behind both because of the steepness of the slope and of the fact that it was covered with ice. About one and one-half hours were taken up in the ascent, while the descent was made in 20 minutes. Some idea of the windy conditions at the summit was obtained far down the slope by observations of swirling clouds of snow that were almost continuously blowing out from the peak. On the southeast slope, where the ascent was made, the air was still and the sunshine almost too warm. Gloves which had become wet from the explorers' going on all fours during the ascent, were almost instantly frozen in the arctic blast that greeted them as they peered over the summit. The frozen gloves were thawed out, but not dried, while lunch was eaten over a steam crack in the crater. Shortly after the start to climb out of the creater, gloves were again frozen, and at the foot of the icy slope it was found that fingers were frosted and a frosted toe was brought home as souvenir. Camp was reached shortly after nightfall.

Before starting home on the morning of January 13, the temperature of the upper Supan's Spring was taken. At a vent where the steam was escaping with a loud hiss the temperature was found to be 194° F., or about 9° F. hotter than the highest temperature reported from this spring by Doctors Day and Allen in 1923.

A perceptible earthquake that was accompanied by a loud rumble was recorded on the Observatory seismographs at 6:20 p. m. January 13.

SEASHORE OBSERVATORIES

England, the United States, and Canada are begining a definite scientific measurement of the shoreline as a sensitive marker of geophysical changes. There was a tremendous Galveston flood in 1900 from the piling-up of hurricane waters by a 100-mile gale, producing a rise of 15 feet. Galveston is now protected by a massive seawall 17 feet high. To June 30, 1925, the American Government had spent $15,000,000 in an effort to deepen and maintain the waterways leading from the ocean to eight principal cities in the region extending from Beaufort, N. C., to Jacksonville, Fla. During the 20 years 1900 to 1919, hurricanes on the coast of the Gulf of Mexico have destroyed 7,225 lives and property amounting to $105,000,000. Now comes the tragedy of Miami, Fla., more appalling than that of Galveston, and "one of the most striking examples of the helplessness of man against the unbridled elements" (R. S. Patton, "The Toll of the Waves," World To-Day, London, December 1926). Enormous sums have been spent on the levees of the lower Mississippi, which in time of flood at New Orleans hold the water so precariously that the flood patrol piles sand bags at weak places, and the water rises to within two inches of the top of the sand bags. Mr. Guy Gest, of New York, points out that an earthquake at such a moment of the kind that devasted the Mississippi valley in 1812, would wreck the whole levee system.

Mr. Patton, a British coastal survey expert, states that there are virtually no quantitative data regarding the forces which attack our beaches from the engineering standpoint. People flock annually in increasing numbers to beach resorts in search of rest and refreshment, and the beaches have become important national assets to meet the efflux of population from the over-congested cities. This is an incident to the more comfortable standards of living attained within the past few years. The coast of England between Bridlington and Spurn, a distance of 36 miles, has receded 2¼ yards annually, amounting to 3 acres lost per year. At this rate the coast, here about 40 feet high, has lost a mile since the Norman Conquest. Mr. Patton states that it is possible for engineering science to minimize or prevent this detrimental course of events, but the way to attack it is not yet clear. He cites the State of New Jersey, which has assumed jurisdiction over the entire problem and is providing for a study of basic principles of shore erosion.

The Coast Survey has just installed a tide gauge at Hilo, and nowhere is there more interest than in Hawaii in the relation of shore erosion to the rising and falling of the land. T.A.J.

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No. 111 RELEASED WITHOUT COPYRIGHT RESTRICTION February 10, 1927

KILAUEA REPORT No. 787

WEEK ENDING FEBURAY 9, 1927

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

On February 3 small avalanches were indicated by dust rising from Halemaumau. This continued the next day, ond on the fifth, at 4 p. m., a considerable slide from the N.E. wall of the pit was seen to start under the stimulus of stones dropped by visitors. The talus below showed much fresh material. The sulphur patch at the south is spreading among the fragments. The wall and slides above this are blackened. At 5:20 p. m. a noisy natural slide fell at the N.E. wall. The steam cracks S.W. and W. of the pit are purring as though water were below, and this is true also of Sulphur Bank flat.

Only eight local earthquakes were registered for the week, none perceptible. A feeble one at 11:26 p. m. February 2 showed origin distance 45 miles. An unusual quiet interval of 60 hours, without even a tremor, occurred after 5:52 p. m. February 6, and is now in progress. Tilt for the week was slight south-southwest.

COMPRESSIONAL HEAT IN VOLCANIC BLASTS

Referring to **Volcano Letter** No. 63, March 11, 1926, I do not think there is "a tremendous compressional wave travelling at an immense speed." There is movement of air ahead of ejecta, rather than great compression. The main compression is probably at the start of the explosion, in the crater. By the time the ejecta reach the rim, the air is moving freely in front of the ejecta. The crater acts like the gun barrel. Such, at least, was my impression watching numerous explosions of Vesuvius. This I took to be proven by the height to which the material rose compared to the initial velocity. Had there been heavy compression, the air cushion formed would soon have terminated their ascent.

I happened to see a factory of high explosives blow up, one day, near Ottawa. I was looking at it at the time, from a distance of about 200 yards, across an open field. It was a thick-walled stone building. The whole building rose bodily, comparatively slowly, then the walls bulged out, and then the roof began to rise, and the whole thing flew into fragments travelling with great velocity. Judging by what I had seen at Vesuvius, I thought their velocity would take the rocks to a height of 1,500 feet, but I judged that not a single one reached 500 feet, though some travelled a long distance laterally. I expected heavy air blast, either from or toward the explosion. I felt none, though plate glass windows in Ottawa, three miles or more away, were broken **outwards**.

At the start of the explosion, there was evidently some compression, which held the light roof on to the walls—and burst the solid masonry walls before the roof went. The comparatively slow speed at first was due only partly to the time taken for complete oxidation of the explosive, but mainly I think to the retardation by the air before it began to move ahead of the material of the factory.

Similarly a large, hot-air balloon when released jumps up about 20 feet, hesitates an instant, and then shoots up like an arrow. The air compressed in front of it stops it, and then travels ahead of it.

In the Frank Landslide (Great Landslide at Frank, Alberta, by R. G. McConnell and R. W. Brock; Pt. VIII, Annual Repoort 1903, Department of the Interior, Dominion of Canada), the main peak of Turtle Mountain for a width of half a mile broke away, and fell into the valley 3,000 feet below to the N.E. Here then was heavy air compression. But it was not felt by anyone in the town on the north edge of the slide, nor could I find any trace of an air blast there. It was, however, felt by miners in the gangway of the local mine. The mouth of the tunnel was aboout 200 yards within the buried area south of the north edge of the slide. South of the edge of the slide, for half a mile down the valley, there were evidences of the air blast. The trees near the edge of the slide were overturned, and farther away were stripped of branches, and still farther, of twigs. There was great air compression, but not enough heat generated to have any observable effect upon the most delicate plants. There were no men for several miles down the valley to the S.E. I did not find any birds or field animals killed or injured by the blast. So it cannot have been very hot.

The above supports the view of T. A. J. that the destruction of volcanic blasts is due to volcanic material and volcanic heat, and not to pressure as suggested by Cole and Brooks. R. W. Brock.

MORE ABOUT SHORELINE OBSERVATORIES

The Hawaiian interest in the shore is deeply involved with the study of volcanoes. Our land is going up and down remarkably, as proved by tilt pendulums and levels. The rising goes with rising lava and the sinking with falling lava. The thing called "mean sealevel" is the only datum to refer to. If the island of Hawaii rises differently from the island of Maui, nothing will prove it unless both islands maintain tide gauges all the time, and unless "mean sealevel" is the same for both islands.

Professor Douglas Johnson (Columbia Univeristy, New York City), Chairman for Shoreline Investigations of the U. S. National Research Council (Science, January 7, 1927), has published remarkable pictures of the stages of receding shoreline at Cape Breton ("The New England-Acandian Shoreline"), and notes that the Canadian Hydrographic Office is undertaking in New Brunswick a comparison of mean sea-level with a large embayment which receives great quantities of fresh water. The tidal range is over 20 feet, and the study involves tide gauge records and the running of lines of levels. Similar studies are being made at New York City and at Eastport, Maine. Graduate students from Columbia University have also been studying the evolution of special shorelines along the Atlantic Coast.

Dr. Johnson asks the support of everyone interested in beach property and in the burdens which coast erosion throws upon the taxpayer. His committee wishes information on changes in shoreline cutting, on engineering works, on artificial beaches, and on photographing shoreline changes. T.A.J.

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No. 112 RELEASED WITHOUT COPYRIGHT RESTRICTION February 17, 1927

KILAUEA REPORT No. 788

WEEK ENDING FEBRUARY 16, 1927

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

In Halemaumau pit on February 12 there was a new scar in the middle of the northeast wall where an avalanche has fallen. In midafternoon Febraury 14, strong, red, dust clouds rose from pit, and when Halemaumau was visited at 6 p. m., a prolonged, small avalanche was tumbling at the north corner of the pit, making a roar and sending up red dust. This slide took several fresh starts from about midway up the wali. The northern taluses were covered with fresh, red debris, and big slides had evidently fallen, for the dust extended across the bottom of the pit. On February 16, with strong south wind, nothing new was noted at the pit, but pinkish dust from the desert filled the air above Kilauea Crater.

One distant and 12 local earthquakes were registered during the week, the teleseism occurring about 3:30 p. m. February 15. Microseisms, which were strong the first part of the week, diminished in spite of the strengthening of the southwest wind. The wind squalls affected the seismogram February 16 beteewn 5:15 and 7:30 a. m., as a short-period, jerky, irreguiar vibration, the microseisms remaining normal. Tilt for the week was very slight WNW.

SUPPOSED NEW VOLCANO

Those who have studied Mexican volcanology recall the case of Jorullo Volcano, famous for having grown up under the eyes of men. A newspaper report (Minneapolis Tribune, December 26, 1926) states that in Chiapas, in southern Mexico, there is a new hill called Mount San Cristobalito. Subterranean rumblings are heard, and a "sulphurous waterfall" of curative powers has increased. German engineers are said to have pronounced the hill as a rapidly developing volcano, which began as an insignificant mound of earth about eight years ago. The statement is that "persons ascending the top of the mound are almost suffocated by the intense heat; and no one knows when the terrific subterranean pressure will blast its way through to the open air." T.A.J.

ERUPTION OF MERAPI

A wireless from the volcano service of Java states that Merapi Volcano, in middle Sumatra, has been in eruption, throwing out ash since February 5. T.A.J.

REVIEW OF HAWAIIAN EARTHQUAKES 1926

The total number of seismic disturbances registered on the seismographs during the year 1926 is 1,801. The number includes 23 teleseisms, of which eight were decipherable as to distance.

The remaining local earthquakes and tremors, individually counted, number 1,778. These may be classified by their strength, or by their kind. The greater number of them were very feeble, 90% being so classified. There were 4% of them feeble, 4% slight, and 2% moderate. The number reported as felt was 101, or 5.7% of the total.

The period of the Mauna Loa eruption, April 10 to 24, is responsible for about a third of the total, and the numbers are given day by day in Volcano Letter No. 71, as a review of the earthquakes during the eruption. The smaller disturbances are of different kinds: those caused by actual earthquakes, those accompanying avalanches in Halemaumau, and those caused by a waxing of harmonic tremor. The large count during the Mauna Loa eruption is in part due to the kind last mentioned. At times of lava flow there is a characteristic and continuous very short-period tremor registered on the seismographs. This type of tremor waxes and wanes, and many of its times of increased amplitude were counted as individual disturbances. It is interesting to note that the large number that came in April in excess of the usual average, were quite definitely confined within the period of flow from Mauna Loa, the beginning and ending of excess numbers being rather abrupt.

The number recorded for 1925 was 922 (see review of earthquakes in Volcano Letter No. 54), so that if the April excess, caused by the Mauna Loa flow, were subtracted from the 1926 total, the two years would be nearly the same.

Following is a table showing the number of local disturbances for each month:

January	54
February	32
March	68
April	761
May	43
June	56
July	101
August	254
September	240
October	62
November	46
December	61

R.M.W.

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No. 113 RELEASED WITHOUT COPYRIGHT RESTRICTION February 24, 1927

KILAUEA REPORT No. 789

WEEK ENDING FEBRUARY 23, 1927

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

There has been no significant change in the lava pit of Kilauea during the past week. There have been the usual small slides from the walls, and the sulphur spots near the bottom of the pit on the debris slopes continue to grow, indicating that lava gas is emerging.

Seismically, the week has been extraordinarily quiet, only eight local shocks being recorded on the seismographs at Kilauea. Six of these occurred on the 21st and the 22nd, and one of those on the last date indicated by the length of its preliminary tremor a distance of origin 12 miles from the Observatory. Tilting of the ground for the week was moderate to the SSW.

EARTHQUAKE AT MORRINSVILLE, NEW ZEALAND

Disastrous earthquakes in the north-central part of the North Island of New Zealand centered about the town of Morrinsville, beginning Friday, November 12, 1926. They occurred intermittently all that day, and by the evening everyone was living out of doors. The old residents described the earthquakes as the worst they have ever known. Fire was prevented, and only one person was injured.

There was first felt a small shock at 9:01 a. m. November 12. Another came five minutes later, and another at 10:16 a. m. The big shock arrived at 10:21 a. m., without noise, swaying buildings violently, followed by a resounding thud and by numerous convulsive tremors.

Chimneys fell on the iron roofs, crockery and glassware crashed to the floors, whole shelves of goods fell in the shops, and people made a rush for the streets. The damage was particularly severe in the drug shops and liquor stores, some plate-glass windows were smashed, cracks appeared in several concrete buildings, and the top part of a granite obelisk was displaced several inches. About half the chimneys broke at about the roof level and fell.

Morrinsville lies between Hamilton and Tauranga, about 30 miles northwest of the Rotorua volcanic district. At Piako, two miles east of Morrinsville, a tank was displaced from its stand. The earthquakes were remarkably local, for in the Waikato district around Hamilton, only 18 miles west of Morrinsville, they did not cause any alarm or do any damage.

For the remainder of November 12, earthquakes continued, and according to the New Zealand "Herald" of December 23, 1926, Mr. L. I. Grange, the New Zealand Volcanologist, determined that 41 shocks occurred during the next few days. The disastrous shock was of intensity No. 8 of the Rossi-Forel scale. He believed the shocks to be of shallow origin, caused by movement of a fault on the east side of the Pakaroa Range. The Te Aroha hot springs, 12 miles northeast of Morrinsville, were unaffected by the earthquakes. One of the smaller shocks at 6:45 p. m. was described as coming without warning as a heavy, double thud, which violently shook the house, caused the windows to rattle, knocked over one or two articles on shelves, and started the people moving toward the street. Cambridge, Hamilton, and Morrinsville felt occasional small shocks during the month following the Morrinsville earthquake.

Mount Ngauruhoe, in the southern part of the New Zealand volcanic belt, was sending up steam and black smoke December 21, and on the evening of December 29 detonations were heard from the crater, followed the next morning at 4:15 by an immense volume of smoke which shot thousands of feet into the air. (New Zealand "Herald," Auckland, November 13 and December 22 and 31.)

T.A.J.

EARTHQUAKE STATISTICS

According to Professor Tondorf, of the Seismological Laboratory of Georgetown University, the frequency of earthquakes in the world was computed in 1900 by Montessus de Ballore. Aftter a close analysis of earthquake records then available, 131,292 in number, he placed the annual average earthquake occurrence at 3,830, equivalent to an earth shock every two hours and 37 minutes.

In 1904, Dr. August Sieberg, of the University of Jena, questioned the estimate as too low. A recalculation made by him in 1923 lifted the annual average frequency to 9,000, or about one every hour. Five thousand of these he indicated as being felt by human beings somewhere on earth. Violent or world-shaking earthquakes occur about every three and one-half days, either on the continents or on the ocean's bottom. Violent ones on land average one every five days.

California is visited by a shock on an average of 81 times annually. The liability of one of these shocks being heavy is about eight-tenths of one per cent. (Associated Press report January 1, 1927.)

Statistics of this kind are useful in order to stimulate thought, but the difference between the totals arrived at by Ballore in 1900 and Sieberg in 1923 is rather due to increased knowledge of the earth through human experience in the 23 years, than to any greater accuracy in the methods of Dr. Sieberg. This means that 9,000 earthquakes per annum is no nearer to the facts than 3,830 earthquakes. Neither figure means anything until we define the word "earthquake." In the Hawaiian Observatory alone we registered 5,877 local Hawaiian earthquakes in 1924, of which 3,961 were recorded during the explosive eruption in May. This is the record of only one of the 430 active volcanoes of the world. What about the bottom of the oceans, with reference to local shocks, not recorded as "world-shaking?" The ocean bottoms cover seven tenths of the earth. Clearly, then, an analysis of such few earthquakes as are recorded, is not an analysis of the terrestrial earthquakes that really occur. T.A.J.

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No. 114 RELEASED WITHOUT COPYRIGHT RESTRICTION March 3, 1927

KILAUEA REPORT No. 790

WEEK ENDING MARCH 2, 1927

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

The changes at Halemaumau pit observed on March 1 were a fresh reddening of the whole northwest wall of the pit where a large shell of the wall had fallen. The debris slopes below were seen to be covered with reddish rocks and dust, and the dusting of the bottom of the pit extended clear across to the south taluses. Most of this had been accompanied by small slides from the decomposed rock of the northwest wall. But there had been at least one big avalanche, which had carried away the greater part of a pronounced bench at the west end of the big intrusive sill which forms the lower part of the northeastern wall. The dusting of the bottom of the pit was further evidence of a big avalanche, and the middle talus of the northeast wall showed more fresh debris. The yellowing of the southern solfataras continued to be conspicuous.

The intense oxidation of the northwestern wall beneath the former surface is remarkable, and it was here that there was excessive heat, along with blue sulphurous fume, in 1923 and earlier.

Fourteen very feeble local earthquakes were registered for the week. Ten of these came on the first two days of the weekly period, February 23 and 24. In the last issue of the Volcano Letter it was noted that a large part of last week's shocks came February 21 and 22. Thus 75% of the shocks for the fortnight occurred within a four-day spell of comparatively greater seismic activity. Three of the earthquakes of that time had indicated distances of about 13 miles, which corresponds to either the northeast rift of Mauna Loa or portions of the northeast rift of Kilauea that were active in 1923 and 1924.

Tilt during the week was moderate ENE. On February 21 the direction of tilt began to change from southwesterly to southeasterly, and by the 23rd it was nearly due east; thus a definite change in direction of tilt coincided with the time of frequent shocks.

The seismological station of the U. S. Coast and Geodetic Survey at the University of Hawaii, Honolulu, Mr. Harold McComb in charge, reports that seismometric measurements of six stations of the United States and Canada locate the distant earthquake of February 15 (noted in Volcano Letter No. 112) as 48° N. Lat. and 153° E. Long., the time at that locality being 1h., 35 m., 22 s., a. m. (G. M. T.) on February 16. The distance from Honolulu was 3,230 miles, and the epicenter is in the Kurile Islands.

EARTHQUAKE IN SCOTLAND

In view of what was said about Britain being stirred in 1926 by recognition of the earthquake peril (Volcano Letter September 23, 1926), the four columns in the Aberdeen "Evening Express" of January 24, 1927, are interesting. They announce that at 5:20 that morning the whole of the north of Scotland and much of southern Norway were shaken by an alarming earthquake, which reached intensity No. 6 (Rossi-Forel scale) in Aberdeen (Nature, February 5, 1927). The British seismographs indicate an origin outside of Scotland in the Norwegian direction. Never before has a North Sea earthquake been felt over so wide an area in Gerat Britain. The area disturbed extended all along the eastern coast of Scotland from the Orkneys to Berwick, and was probably felt in Northumberland. At the northeast end of the great Scottish rift near Moray Firth, an earlier shock the previous evening occurred at 11:05 o'clock.

The shock lasted from five to 30 seconds, and in Aberdeen people were awakened by a loud rumbling noise, doors and crockery rattled and bells were set ringing, and in some places furniture was moved. Ornaments fell from mantlepieces and shelves; doors were slammed; beds pitched up and down, and many persons were greatly alarmed; in some places plaster fell from ceilings.

The press reports from Norway state that the time was 6:20 a. m. by Norwegian Time, which is an hour earlier than Greenwich Time, and that in some towns masses of masonary crashed to the ground and other houses were cracked. People rushed panic-stricken from their homes, but there were no deaths. Three principal shocks were counted, felt from Notodden to Stavanger. The shocks were followed in Norway by terrifying rumblings which sounded like subterranean thunder. All of this indicates greater violence in Norway than in Scotland. T.A.J.

LOWER CALIFORNIA EARTHQUAKE

A violent earthquake at Calexico, on the California-Mexico boundary, occurred about 18 minutes after the midnight that ushered in the New Year (California Time.) Damage was reported at $2,000,000 throughout the entire Imperial Valley, martial law was declared on the Mexican side, and to prevent looting a special police patrol was organized on the California side of the border, with orders to shoot to kill. Many persons were cut and briused, subterranean rumblings were heard almost constantly, 50 or more shocks followed the disastrous one, and during New Years Day these diminished in intensity. At the first shock the mud houses of the Mexicans crumbled to dust, and the merry-makers of the cafes and casinos celebrating the New Year were terrified and poured into the streets. The shocks were felt from Anaheim, Calif., 150 miles north of Calexico, to Yuma, in Arizona. Damage by breakage of the water mains, followed by fire, was heavy in Mexicali. Yuma reported a succession of shocks, terminating at 6:10 a. m. The ocean at Ensenada, on the Pacific coast of Mexico, 50 miles south of the border, was thrown into extraordinary heavy swells, which prevented the launching of small boats. T.A.J.

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No. 115 RELEASED WITHOUT COPYRIGHT RESTRICTION March 10, 1927

KILAUEA REPORT No. 791

WEEK ENDING MARCH 9, 1927

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

The week has been very rainy, with northeast wind, and this moisture increased the volume of visible vapor in Halemaumau. Slides have continued. One considerable avalanche was seen about 11 a. m. March 6, and another one fell with a roar at 1:50 p. m. March 9. Both of these were at the northwest wall.

Five local earthquakes and one distant one were registered during the week. The local ones were very feeble. The preliminary wave of the teleseism, here faintly recorded, arrived about 11:09 p. m. March 6, and the disturbance continued weakly for three-quarters of an hour. Allowing for the difference in time, this was probably the disastrous earthquake in central Japan reported as "Monday night" (March 7).

Tilt for the week has accumulated slightly to the south.

LASSEN OBSERVATORY SEISMOGRAPH

Two horizontal pendulum seismographs recording on a single drum by the smoked-paper method were built along with the cellar to receive them, by R. H. Finch between his arrival at Mineral, September 15, and November. The dimensions of the cellar are 10 by 10 feet, and an office room was constructed above it. The general plan of the instruments follows the lines of the Omori seismographs as they have been modified by Hawaiian experience. The time-piece is an excellent Howard pendulum clock, with seconds pendulum and eight-day movement. The upright posts, 10 by 10 inches square, rise 27 inches above piers which are 18 inches high and two feet square. The heavy masses weigh 225 pounds, consisting of cast-iron containers holding nine lead weights, each bored to take a screw-eye for convenience in handling by one man. A mental rod passes horizontally through the middle of the heavy mass and protrudes 52 inches from the center of the latter, greatly reduced in size at the outer end. The larger portion next to the post is bent slightly, and fits a niche in the face of the post, where it is held by a cardan hinge consisting of a very short piece of fine steel wire, in slots. The upper support is a piano wire with the usual adjustments at the top of the post. The sytem is damped by sheet-aluminum vanes attached to the arm, moving edge-wise in a tank of oil, supported by a removable stand in front of the pier. This permits instant lowering of the oil tank for tests of free swing of the pendulum.

The magnification of the boom is 5, and of the writing lever, 40, making the total static magnification 200. The drum is built on a steel spindle threaded with ¼-inch worm, the ends being made of 3/16-inch three-ply wood, and the cylindrical surface of pasteboard. Light-weight glassine paper is used, each seismogram being 12½ by 38 inches in size. The writing pens are of magnetized steel, lifted to make a gap in the record every minute by an electromagnet, and the pivots of the tubular aluminum writing levers and of the pen-points are made of clock and watch balance staffs. The speed of the drum is 30 millimeters to the minute, and the transmission of motion from the pendulum arm to the writing levers is by means of light metal T-bars, with points resting in sockets in the arm and the lever, respectively. A marker pen attached to the plate supporting the drum and lever system, writes a line for a few minutes once a day on the side of the smoked paper, to be used as a datum line for measurement of wandering of the pendulums under tilting of the ground. The free period of the pendulums is seven seconds.

All of this material, with the exception of the time piece, was gathered together and erected by the Associate Volcanologist, and the driving clocks for the drum were obtained from the Seth Thomas Company, having two-barrel drive and a rotation rate of the spindle of about 15 minutes, which is slowed down with the appropriate gear. The uniformity of rotation given to the drum by these clocks with a speeded balance wheel, is remarkable, and no trace whatever of jerking movement due to the ticking escapement appears in the seismograms. Hitherto, although Mineral is on the actual slope of the Lassen volcanic mass, the seismometric registration has not shown tilt and has been free from tremors of the non-earthquake type. A few tremors have been recorded that have not been identified. R.H.F.

HAWAIIAN OBSERVATORY NOTES

Since the Section of Volcanology was established (Volcano Letter August 12, 1926) the work of the central station in Hawaii has been directed to adaptation of the plant and personnel for its enlarged scope, and to systematizing of its local Hawaii work in the three branches; namely, geodetic, temperature, and seismometric measurements.

The buildings have been repaired and improved, and a new machine-shop was started in operation March 1, 1927, with F. Y. Boyrie as instrument maker. The shop contains lathe, drill presses, power hack-saw, and circular-saw table, and hereafter saving of time and money will be accomplished by machine work done on the spot.

Ground was broken for the new exhibit and lecture building of the Hawaiian Volcano Research Association February 22, and the concrete floors of the new buildings have been laid. The site selected is the actual summit of Kilauea Mountain, on top of Uwekahuna Bluff, where the view of Kilauea Crater, the Kau Desert, Mauna Loa, and Mauna Kea is magnificent. The main building will be of iron and concrete, with stone corner posts and stone benches along the outside. In front a large terrace is being built, inclosed by rough stone wall and containing stone benches. The showroom will contain an alcove exhibiting through glass a modern set of seismographic instruments in operation, as well as other instruments, and on the floor will be glass cases containing the best of the cabinet specimens collected by the Observatory. There will also be wall cases and special exhibits, roller maps illustrating Pacific geograhy, photographic prints and transparencies, and projection apparatus.

The plan of operation so far as can be foreseen is that at a certain hour in daytime the tourist groups will be received and given a short talk on the open terrace concerning the geology of the crater. They will be shown the collections, and their questions will be answered with the aid of the maps and diagrams; then a projection lecture will close the proceedings. Later there will be a National Park naturalist with office hours to meet those who are interested in the walks and rides and natural features of this volcanic park. T.A.J.

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No. 116 RELEASED WITHOUT COPYRIGHT RESTRICTION March 17, 1927

KILAUEA REPORT No. 792

WEEK ENDING MARCH 16, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

Rainy weather has continued through much of the past week at Kilauea Volcano. Dust from slides has not been noticed at Halemaumau pit.

The total number of local earthquakes registered at the Observatory during the week was 14, all very feeble. There are also four records of blasts that were noted and timed. Tremors due to blast are of the same character as the usual spasdomic tremor; they wax to a maximum amplitude about the middle of the disturbance, and then diminish to zero, the whole lasting about 15 seconds. The source is on the Hilo road, about a mile away, where the contractor is using dynamite, approximately ESE from the Observatory, and 15 feet lower.

Probably several of the jarrings counted as earthquakes are also due to this cause, but it is not possible to tell which ones. One definite feeble earthquake had phases sufficiently distinct to indicate an origin 20 miles away. This shock was recorded at 8:50 p. m. March 12, and was also registered on the seimograph operated by Captain R. V. Woods, in Kealakekua, on the other side of Mauna Loa.

The Kona seismograph also made a feeble record of the Japanese earthquake of March 7, noted in last week's Volcano Letter.

Practically no tilt accumulated for the week, as the slight SW tilt of the beginning of the week was compensated in the opposite direction later.

THE ALEUTIAN ISLANDS

The region in Alaska which contains the largest number of volcanoes extends in a continuous curved belt from the Aleutian Range of mountains west of Cook Inlet, through the Alaska Peninsula and the Aleutian Islands, to Attu, the westernmost possession of the United States, where there are warm springs. Volcanoes that have an active record lie along a broad arc 1,500 miles long. There are at least 40 of them, ranging in height from mere islets to Redoubt Volcano, 10,200 feet high. Many of the volcanoes ore symetrically-shaped snow-covered cones, with glaciers on their flanks. All along the belt there are hot springs, and in some places sulphur springs (Mineral Springs of Alaska, by Waring, Water-Supply Paper 418, 1917, U. S. Geological Survey).

The Section of Volcanology is authorized to establish one or more volcano observatories on the Aleutian belt. The greatest recent eruption in Alaska was at Katmai Volacno, opposite Kodiak Island, in 1912. This gave vent to tremendous explosions ejecting bowlders, sand, and dust, and also a very siliceous, stiff, soda rhyolite lava, with about 77.5 per cent silica. This magma is chemically at the opposite extreme from the basic olivine basalt of Kilauea, with 48 per cent silica.

The writer criused from Unimak Pass to Atka in 1907, and learned from traders that lumps of pure native copper had been found on the shore of Copper Island, belonging to the Russians, west of Attu. On Attu is a small village of Aleuts. On Agattu there are high peaks, and all of the islands west of Buldir are believed to be pre-Tertiary rocks.

Following the chain east from here, the southern half of the island belt, comprising the larger land areas in the middle of the chain, consists of ancient igneous rocks, without active volcanoes. The northern half, on the other hand, with the dividing line sometimes in a single island and sometimes separating different islands, consists of shapely, recent, volcanic cones, many of them fuming and some the sites of eruptions during the last 50 years.

Buldir is an eroded volcanic cone, with sunken rocks to the south, where islands are said to have existed prior to eruptions that destroyed them more than a century ago. Kiska has a fuming volcano 4,050 feet high at its north end, it contains a good harbor, and its southern half is geologically different, and said to contain "mineral." Chugul and Little Sitkin are said to be fuming volcanoes, the former containing iron. Amchitka is nonvolcanic, and has good cattle feed. Semisopochnoi is covered with volcanoes, but does not smoke.

We now come to a group of large islands strongly volcanic on their north sides. Gareloi is always fuming. A smoking volcano occupies the north end of Tanaga. The north end of Kanga was very active in 1904. Great Sitkin was reported fuming in 1904, and Kasatochi is said to be the top of a volcano with a big crater lake; about 1899 the lake disappeared, and steam was rising. Copper is reported from near Salt Island on Atka, and sulphur amid the volcanoes in the north of Atka. The writer camped there in 1907, and found a boiling spring, and saw fresh volcanic cinder on snow fields.

Seguam broke into eruption for a week in December, 1891, and this was followed by a terrific eruption in the spring of 1892, making detonations heard at the native village on Atka, 75 miles away, and exhibiting two jets of cauliflower clouds. Mount Cleveland, 8,156 feet high, in the Islands of Four Mountains, was active in 1893.

This brings us to Bogoslof, Makushin, Akutan, Shishaldin, and Pavlof, well known volcanoes with an active record.

The Section of Volcanology of the American Geophysical Union (Bull. Nat. Research Council, November, 1926) conducted a symposium on scientific cooperation in the Aleutian Islands in Washington, April 29, 1926, wherein the need was urged for a permanent cooperative observatory in the large central islands, dealing with volcanology, climate, charting, the sea bottom, geology, seismology, magnetism, and atmospheric electricity. As a beginning, we shall establish a seismograph station at Kodiak in the summer of 1927, and make exploration of the eastern Aleutians. T.A.J.

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No. 117 RELEASED WITHOUT COPYRIGHT RESTRICTION March 24, 1927

KILAUEA REPORT No. 793

WEEK ENDING MARCH 23, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

The week of the equinox has been marked in the Hawaiian Islands by an exceptionally far-flung earthquake and by some slides in Halemaumau pit. The slides in question were not wholly due to the greater earthquake, as they had been observed the day before.

On March 19 there were numerous slides at Halemaumau in the afternoon which sent up dust. At 10 a. m. of March 20 the pit was visited with a view to discovering what were the effects of the strongly felt earthquake that had shaken all the eastern islands in the early morning. There were evidences that large slides had fallen at the northeast corner of the pit, and big boulders lay on the lava floor which has displaced a very large boulder known as a landmark there previously. There were also freshly fallen accumulations of debris on the northwest talus, characterized by white salts deposited upon their surfaces. At 4 p. m. March 22 some slides were in motion at the middle of the large northeast sill.

The local earthquakes for the week registered at the Observatory were 16 in number, all very feeble with one exception, the moderate shock that occurred just before 5 a. m. on March 20.

The beginning of this shock was recorded at the Hawaiian Volcano Observatory abruptly at 4:52:00 a. m. Hawaiian Standard Time. The instruments show no preliminary phase, the motion breaking abruptly into a strong movement of about 10 millimeters per second per second acceleration. This continued for about 10 seconds, and then became stronger, dismantling the instruments, so that the maximum acceleration and the subsequent details of the shock were not recorded. The shock was perhaps the strongest and most widely felt that has occurred for a year. Reports from other islands indicate that it was felt with about the same intensity throughout the group. Its beginning was recorded in Honolulu by the seismological station of the Coast and Geodetic Survey at the University of Hawaii, at 4:51:07, reaching its maximum there as 4:51:50. That station also reports a second shock at 5:59 a. m. The extent of damage in Hilo was limited to a few broken dishes and small articles thrown from shelves in various localities.

The fact of its abrupt beginning, without preliminary phases, at any of the places where it was recorded in the islands, makes localization of the epicenter a difficult problem. It is worthy of note that Washington, D. C., reports an earthquake 4,800 miles away for the same morning, but the time is not given.

On the Island of Hawaii, the shock was recorded at the Volcano Observatory, at Kealakekua, and at Hilo. An interesting coincidence is the fact that on March 19, 1926, at 10:33 p. m., almost exactly the same date a year ago, a heavy shock occurred with almost the same characteristics. This time of year is very close to the vernal equinox.

There were several severe electric storms during the night of March 22-23, apparently centering near Hilo.

Tilt for the week has accumulated slightly to the SE.

LASSEN REPORT No. 5

Mineral, California, March 2, 1927
R. H. Finch, Associate Volcanologist

Lassen Peak Volcano again showed signs of uneasiness on March 1, 1927, after having been relatively quiet since December 28, 1926. About seven o'clock in the morning of March 1, six earthquakes followed one another in rapid succession. Two of this number were plainly perceptible, the others were detected only by means of the seismograph. At 2:26 p. m. of the same day there came another and larger shock. It was preceded by a loud rumble, and was strong enough to cause buildings to creak. It is interesting to note that "swarms" of earthquakes have been occurring at intervals of about two months.

ADRIATIC EARTHQUAKE

A severe local earthquake was described in the British press of about February 16, 1927, as occurring along the shore of the Adriatic in Jugo-Slavia, and affecting the provinces of Dalmatia, Bosnia, and Herzegovina. Near Serajevo, famous for the murder of the archduke that precipitated the world war, there were big landslides. Chimneys fell, even in Belgrade. The center is said to have been under sea, huge waves were reported on the Dalmatian coast, and ships were said to encounter gigantic seas, even in the Mediterranean off southern Italy, but the correlation of these events with the earthquake may be erroneous.

The reports stated that 19 earthquakes occurred, the first on February 14 at 4:40 a. m. by the local time, and the others during the following 20 minutes. There was said to be subterranean rumbling, and also thunder and lightning out of a clear sky. There appears to have been engulfment in some places, attributed to the underground drainage in a limestone country known to be honeycombed by solution cavities, and much subsidence due to this cause is said to have gone on in the past. The last serious subsidence was at the time of the Laibach Earthquake of 1895. The worst damage of the present earthquake is said to be in Stolac, 35 miles south of Mostar, the capitol of Herzegovina, and cracks formed in the ground.

A later report from Belgrade (Daily Telegraph, London, February 21) states that three persons were killed, 15 injured, and the damage was about $175,000. This took the form of collapsed houses, a tobacco factory destroyed, a fallen railway bridge, damage to famous historical buildings ruined from flood waves, and the crashing down of sculpture and frescoes. T.A.J.

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No. 118 RELEASED WITHOUT COPYRIGHT RESTRICTION March 31, 1927

KILAUEA REPORT No. 794

WEEK ENDING MARCH 30, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

The week in the vicinity of the Volcano Observatory has been rainy, with light southerly winds. some thunder showers and increased snow is seen on Mauna Kea. At Halemaumau pit some small slides have occurred, chiefly from the north wall, where the rock is oxidized to a bright red color. The red debris has changed the appearance of the slope below.

After the heavy rains, the steam from vents in the lava floor and the talus has increased the visible volume of vapor clouds, and the three sulphurous patches at the south talus are growing in size. The two lateral ones have hitherto been very small, but they are now becoming large yellow patches like the big middle solfatara at that talus. It is extraordinary that the bluish fume mixed with steam that formerly was conspicuous at this middle vent, has there entirely disappeared, as though the sulphur were now deposited by a gas without the blue fume characteristic. Blue fume is seen, however, at the lower sulphur patch next the north edge of this talus. In addition to these places, white vapor rises abundantly at the center of the floor and from the southwest and northwest taluses.

There is much steam at the southwest rim cracks on the edge of the pit, and along the south wall inside the pit. An extraordinary change has happened at the southeast rim cracks of Halemaumau crossed by the tourist trail about 70 feet back of the rim. With wind in the southeast, these cracks were first observed to be free from steam March 26 and 27. They had been measured January 24, 1925, and had a temperature of 169° F., and were producing much visible vapor until recently. They have frequently been observed to yield so much steam as to be disagreeable where the trail crosses them. Now, however, the visitor may thrust his hand into the cracks, and almost no vapor is visible. Vegetation, such as lichens, mosses, grasses, and ferns, is taking hold in abundance about the openings of these cracks.

Twenty-two local earthquakes of very feeble intensity were registered at the Observatory during the week. There were two periods during the week of almost continuous tremor, apparently very much like the harmonic tremor that is the usual accompaniment to lava outbreaks. At 1:27 p. m. March 26 a very feeble tremor began, waxing gradually to a maximum at 1:37 p. m., waning, and waxing again to a second larger maximum at 1:41 p. m., and finally waning to the point where it no longer recorded itself on the seismogram at 1:48 p. m., making about 20 minutes of continuous tremor. The two maxima noted were counted as two earthquakes of the total for the week. On March 28 continuous tremor was again evident, beginning at 9:01 a. m., and continuing until 9:10, starting again at 9:16 and waxing to a maximum at 9:20 a. m., and waning to an end at 9:41 a. m.

Microseisms were rather strong on March 29.

Tilt has accumulated during the week moderately to the SSW.

LASSEN REPORT No. 6

Mineral, California, March 15, 1927
R. H. Finch, Associate Volcanologist

From March 10 to 14, 1927, the most remarkable series of local earthquakes was recorded since the establishment of the Lassen Observatory. The seismographs were dismantled three times. The strongest earthquakes were on March 10 and 11, though the majority of the entire 52 shakes were perceptible. Lyonsville, 12 miles to the southwest, also reported the strongest of the quakes. As seems to be a characteristic of Lassen earthquakes, all shakes both large and small were accompanied by loud rumbles. After the occurrence of such a series of earthquakes, it would seem indiscreet to say that Lassen Peak is dead.

CAUSE OF LASSEN MUD FLOWS

During the eruption of Lassen Peak in 1915, there were strong horizontal blasts on May 22 that denuded a section of the northeast slope of the mountain and produced remarkable mud flows down Lost and Hat Creek valleys.

It has been maintained by some that mud flowed over the lip of the crater, by others that hot water came out of the crater, and by still others that the water was derived from condensed steam and from snow melted by the steam and hot ashes. In looking over the Peak last January (Volcano Letter No. 110), it seemed to the undersigned that the source of the water may well have been due entirely to melting snow, that hot water from the crater was rather improbable, and that condensed steam, if any, played only a minor part. Snow usually accumulates on the slope in question until in March, while in the middle of January the depth of the snow—five to six feet —was sufficient to furnish water enough to account for the floods. The snow in the upper half of the comparatively narrow belt four miles long, if melted suddenly as must have been the case in 1915, could have produced steep flood waves of about the proportion of those that swept down Lost and Hat creeks. Gravel and boulders must have aided the finer particles in melting the snow and in raising the temperature of the water well above the melting point of ice. A very large boulder was still hot several days after the floods.

If the direction of the horizontal blast on May 22 was only slightly different from that of the one on May 19, as was the case, there would have been enough snow in its path to account for the minor flood that accompanied it, and the condensed steam factor may have been trivial.

R.H.F.

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No. 119 RELEASED WITHOUT COPYRIGHT RESTRICTION April 7, 1927

KILAUEA REPORT No. 795

WEEK ENDING APRIL 6, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

Halemaumau pit at Kilauea Volacno has been visited several times during the past week, but nothing has occurred to indicate any marked change in the magma that underlies the volcano. There are usually small slides of loose rock from the walls of the pit if the visitor waits a half hour or more, but large slides have not been seen, and the sulphurous spots on the debris slopes have remained about as before. In rainy weather these solfataras give off much steam, and in dry weather the steam diminishes, but always there is some vapor at the sulphur patches. At the crack back of the southeast edge of the pit, there has been no return of steam where the trail crosses, and the winds have continued southerly. It will be of interest to observe what happens there when the northeast trade winds are resumed.

The seismographs at the Kilauea Observatory have registered a total of 16 local earthquakes, all very feeble. The only possible exception was one of these at 8:44 a. m. April 1, which appeared to be part of the faint record of a distant earthquake. Tilt for the week was moderate to the SW.

AMERICAN GEOLOGISTS

Professor E. H. Sellards, of the University of Texas, has compiled on a map the geographic distribution by states of geologists in the United States. He has presented on the same map the approximate number of papers on geological topics published in the two years 1921-1922, relating wholly or in part to each state. This figure, along with the figure showing the number of geologists, indicates to what extent the published work of the geologists concerns their own states. The list indicates all professional geologists who have worked at the science at least three years after their graduation, and at specialties that include geology, paleontology, mineralogy, petrography, engineering geology, and physiography Presumably geophysicists are distributed among several of these branches.

There are listed 1,744 geologists, and these produced in two years 1.072 scientific papers. Although the district of Columbia contains 114 geologists, only four papers were published concerning that district. On the other hand, California contains 180 geologists, who published 89 papers; and Texas 220 geologists, who published 75 papers, in each case about the state in question. New York has 171 geologists, but only 38 papers were published about New York geology. The activities of the geologists of New York and Washington, D. C., are largely in regions distant from the place where they reside.

The total number of papers for 1921-22 concerning state geology is 1,072, and of these 243 relate to the oil and copper states—Oklahoma, Texas, New Mexico, California, and Arizona. It is remarkable that of 1,744 geologists, 503, or more than one-fourth, live in Oklahoma, Texas, and New Mexico. This shows an astonishing development of geologic activity centering around oil in the last 30 years. The geologists most prolific of publications concerning their own states are in Utah, Nevada, and Oregon. In Utah eight geologists produced 32 papers, in Nevada three geologists produced 24, and in Oregon seven geologists produced 31.

Figures of this kind are very stimulating, and they mark the overwhelming domination of economic geology and especially oil geology which has grown up in connection with the vast industry of drilling and producing petroleum in the southwestern states. T.A.J.

THE TANGO EARTHQUAKE

A very severe and disastrous earthquake occurred on the west side of the Lake Biwa depression that crosses central Japan, on Monday, March 7, 1927. The principal damage was in Mineyama and vicinity, on the northwestern coast of Japan, the destruction being confined largely to fishing villages.

The Home Office on March 10 reported 2,458 dead, 4,107 injured, some 60,000 people homeless, and 88 missing. About 6,000 houses were destroyed by fire or collapse, and some 2,000 more were damaged. Airplanes were used for inspection and investigation, as railways were broken, roads were blocked, and the country at the time was suffering from floods. The misery was accentuated by snow and cold, there were numerous cracks, rumblings continued after the first earthquakes, and a flood-wave from the sea was said to have damaged Yamada and other villages. A terrific gale swept the region on March 11, adding to the misery by demolishing refugee shelters.

The earthquake was felt strongly in Kyoto, Osaka, and Kobe, but no very serious damage was done on the Pacific side of Japan. The details of the seismological data have not yet been reported outside of Japan. T.A.J.

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No. 120 RELEASED WITHOUT COPYRIGHT RESTRICTION April 14, 1927

KILAUEA REPORT No. 796

WEEK ENDING APRIL 13, 1927

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

Halemaumau continues to show little change, but the red dust made by avalanches on the north talus has increased. On April 10 some slides were heard falling in the forenoon from the northeast wall of the pit, and at 5:15 p. m. a larger avalanche sent up a distinct dust cloud that rose above the rim of the pit and was simultaneous with a short-lived avalanche tremor registered on the seismographs at the Observatory. Heavy rain has washed away part of the sulphur and salts that were so conspicuous on the south and east debris slopes.

For the week 17 feeble local earthquakes were registered. One beginning at 9:02 p. m. April 7 continued feebly for about six minutes. Another at 2:09 p. m. April 8 had an indicated distance of origin 14 miles away. Tilt for the week was very slight to the east.

LASSEN REPORT No. 7

Mineral, California, March 30, 1927

R. H. Finch, Associate Volcanologist

Mr. Finch made a reconnaissance of the volcanic steam district of Sonoma, Napa, and Lake counties in California March 20-30. Volcanic cones are numerous in this district, and some are well preserved. A crater was found just above the petrified forest near Calistoga, which is very well preserved and shows a cone in the middle and a distinct Somma rim. The rainfall in this region is variable, so that age determinations on the basis of erosion changes affecting topography are apt to be misleading unless precipitation is considered. Thus the crater above mentioned appeared much younger than anything on Mount St. Helena. Near the petrified forest there are some interesting caves, either excavated by cliff-dwelling Indians, or else formed by erosion of softer material along an ancient lake shore that once occupied the valley.

THE UNDER SIDE OF THE EARTH'S CRUST

Seismology and the physical study of the elastic constants of rocks are making discoveries by a combination of experiments in the laboratory and measurements with the seismograph. The Geophysical Laboratory has published evidence that the earth consists almost entirely of ultra-basic rock, largely olivine, except for a thin crust and for a metallic core (Volcano Letter No. 3, January 15, 1925).

Adams and Gibson (Proc. Nat. Acad. Sci. Vol. 12, No. 5, pp. 275-283, May, 1926) have attacked the problem of what the material is under the crust of the earth. They believed it to be olivine rock or peridotite, Daly believed it to be basalt (Volcano Letter No. 59, February 11, 1926). They took specimens of granular olivine rock (dunite) from North Carolina, and basaltic glass from Kilauea, and cut a polished cylinder from each, and subjected these to pressures of from two to twelve thousand atmospheres immersed in a liquid. The changes of volume in the two substances under different pressures were determined with precision. Given the compressibility and the density, it is possible to calculate the velocity with which the preliminary and the secondary earthquake waves will be propagated through these substances.

Now in the earth itself the velocities of these two types of wave motion, the first compressional, and the second distortional, are known for various depths below the surface from seismologic data. Hence a comparison of these velocities with those calculated from the elastic constants of different rocks provides a key for elucidating problems of the earth's interior. From the seismologic data the velocity of the compressional waves increases slowly to a depth of 60 km., and at this level it changes suddenly from about 5.9 kilometers per second to 8.0 kilometers per second. The velocity in rock increases with increasing basicity and density. The pressure at 60 kilometers of depth is about 17,000 atmospheres.

Applying the formulae to the compressibility results for the granular olivine and the Kilauea basaltic glass, respectively, the investigators found that at that depth the velocity in the olivine rock for the compressional waves would be 8.4 km./sec., and for the basaltic glass the Kilauea rock would transmit these earthquake waves at 6.9 km./sec.

It is evident from this that the material at depths greater than 60 km. is heavier and more basic than gabbro, and approaches olivine in composition. With due allowance for the effects of high temperature which would probably decrease the velocity a little, the authors estimate that the material below the crust of the earth at 60 km. of depth should consist of a peridotite largely olivine, but containing some less basic silicate like hypersthene. The authors believe that measurements of the compressibility of rocks at high temperatures would enable one to make a precise estimate of the composition of the earth's crust.

The results show that the glassy, basaltic substratum under the crust of the earth, which Daly has characterized as "slippery", cannot exist there if the seismograph data are correct, and "whatever basaltic material there may be within the earth is probably confined to a comparatively thin zone." T.A.J.

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No. 121 RELEASED WITHOUT COPYRIGHT RESTRICTION April 21, 1927

KILAUEA REPORT No. 797

WEEK ENDING APRIL 20, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

The week at Halemaumau pit has produced no important changes. At 11 a. m. April 20 the taluses showed fresh debris N, WNW, and SSW, and the sulphur patches of the eastern inner slopes showed dimming of their brilliant color through the washing of recent rains. The upper walls were dark red in color, owing to wetness. The large sulphur patch at the S talus was still bright yellow with a dark area in its center.

There has been for many weeks past a lump of red rock at the core of the west boss, an irregular dense rock mass underlain by intrusive gabbro in the middle of the western wall of the pit. This lump protruded; now it has totally fallen away, and it was evident from small slides observed three times on this morning that motion there was still in progress. The slides were very small, so that the dust from them was detected with difficulty, though the noise could be heard plainly. At 11:16 a. m. a small slide occurred NNE.

Steam appeared at the usual places in the pit, and although light NE wind was blowing, the steam cracks back of the SE station had failed to develop any return of their heat and vapor. It is evident that the cessation of steaming there, first noted about March 30, is not connceted with the direction of the wind and is more or less permanent. They are vaporing about 50 yards south of the trail, but this is quite invisible at the trail crossing, and the air rising from the cracks is barely warm.

Fourteen very feeble local earthquakes have been registered for the week at the Observatory. Tilt was slight SSW.

OPENING OF THE UWEKAHUNA OBSERVATORY

During the visit to Kilauea of the Pan-Pacific Conference on Education and Recreation recently held in Honolulu, Dr. Hubert Work, U. S. Secretary of the Interior, at 9 a. m. April 19 opened to the public the new Uwekahuna Observatory and Exhibition Room of the Hawaiian Volcano Research Association (See Volcano Letter No. 115).

Dr. Jaggar made a short address, mentioning the fact that for 11 years past it has been the hope of the workers at the Hawaiian Volcano Observatory (Bull. Hawn. Vol. Obs. Vol. 4, No. 4, 1916) that some sort of a trailside museum might be provided for which would make it possible to explain to travelers in an appropriate setting the fascinating mechanism of volcanoes, and at the same time show them pictures of recent activities and maps or diagrams illustrating the relation of the Hawaiian volcanoes to the surface features of the globe. Thanks to the liberality of Congress in creating the Volcanology Section of the Geological Survey in 1926, the Research Association supplied money for the building of a small exhibit hall equipped with electric current and projection apparatus. This is now finished, and some of the best of the collections of the Observatory have been placed in display cases, the whole room being faced with large plate-glass windows that command a magnificent view southward of the whole Kau Desert and Halemaumau pit. As the buildings and equipment furnished by the Hawaiian Volcano Research Association are all part of the plant of the Observatory, Dr. Jaggar took occasion to convey the new establishment to the use of the Department of the Interior through the two branches here presented, the National Park Service and the Geological Survey.

Secretary Work accepted the offering on behalf of the Department of the Interior, and short speeches were made also by Honorable Stephen T. Mather, Director of the National Park Service, and by Honorable Wallace R. Farrington, Governor of Hawaii.

The new buildings are of iron, with rough stone corner posts, the smaller one housing the water tank, preparation room, and power plant, the larger one standing on the highest rim of Kilauea Crater, with a terrace in front designed to display the view that on bright mornings extends all the way from Mauna Kea and Mauna Loa around past the south point of the island in panorama, and thence eastward, including all the cones and landmarks of the Kau Desert, to Halemaumau, spread out at the feet of the observer as an enormous chasm less than a mile away. Beyond it and around is seen all the detail of Kilauea Crater and the pits Keanakakoi and Kilauea Iki, while in the distance to the east lies Puu Huluhulu, that marks the site of the new Chain of Craters Road, which Secretary Work dedicated the same morning.

It is hoped eventually to install on the terrace a large Zeiss binocular telescope, and projection apparatus for lantern slides and motion pictures has already arrived, and in a short time will be installed and in operation.

T.A.J.

HILLS CREEPING IN QUEENSLAND

From Nambour in Queensland comes the report (The Argus, Melbourne, Australia, January 28, 1927) that an unusual and serious catastrophe occurred about January 26, 1927, near Perwillowan. Whole farms have moved, fissures have opened, and small earthquakes have occurred. This is a hilly country near the sea, and one farm is described as having moved a portion of its lands bodily across a road onto the territory of another farm, so as to lose part of its acreage. In one place a washout is described nine feet deep, in another place the slip of a block country 700 feet long by 60 feet deep, with a forward motion of over 600 feet, carrying banana plants on its surface. Elsewhere there is a chasm 12 feet deep and three feet long.

At Robinson's farm the roadway is reported entirely gone for a mile of length, creaking noises are heard, the hillside at the back has moved to within a few feet of the house, and the house has tilted.

At another residence on the morning of January 26, there was a landslip carrying with it trees, boulders, and earth. Culverts have been carried away or shifted. The loss in property is severe, and some families have moved into Nambour.

T.A.J.

EARTHQUAKE IN CHILE

On April 13, 1927, the press reports 50 injured and 16 dead over 1,000 miles of Chilean coast near Santiago and Valparaiso.

T.A.J.

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THE VOLCANO LETTER

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No. 122 RELEASED WITHOUT COPYRIGHT RESTRICTION April 28, 1927

KILAUEA REPORT No. 798

WEEK ENDING APRIL 27, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Halemaumau, the inner crater of Kilauea Volcano, continues to evidence little change. There is no avalanching, though during a circuit of the pit on April 23 it was noticed that there are several places ready to fall whenever there is sufficient seismic disturbance. The intrusive mass at the west boss, mentioned in last week's report, has fallen away a little more, and several rock falls were heard on three visits to the pit during the past week. One of these, on April 27, 8:45 a. m., made echoes lasting for a few seconds.

White salts are seen on the walls, the sulphur patches on the talus slopes and floor remain about the same, and steam continues at the usual places. On April 25 it was noticed that the cracks near the tourist trail crossing, mentioned in Volcano Letter Nos. 118, 119, and 121, are again steaming, though very moderately.

During the week the total number of earthquakes recorded has been 19, all of them very feeble. More than half of this number occurred on the 23rd and 24th, culminating in a shock in the early morning of the 25th somewhat stronger than the rest, which had an indicated distance of 12 miles. Tilt has accumulated moderately ENE.

It has so frequently happened that either Mauna Loa or Kilauea has erupted soon after Dr. Jaggar's departure from the station, it has become almost a superstition that his leaving should be a signal for an eruption to occur. Two days after his recent departure for Alaska rumor was rampant on Hawaii that an eruption was in progress without, however, the slightest foundation in fact.

THE OCEAN

Since three-fourths of the area of the earth is covered by water, such studies as geology, topography, geodesy, volcanology, seismology, and other investigations dealing with the composition, shape, and mechanics of the earth's crust, are most easily persued over the area limited to the remaining quarter, or land area. These water-covered areas are attracting increased attention, however, through modern methods of sounding, and through evidences supplied by seismology and allied sciences.

In "La Science Moderne" (Montreal, Feb. 1927) Professor J. Thoulet writes concerning volcanic and seismic disturbances beneath the oceans. He describes the ocean depths as places of almost perfect rest. The motion of the waves and tides are for the most part surface movements and do not affect the depths, and disturbances due to diffusion must be slight, and ordinarily convection currents due to either solar or earth temperatures cannot very much disturb the deep ocean waters.

On land, geologic formations show evidences of the crust having been many times revised and made over, volcanoes are seen building new surface, and rivers are seen removing old surface. Geodesy is now a science of sufficient precision to detect progress of slow warpings and bendings. Changes must also be taking place beneath the seas, and may in time made available for study.

Volcanoes, under water, are undoubtedly producing lava flows. Lava erupting in air tends to be light and frothy due to gas expansion. But under water at great depths the pressure is so great, and cooling is so fast, that in all probability the gases are never released, and the lava is compact and dense. Thus there would be no gas bubbling to the surface, there would be no light pumice-like material ejected to float to the surface, nor any other surface indication of such an eruption, unless it might be a local heating of the water detectable at the surface—though diffusion would make this improbable.

The presence of such flows may perhaps be detected, while still fresh and unmasked by sedimentation, by sounding for character of surface. Volcanic cones and topographic shapes might become apparent with depth soundings in sufficient detail.

The U. S. Coast and Geodetic Survey has developed a sonic sounding device, utilizing a transmitted sound and a timed echo, wherewith depth measurements are possible with ease at the rate of one or more a minute, without checking the ship's speed. The sounding lead requires half an hour or more in moderately deep water, with the ship's position held. Thus it seems that here a new field of investigation is opening, through the possibility of greatly increased detail in sounding.

Earthquakes in the ocean floor are easily detected, through seismology, and their locality closely determined. But the nature of the movement producing them can only be guessed at. On land the movement along a fault can at least be measured at the surface.

Risings and fallings of the ocean's floor, of a gradual sort, defy detection, though the sudden change in depth of Sagami Bay, Japan, in 1923, was made available for study through detailed soundings in existence before the change, compared with soundings made afterwards. On land such risings and fallings of the earth's surface are made apparent through stream erosion, and if rapid, through precise leveling.

The ocean itself gives some indications of earth changes. Suboceanic earthquakes may produce tidal waves. Mean sea level, as a reference datum, has inscribed itself in geologic time as shore lines, now elevated for inspection and proof of rising of the crust. Rapid rising or falling of shore lines may be detected and measured by tide gauges, as was done at Sagami Bay.

R.M.W.

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No. 123 RELEASED WITHOUT COPYRIGHT RESTRICTION May 5, 1927

KILAUEA REPORT No. 799

WEEK ENDING MAY 4, 1927

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

Halemaumau shows no suggestion of lava activity, but slides from the walls have increased. These are taking place mostly from the northeast side, and at 10 a. m. on April 30 dust from an avalanche was seen to rise from the north corner and drift away. Later that day there were more slides, accompanied by much dust. On a visit to the pit on May 2 a large scar was seen at the north, beginning just above the west horn of the big sill and extending all the way down to the talus slope, which was coated with new debris. The wall at the other end of the sill is similarly freshly broken away, and a new boulder lies at the foot of the NNE talus. During a circuit of the pit on May 3 rocks were heard falling almost continuously from the north and northeast walls.

For the past week there have been 18 local earthquakes, all very feeble with one exception. On April 30, at 2:33 p. m., a shock occurred that was felt by a few people, both at the volcano and in Hilo. It may be classed as "slight," its maximum acceleration being about 11.0 mm. sec. per sec. The indicated distance to origin from Kilauea is about 40 miles, and from Hilo, 34 miles. It was followed by several very feeble after-shocks, one of which was of four minutes duration.

During the first part of the week tilt accumulated moderately to the south, which was recovered by northerly tilt, so that the net for the week is practically zero. The change from south to north tilting closely agrees in time with the time of the earthquake above described.

EARTHQUAKE INTENSITY

So many factors enter into the determination of the intensity of an earthquake that it is difficult to secure a scale by which the wide variety of different kinds and sizes of earthquakes may be definitely graded. The motion of an earthquake is very complicated and involved, any given point of the earth's surface traces a path which, if reproduced, would very much resemble a bad tangle in an unwound spool of thread. It is a complicated elastic vibration. The motion defies mathematical analysis. Seismographs record it ordinarily in three parts representing the three dimensions of space; for example, north-south, east-west, and up-down are the usual three components. Each of these components represents the motion back and forth in its particular direction only. In order, therefore, to unravel the actual complete motion, all three of these components must be combined, instant for instant; an undertaking of considerable complexity.

As a given point traces its tangled path, every time its motion is changed in direction or velocity, it is spoken of as being accelerated; the acceleration being ever changing in amount and direction, and its intensity being measured by the suddenness in the change of velocity or direction that it produces in the motion of the point in question. The maximum acceleration attained is the index of the power and severity of the earthquake. We feel no motion until the earth's crust is shaken or accelerated beneath us. The acceleration of an earthquake is rapidly and repeatedly reversed in its direction, producing a swaying or vibrating motion back and forth. A great acceleration means a strong starting and stopping, and re-starting and stopping again in reverse direction, of the ground beneath our feet; a harsh shaking that we feel and that tests the strength of our structures. The range of such a motion may be small—a few hundredths of an inch perhaps—but if the shaking is rapid it is nevertheless evidence of strong acceleration. If, however, the same range of motion is only accomplished through a longer period of time; say a complete cycle of motion requires fifteen or twenty seconds, as in an earthquake the origin of which is at a great distance from the observer; then the acceleration is weak and the earthquake is not felt by the observer, though the shock may be severe at its origin. Thus the intensity of an earthquake, its acceleration, its perceptibility and resulting damage, is dependent not only upon the range of motion, but also upon the rapidity with which the ground is shaken back and forth through this range. No one of the three components alone will, as a rule, show the amount of the whole acceleration; therefore, in order to compute by rigorous mathematics the value of the maximum value so as to grade the earthquake, it would be necessary to compute instant for instant throughout the disturbance the value of the varying acceleration as found from a combination of the three components, and so find where the maximum occurred. That would be an impracticable and tedious problem. Ordinarily the approximate time of maximum acceleration will be apparent in the records. The approximate maximum acceleration may then be computed for that portion of the earthquake. The same earthquake results in different action in different localities, due to distance from the origin and to the varying elastic properties of the earth's surface at different places. An earthquake is ordinarily graded, however, by its intensity at or over its origin, or where it is most severe.

Thus it is seen that it is difficult to accurately scale an earthquake, even with good records of it, and also a seismograph is not always located near the origin. The instrumental and mathematical measure of the acceleration is hardly more satisfactory as a measure of the intensity of an earthquake than is the simpler method of feeling and noting its effect on objects around us. Thus the natural scales are still in customary use. Of these natural scales the common ones are the Rossi-Forel, the Cancani, the Mercalli, and others, in general similar. These scales may be found in any textbook on seismology, but for convenience a copy of one of them will be included in next week's "Volcano Letter." R.M.W.

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No. 124 RELEASED WITHOUT COPYRIGHT RESTRICTION May 12, 1927

KILAUEA REPORT No. 800

WEEK ENDING MAY 11, 1927

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

The activity at Kilauea is still confined to avalanching, which has diminished toward the close of the week. Small rock falls continue intermittently. Several falls were noted on May 5 and 7. On May 9 the wind was too strong to hear clearly sounds in the pit. Rain accompanied the wind, and from the dry places in the pit the hot areas could be detected. May 11 the pit was very quiet, and but a few rock falls were heard during a two-hour observation, the largest slide being one from the SSE wall, which is ordinarily very stable.

During the week ending May 11 there were 36 very feeble local earthquakes recorded. This is an increase in number over that for any weekly period since the middle of September, 1926. At that time there was a marked decrease in number, as noted in Volcano Letter No. 92. Since then the weekly average has been 15 local earthquakes, and the number per week has clung close to the average, the maximum and minimum during this time being 29 and 6, respectively. Thus the increase this week is worthy of note. One of these shocks, while still very feeble, yet plainly indicated a distance of 36 miles. On May 8 there were five cases in which the earthquakes appeared to come in pairs, the interval between the first and second tremor being in all cases close to 50 seconds. In the count for the total for the week, each pair has been counted as one. Avalanches during the first part of the week were more frequent than usual, and it may be that the second tremor in the pairs above noted are the result of avalanches precipitated by the first, and real, earthquake.

Tilt has been feeble during the week, accumulating only very slightly to the NE.

THE ROSSI-FOREL SCALE (1883)

Grades of Earthquake Intensity.

No. 1, recorded by a single seismograph, or by some seismographs of the same pattern, but not by several seismographs of different kinds; the shock felt by an experienced observer. No. 2, recorded by seismographs of different kinds; felt by a small number of persons at rest. No. 3, felt by several persons at rest; strong enough for the duration or direction to be appreciable. No. 4, felt by several persons in motion; disturbance of moveable objects, doors, windows, creaking of floors. No. 5, felt generally by everyone; disturbance of furniture and beds; ringing of some bells. No. 6, general awakening of those asleep; general ringing of bells; oscillation of chandeliers, stopping of clocks; visible disturbance of trees and shrubs; some startled persons leave their dwellings. No. 7, overthrow of moveable objects, fall of plaster, ringing of church-bells, general panic, without damage to buildings. No. 8, Fall of chimneys, cracks in the walls of buildings. No. 9, partial or total distruction of some buildings. No. 10, greater distasters, ruins, disturbance of strata, fissures in the earth's crust, rock-falls from mountains.

No. 1 grade above described is too strong in which to class the great numbers of non-perceptible tremors recorded on the seismographs at the Hawaiian Volcano Observatory, where the grading used is as follows: Very feeble, acceleration 2.5 mm. per sec, per sec., totally instrumental. Feeble, acceleration 5.0, mostly instrumental. Slight, acceleration 10, slightly perceptible. Moderate, acceleration 25, generally felt. Strongish, acceleration 50, strongly felt. Strong, acceleration 100, alarming. These terms are as used in the Volcano Letter. Dutton evaluates the Rossi-Forel grades (excepting the tenth) in terms of acceleration as follows: No. 1, 20 mm. per sec. per sec.; No. 2, 40; No. 3, 60; No. 4, 80; No. 5, 110; No. 6, 150; No. 7, 300; No. 8, 500; and No. 9, 1,200 mm. per sec. per sec. Comparisons may be made through equal values of acceleration. It is seen that "very feebly," feeble," and "slight" come below the lowest Rossi-Forel grade. Some uncertainty is introduced, as "slight" includes shocks that may be perceptible, in spite of the fact that Rossi-Forel No. 1 is intended for the lowest perceptible grade. R.M.W.

TIME

At the Hawaiian Volcano Observatory, the controlling timepiece is a Howard seconds-pendulum clock. Its correction is frequently determined by radio, and it runs in a room in which the temperature range is small. A chronometer is used in daily comparison. During the months of December, 1926, January and February, 1927, its rate was remarkably constant at -0.08 second per day. Near March 8 its rate changed to -0.66 second per day, and since then it has run at -1.71 second per day. These changes in rate are most likely due to disturbances of the clock when winding, by earthquakes, or any other of many possible causes. An interesting speculation, however, suggested by the timing of the pendulum in the gravity apparatus used here last December by the U. S. Coast and Geodetic Survey (Volcano Letter No. 106) is the possibility that the pendulum of this clock may be sensibly indicating changes in the value of gravity. Other geodetic dimensions here at Kilauea are changing—elevations through a range of about two feet, and horizontal positions as much as five feet—amounts measureable during a few months' time. Gravity would change very slightly due to the known changes in elevation, and it might also be changed by the movement or intrusion of magma in the edifice of the volcano. The value of gravity determined here in December was 978.667 dynes—not corrected for elevation, topography, etc. This value would need to change but .013 dyne and .024 dyne to produce the two changes in clock rate mentioned above.

In making the series of clock corrections observed, 82 during the period of time since the first of December, 1926, the radio signals sent out from Pearl Harbor, Hawaii, were used. It was at first thought that the clock rate fluctuated badly, but it soon became apparent that the chronometer showed precisely the same fluctuations, if the radio signals were taken as correct. It seemed inconceivable that both clock and chronometer should execute the same fluctuations, and it so became evident that the time signals themselves were in error by varying small amounts over and above the published correction. The mean rate over a long period would be practically free of these errors.

R.M.W.

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No. 125 RELEASED WITHOUT COPYRIGHT RESTRICTION May 19, 1927

KILAUEA REPORT No. 801

WEEK ENDING MAY 18, 1927

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

Halemaumau shows little change over last week, except for a nitch which has formed in the upper part of the north sill, near its west end. Small rock falls from the walls continue, and steam issues quietly from the usual places on the walls, taluses, and floor.

During the week ending May 18, there were recorded 13 local earthquakes, all very feeble with the exception of one at 7:01 a. m., which was feeble, with an acceleration of 9 mm. per sec. per sec., its indicated distance being 17 miles. It was felt by only one or two persons in this vicinity. On the same day a perceptible earthquake was reported in Kealakekua, which was recorded here as a very feeble shock at 9:01 p. m., with an indicated distance of 31 miles.

Tilt has accumulated very slightly to the west.

KILAUEAN ASHES

It has sometimes been asserted that the term "volcanic ash" is a misnomer, since it implies the false idea of a residue from combustion, and that its usage should be discontinued. Such a suggestion receives additional support from the fact that the term ash has been so widely employed and in such different senses that it has ceased to have any accurate connotation. The term, however, has come to stay in geological literature, and has its value as a general field name for all loose pyroclastic material smaller in size than a pea. When such material is compacted, it is usually described as tuff. The palagonite-tuffs of Diamond Head and of Punchbowl, on Oahu, are typical compacted ashes.

A tuff composed essentially of glass fragments is spoken of as a vitric tuff. Such a tuff results from the violent comminution of frothy lava, and is especially characteristic of viscous acid lavas, such as rhyolites. The more liquid basaltic lavas of Kilauea usually give rise to thread-lace scoriae (limu) on explosion, the vesicles being retained within delicate walls. Occasionally, however, even the liquid Kilauean basalt has been so quickly chilled and triturated as to give rise to vitric tuff, composed of angular and crescentic chips of glass. The olive-green and yellowish tuff of the 1790 eruption which rests upon pahoehoe lavas along the 1868 cracks west of Halemaumau, consists locally of over 95 per cent of glass dust, probably derived from the shattering of thread-lace scoriae. In places the upper surface of this glassy deposit is curiously channelled by sharp U-shaped valleys, occupied by the coarser ejecta of later eruptions.

When crystals predominate over glass in a tuff, the term crystal tuff is employed; when rock fragments predominate over both glassy and crystal fragments, the term lithic tuff is used. Among the later products of the 1790 explosive eruptions, lithic and crystal tuffs alternate irregularly. Much of the dark gray ash in the road cuts near Keanakakoi is almost devoid of glass, being composed of chips of olivine, augite, felspar, and magnetite.

The ejecta of the 1924 eruption are almost wholly made up of pieces of previously consolidated rocks; the ash is thus essentially lithic. Certain specimens collected from the present surface of the old "aviation field," southeast of Halemaumau, are, however, chiefly composed of glass dust, with subsidiary amounts of crystal and basalt chips. The presence of glass in the 1924 ash is more likely to be due to the trituration of old, glassy basalts than to the explosion of fresh lava froth, since bombs appear to be absent from the ejecta.

Pyroclastic materials varying in size between that of a pea and that of a walnut are classed as lapilli. Coarser materials, if composed either wholly or in part of fresh magma on eruption, are included under the term bombs; if composed of previously formed rocks, as in the 1924 ejecta, they are described as ejected blocks, pebbles, and cobbles, according to their size.

Compared with the explosive ejecta of acid volcanoes, those of basaltic character are normally of very limited distribution and of more irregular thickness. For example, the palagonite-tuffs from the craters on Oahu are notably restricted in extent, and the 1790 ash of Kilauea varies rapidly in thickness over small areas. By contrast, an acid, rhyolitic ash-band averaging only a foot in thickness has been traced for over 200 miles along the Pelly River, Yukon, and an ancient Palaeozoic acid tuff is believed to occur at intervals over an area stretching from Kentucky and Tennessee in the east to Missouri in the west, and from just south of Lake Erie to near the shores of the Gulf of Mexico.

Howell Williams.

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No. 126 RELEASED WITHOUT COPYRIGHT RESTRICTION May 26, 1927

KILAUEA REPORT No. 802

WEEK ENDING MAY 25, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Halemaumau continues to show little change. Rocks can be heard falling nearly every time the pit is visited, and occassionally slides of varying sizes are witnessed. A rather large one occurred at the southwest rift tunnel about 9:30 a. m. May 23. The sulphur spots seem to be increasing low down on the southwest talus and on the lava floor of the pit.

There are recorded on the seismographs at this station 11 very feeble local earthquakes for the week ending May 25. On May 22 there is record of a teleseism with a vaguely indicated distance of 6,340 miles. The preliminary wave of this earthquake came at 15 minutes and 33 seconds past noon Hawaiian Standard Time, and the following phases lasted nearly an hour before the record died out completely. This earthquake was also feebly recorded on the seismograph at Kealakekua.

Tilt has accumulated only very slightly to the west.

A SIMPLE SEISMOMETER

The overthrow of columns by earthquakes long ago suggested the design of a seismometer composed of bars standing on end as a means of detecting earth shocks. Bars having very narrow bases would overturn more easily than those upon a wider footing. Bars hinged at the bottom, or resting on a knife edge, and leaning back against a rest, ladder-fashion, would be thrown over away from the support the more easily if held nearly vertical. For these types of seismometers West's formula has been used in computing the horizontal acceleration of the ground required to effect the overthrow, given the dimensions of the column. This formula is based upon an assumption that the acceleration is constant for a long enough time to allow the column to become overbalanced beyond recovery.

In "Science" of April 15, 1927, Professor Paul Kirkpatrick of the University of Hawaii has deduced a formula for the acceleration necessary to overthrow a column or bar of given dimensions, which takes into consideration the fact that the acceleration of an earthquake is not constant, even for very short periods of time, but is oscillatory. The formula contains several variables; the distance of the center of mass above the horizontal axis of rotation, the radius of gyration of the bar about that axis, the angle that the bar is allowed to lean back from its vertical against the support, the period of the oscillatory acceleration (assumed simple harmonic). From these, the value of the acceleration that will just suffice to overthrow the bar is computed. This formula suggested the design of a simple seismometer, which has been tried out on an oscillating table in the laboratory. Bars of varying form tested by accelerations of varying period and amplitude have proven the formula by experiment. Professor Kirkpatrick plans to bring the device to Kilauea to study its action in recording the local earthquakes in the vicinity of the volcano. He promises a more complete description as his experiments progress. R.M.W.

A DEFECT IN HORIZONTAL PENDULUMS

Kyoji Suyehiro, in the March, 1927, issue of the "Proceedings of the Imperial Academy," Japan, indicates that there may be an effect, hitherto ignored, that would cause the records of horizontal pendulum seismographs to be inaccurate representations of the true earth movements. Seismographs of this sort are arranged to swing about an axis that is nearly vertical. There are usually two pendulums, to record the two horizontal components of earth movement, hanging in vertial planes at right angles to each other. Thus the axis of a pendulum intended to record north-south motion is inclined slightly away from the vertical in an east or west direction in order that the pendulum will come to rest in a position at right angles to the direction whose component it is intended to record. This angle of inclination of the axis from the vertical is called the angle "I", and is assumed in most discussions to be constant, once the seismograph is set up and kept in adjustment. If this angle is changed, the period of the pendulum is changed, and if the angle is diminished to zero, the pendulum becomes unstable. A pendulum of this sort is usually regarded as being affected only by that component of the earthquake motion which is at right angles to the plane of its angle "I", which is duly recorded. If tilt is present to affect the value of "I", obviously the period of the pendulum would be changed, and if tilt were sufficient to make "I" zero, the pendulum would be unstable and would record meaningless wanderings instead of real earth motion. While tilt would hardly attain values large enough to accomplish this effect, it is shown in Mr. Suyehiro's paper that the component of the earthquake acceleration in the plane of the angle "I", supposedly without effect, may change the inclination of the effective axis of the pendulum, and so temporarily change the effective value of "I", even to the point of making it zero. Thus the pendulum would be rendered unstable, and its records might show swings of large amplitude without real earth movements to warrant them. R.M.W.

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No. 127 RELEASED WITHOUT COPYRIGHT RESTRICTION June 2, 1927.

KILAUEA REPORT No. 803

WEEK ENDING JUNE 1, 1927

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

Kilauea Volcano continues dormant, the only activity being rock falls and small avalanches from the walls of Halemaumau pit and steaming at the usual places in the pit and on the floor of the crater. On May 30 about 11:30 a. m. dust from a big slide was seen to rise on the north side of the pit and hang over it about five minutes. During a visit to the pit on the 31st new debris was noticed on the northwest talus, reaching nearly to the lava floor, and the wall above was very dusty. At 11:53 a. m. slides were heard both northwest and south. On June 1 new debris was seen on the east, north, and south-southwest talus slopes, and the wall below the west boss appeared to be more broken away.

There have been 13 very feeble local earthquakes recorded during the week ending June 1. Tilt has accumulated very slightly to the north.

The teleseism reported last week, which occurred on May 22, originated in latitude 35 degrees north, longitude 92 degrees east, at 22 h., 32 m., 48 s., Greenwich Civil Time, according to a determination made by the U. S. Coast and Geodetic Survey.

PHOTOGRAPHIC RECONNAISSANCE

The use of photographic surveying is increasing rapidly, especially under conditions that limit the time for field operations. Methods have been developed to use pictures taken from airplanes for map making, that allow tremendous areas to be covered in a short time. A recent undertaking, and one of the largest, is the U. S. Naval expedition to southeastern Alaska. This is well described in the "Scientific American" of May, 1927. Many parts of this area are very inaccessible, and mapping by ordinary ground methods is slow and arduous in the extreme. The shore lines are precipitous, and the waters rough, so that to run a ground survey along them is a serious problem. The Navy airplanes have been able to fly over and photograph, from an altitude of 10,000 feet, more territory in a day that a survey party on foot could cover in many weeks. The airplane photographs exhibit shore lines excellently, but are not so well adapted to determine land elevations and topographic shapes, especially in a country blanketed with timber. In general, aerophotography must be supplemented by a certain amount of ground work before a complete topographic map can be secured. But until such ground work can be done, the photographs furnish an excellent and useful reconnaissance map of the area.

Southeastern Alaska is not an area of volcanoes, but this work will undoubtedly be extended to other regions where its usefulness to volcanology will be more direct. Recent topographic work on the Alaskan Peninsula has brought to light volcanic craters hitherto practically unknown that would not have escaped notice in an aerophotographic survey. When the work is expanded to cover the Peninsula and the Aleutian Islands, the photographs will unquestionably yield a great deal information to those interested in volcanoes.

In a smaller way airplane photography will probably come into greater usefulness in the vicinity of active volcanoes. Already Mr. R. H. Finch has made use of airplane flights in connection with volcanologic reconnaissance both in Hawaii and in California. Photographs of Mauna Loa from the air would show perhaps more graphically than topographic maps the outlines of the more recent lava flows. In case of eruption, an airplane view of the mountain would tell much more surely and speedily the trend and progress of a lava flow than would a slow trip up the rough and forested slopes on foot. The Forest Service makes use of aeroplanes to reconnoiter forest fires, so in the same way may volcanology watch the fires of a volcano.

R.M.W.

A PRESS FANTASY

The Mauna Loa flow of April, 1926, was described in the Volcano Letter at the time. It was a spectacular cascade of lava, but was no larger than most of Mauna Loa's flows. The ribbon of new lava, from its source two-thirds of the way up Mauna Loa's 13,650 feet of elevation, down to the sea, averaged not more than a half mile in width. It covered country already rather barren, and destroyed a half mile of county roads and some twelve houses at the beach.

The "Cape Argus" (April 2, 1927), Cape Town, South Africa, excites in your imagination this terrible calamity:

"Towering 1,300 feet above the blue waters of the Pacific, Mauna Loa was covered with lush green forests and waving fern trees, with dancing streams and picturesque dwellings until the eruption of last April, when, without any warning, a sea of boiling lava eddied and surged down the mountain slopes, melting the rocks, whose grandeur of outline had been one of Mauna Loa's most arresting charms, and reducing them to a shapeless mass; destroying the bridges and transforming the forest into charred and stunted remnants.

"From the snow-capped summit great jets of black liquid spouted, the air was filled with the hissing of steam, the churning of molten lava, the fumes of sulphur, the exploding of noxious gases, and no longer did one wonder why long-dead Hawaiians called Mauna Loa the 'House of Eternal Fire'."

R.M.W.

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No. 128 RELEASED WITHOUT COPYRIGHT RESTRICTION June 9, 1927

KILAUEA REPORT No. 804

WEEK ENDING JUNE 8, 1927

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

On the morning of June 2 a dense cloud of steam, due to falling moisture, was rising from the north side of Halemaumau pit. On June 4 the walls of the pit were seen to be colored dark red from the recent rains. No rocks were heard falling during this visit. The sulphur patch at the southeast bank appeared on June 6 to be a little brighter. A visit to the pit on June 8 discloses the fact that there has been an increase of rock falls. Both the north and the south walls are very dusty. Several rock trickles were heard from the north side, and a little dust was seen rising there.

During the week ending June 8 there have been only five local earthquakes recorded. In addition to these, on June 2 there is record of a faint teleseism, probably about 5,500 miles distant. The prefiminary wave arrived at 8 h., 53 m., 53 s. p. m., Hawaiian Standard Time, the secondary wave arriving approximately 9 minutes and 45 seconds later.

Early in the morning of June 8 several people in the vicinity of the volcano were awakened by a noise resembling the falling of a heavy weight or the striking of a heavy mass with a hammer. The effect seems to have been more a concussion than an earth shake. It is reported that this noise was also heard in Hilo. All observers have agreed as to the time close to 1:30 a. m. On the seismograph there is a very feeble tremor recorded at 1:29 a. m., but so small as to be certainly imperceptible as an earthquake. It resembles very much the records made by blasting a few miles from the Observatory. The night watchman at the hotel reports having seen a bright glow in the sky two or three minutes before he heard the noise. Indications are that this disturbance is not volcanic or seismic, having the appearance rather of an explosion of powder. But that such an explosion should occur at that time of night and be strong enough to awaken people at widely separated places is unusual. Diligent inquiry has not yet disclosed the cause of the disturbance.

SURVEYS AROUND KILAUEA

In 1920 a number of points in the vicinity of Kilauea were selected and permanently marked on the ground. These marks were then tied in both by spirit levels and triangulation, making a net covering about 24 square miles surrounding the volcano. The object is to repeat the surveys at intervals in the future to determine possible ground surface movements. Some of the points so tied in were points established by older surveys, and comparisons made it at once apparent that actual changes had taken place. Since 1920 there have been several surveys made for various purposes touching some of these points, and further movements have been disclosed. The leveling done by the Bureau of Public Roads and by the County of Hawaii in connection with new road work has yielded differences of elevation that are not the same as those secured by the 1920 work. In March and April, 1926, the Kilauea net was releveled, confirming the changes found by the road surveys. The elevation of the Volacno House bench-mark above the old Hilo datum was accurately determined by the modern precise methods of the Coast and Geodetic Survey in November and December, 1926, with results differing from the 1920 values, just as the 1920 values differed from the original 1912 level line. In May, 1926, a partial re-triangulation of the Kilauea net was made, and in December, 1926, the points were again triangulated, this time completely, the same accuracy being secured as in 1920. Another complete re-leveling of the Kilauea net is just now nearing completion, using a precise level and rods with graduations upon invar metal strips.

In studying the differences developed by successive surveys, the first question that arises is of course the accuracy of the surveys. Upon the answer to this question depends the decision as to whether the differences developed represent actual ground movements. The levelings in the vicinity of Kilauea have circuit closures averaging only about two tenths of a foot, yet successive surveys may yield relative elevations differing several feet. In the triangulation, accuracy represented by an average triangle closure of close to three seconds has been secured, yet some angles in the net of 1926 differ by several minutes from the corresponding angles of 1920. Clearly, these differences are too large to be ascribed to inaccuracies of surveying.

Results of these surveys are being computed, and work is being done towards the making of a systematic intercomparison of them all, with an attempt to correlate the changes with changes of tilt, and eruptive stages of the volcano. R.M.W.

ALEUTIAN STATION NOTES

Dr. Jaggar sends word from Alaska, telling of his arrival in Kodiak on May 12. It is his intention to spend the season making a reconnaissance of the volcanology and seismicity of the Alaskan Peninsula and the Aleutian Islands. He expects to establish one or two seismological stations, the one already temporarily decided upon being at Kodiak. The seismographs for this station were constructed in the shop of the Hawaiian Volcano Observatory, and others are now being made for a possible second station in Alaska. The instruments in Kodiak will probably be set up in the cellar of a building of the Agricultural Experiment Station, a settled structure about 10 years old, whose foundations are close to bedrock. This will have advantage over a new building in that the instruments will not require so long a time to adjust themselves to the settlement in new foundations. The location of the station in Kodiak may be temporary or permanent, as may be found advisable by further investigation of seismic conditions. The object is to go over the country more thoroughly before final selection is made for the location of a permanent station.

On May 17 Dr. Jaggar was expecting to make a trip around the Peninsula to Nushagak, probably returning to Kodiak about June 1. R.M.W.

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No. 129 RELEASED WITHOUT COPYRIGHT RESTRICTION June 16, 1927

KILAUEA REPORT No. 805

WEEK ENDING JUNE 15, 1927

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

Few changes have taken place in the great pit Halemaumau. Coatings of white salts have increased on the wall east of the lower southwest rift tunnel and down the north edge of the southwest talus. The hole formerly at the top of the northwest talus no longer exists, because the wall has broken away around where it was. Its outline, however, is still discernible on account of the difference in the color of the dirt there. New debris on the north talus indicates that recent slides have occurred from the wall above. By far the greater number of slides in the pit take place at this point. For some time this north wall has been kept red by peeling. Steaming in the pit is about as usual, increasing and decreasing according to the rainfall.

At 1 p. m. on June 10 dust from a slide at the northeast corner of the pit was observed.

The seismograph records for the week ending June 15 show 11 very feeble local earthquakes. During the afternoon of June 14 there were numerous traces of minute spasmodic tremor—so feeble that they have not been included in the count as earthquakes. Microseisms have been unusually feeble during the week. Tilt has accumulated moderately to the southwest.

LATITUDE VARIATIONS

In Volcano Letter No. 94 (October 14, 1926) a brief review was made of Professor E. W. Brown's evidence of fluctuations in the rate of rotation of the earth. There has since appeared in "Nature" (February 5, 1927) another paper by Professor Brown essentially the same as the first, but condensed. The question is attracting widespread interest, as several reviews and criticisms have appeared.

Mr. Walter D. Lambert has published in the Journal of the Washington Academy of Sciences a discussion of the possible correlation between the fluctuations in rate, and the variation of latitude of which he has made a study for the U. S. Coast and Geodetic Survey. Attention is here called to the fact that if the expansion and contraction of the earth is not uniform over its entire surface, so that the alteration is not symmetrical with respect to the axis of rotation, then the axis of rotation will seek a new position through the mass of the earth. The precise positions of the poles and the equator will therefore change, on account of this adjustment to the unbalanced moments of inertia resulting from the lopsided expansion or contraction. Latitudes are based upon the position of the poles and equator; such a change will affect the precise latitude of a given point on the earth's surface. The positions of the poles do change slightly, through explainable causes. But after the explainable causes have been computed and accounted for, there still remains a slight polar motion without apparent reason. Mr. Lambert shows that these remaining motions may thus be conveniently explained, if the expansion and contraction is not uniform or symmetrical with respect to the earth's axis. He states that there is indication of a correlation between latitude variations and changes in rate of earth rotation. He has made calculations, showing that the earth changes required to produce the unexplained latitude variations would be of the same order of magnitude as those required to produce the observed changes in rate of the earth rotation. Lopsided changes may, therefore, explain both of these effects.

The objection to the idea of non-uniform expansion or contraction is taken on the basis of sea-level. If expansion or contraction affects a part, only, of the earth's mass, the resulting elevation or depression of the earth's surface over that part should become immediately apparent through the change of its relation to sea-level.

There are, however, evidences of elevation or depression of certain sections with respect to sea-level. Geology speaks of elevated shore lines, or of drowned valleys. In Alaska, not long ago, a sudden elevation of shore line took place. This was probably an index of the elevation of a considerable area of the earth's surface. Such an elevation might represent no disturbance to isostatic compensation, yet through the increase of distance from the earth's axis, would represent a change of moment of inertia.

Here at Kilauea, it has been estimated that during the collapse that followed the 1924 explosive eruption, many times more material was engulfed than was ejected. Also, elevations have been lowered in the vicinity of the volcano. This has already been noted in the Volcano Letter (No. 74, May 27, 1926). The volume of material here locally involved is doubtless of too small an order of magnitude to produce the effects in question. But it may be that this engulfment is the result of a more general contraction, the volcano acting as a sensitive point for its registration.

A suggestion attributed to Professor J. W. Evans is that the variable amount of volume in the polar ice caps may affect the total moment of inertia of the earth. The volumes of these ice caps change through long periods of years. As they melt to their smaller volumes, water is added to the oceans, raising their level, and tending to transfer mass from the poles towards the equator, thus increasing the earth's moment of inertia, and so to change its rate of rotation. This would be a "lopsided" effect, since ocean and land areas are not symmetrically arranged on the earth's surface, and only the ocean masses would be changed. Therefore, Mr. Lambert points out, latitude variations would probably result, along with the change in rate of rotation. R.M.W.

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No. 130 RELEASED WITHOUT COPYRIGHT RESTRICTION June 23, 1927

KILAUEA REPORT No. 806

WEEK ENDING JUNE 22, 1927

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

Several changes have taken place at the lava pit, but nothing by which to predict an eruption. The solfataras are a little brighter on the floor and southwest talus; white salts are forming on the north wall; a new scar is on the south wall about a hundred feet below the rim, produced by a slide; the northern walls of the pit have avalanched considerably; and the ground at the east rim has moved inward slightly, as evidenced by a widening of the surface cracks. Probably most of the slides from the north walls took place on June 21, as dust clouds were seen rising about 9:30 a. m. There is some movement of the walls at the southwest rift tunnels, as slides were seen there on June 22 about 9 a. m.

Due to the strong northeast wind on June 17, great clouds of dust, resembling smoke, covered the Kau Desert south of Kilauea Crater.

The seismographs have recorded 15 very feeble local earthquakes during the week ending June 22. There is also a feeble trace of a teleseism at 8:40 p. m., Hawaiian Standard Time, on June 16. One of the local earthquakes (7:11 a. m. June 19) was of sufficient intensity to record indications of its distance, probably 11 miles. Microseismic motion is still very weak.

Moderate north tilt has accumulated during the week.

SOME POINTS CONCERNING 1927 OBSERVATIONS AT KILAUEA

Avalanches in the pit of Halemaumau have seemed to be more frequent in the afternoon than in the forenoon. If large enough, they undoubtedly make small records on the seismographs; and earthquakes may cause avalanches, if rock is ready to fall in reponse to a slight impulse. There is, therefore, a loose correlation between the two, especially during these quiet times when there are no larger disturbances present to mask the effect.

This suggested that the small local earthquakes recorded by the seismographs might be more frequent during some particular part of the day. Local earthquakes during the last eight months (October 1, 1926, to May 31, 1927) have been counted according to the hour of the day in which they occurred. The percetnages of the total for each of the 24 hours of the day are as follows: A. M.; 2.3, 3.3, 2.3, 3 1, 1.7, 3.5, 4.2, 2.8, 2.7, 3.8, 3.5, 8.1; P. M.; 5.6, 7.6, 6.0, 6.1, 5.8, 5.6, 4.4, 3.6, 4.2, 2.7, 3.5, 3.6. Thus it is seen that the early morning hours are the most quiet, with a slight increase in number during the forenoon. At 11 a. m. is an abrupt increase, and the following afternoon hours contain large percentages, decreasing towards evening. This irregular distribution is perhaps not due to seismic causes. Most of the disturbances counted are very feeble, and some of them may not be true earthquakes. Avalanches in Halemaumau apparently occur more frequently in the afternoons due to temperature and drying effects of the sun on the walls of the pit. During some of these eight months road construction has been in progress within a few miles of the Observatory, involving the blasting of rock. Some of the blasts are known to have caused records on the seismographs. The contractors usually tried to set off their "shots" just before noon in order that the workmen could be off work for lunch. These blasts are very likely the cause of the large percentage in the hour between 11 and 12 a. m., and others may also have added to the number of records made during the afternoon hours. Records made by avalanches in the pit also are added more to the afternoon numbers.

It seems possible that the true earthquakes may be evenly distributed throughout the twenty-four hours, and that the surpluses shown by these percentages for the afternoon hours are the result of non-seismic disturbances. This question should be considered in making use of the numbers of earthquakes given in the Kilauea Report. In times of more frequent earthquakes, and when no blasting is in progress, the proportion of non-seismic records would be so small as to be negligible.

Tilt, as given in the Kilauea Report, taken one week at a time, seems to have little significance. But at times when lava is in the pit, east tilt is observed to have correlation with the height of lava. During the 1926 eruption of Mauna Loa, tilt exhibited a rapid surge towards the east and southeast; a movement distinctly apart from its regular annual accumulation to the southwest and back. The source of the Mauna Loa flow was 24 miles from the Observatory. It seems certain that tilt changes are produced by volcanic activity within the mountains of Kilauea and Mauna Loa, even if evidences of that activity are not otherwise apparent at the surface. A review of this movement over the last six months is of interest. A surge of tilt towards the east during the last few days of February is a feature, and somewhat resembles the movement accompanying the Mauna Loa eruption. A rapid change towards the southwest beginning March 21 and ending abruptly on May 5, probably has some significance. It is interesting to note that the latter movement began practically at the time of the moderate earthquake that was perceptible throughout the Hawaiian group; a coincidence only, perhaps. Since May 5 tilt has been particularly sluggish, and the normal northeast accumulation seems to have begun. Values throughout the whole six months period are considerably more to the northeast than contemporary values of 1926, as if Kilauea were trying to gain back the east and northeast tilt lost during the 1924 explosive eruption.

The first three months (February, March and April) of records of the tide gauge installed at Hilo, mentioned in previous Volcano Letters, have been subjected to a preliminary analysis and comparison with the Honolulu records. It is the aim to detect possible seismic sea waves, and after a long period of time to detect possible shore line elevation or depression, but so far there has been no evidence of either. The records near March 20 were carefully inspected to see if the earthquake of that date had any effect, but there was none noted. R.M.W.

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No. 131 **RELEASED WITHOUT COPYRIGHT RESTRICTION** June 30, 1927

KILAUEA REPORT No. 807

WEEK ENDING JUNE 29, 1927

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

The working of the walls of Halemaumau pit has continued this week, though not so actively as last week. Several small slides have occurred, and one large slide was seen at the southwest at 3 p. m. on June 26. Red dirt lies thickly on the north debris slope and at the foot of the northern and western walls. Steaming is very moderate at all the vents.

A circuit of the pit was made on June 25. At this time it was noted that the cracks back of the north and northeast rims seem to have the greater movement. One of the larger northeast cracks is very hot, but not steaming. The freshness of some of the smaller cracks give the ground a very unstable appearance. The top of a prominent pinnacle which overhung the northeast rim has slid off. This must have occurred on June 21, when there were some large avalanches on that side.

There have been only nine very feeble local earthquakes recorded during the week ending June 29. Of these, four were on June 24, and on the 23rd, 27th, and 28th there were none. Tilt has accumulated moderately NNE, apparently continuing its normal annual course.

CYCLICAL VOLCANIC ACTIVITY

Among the questions now most frequently asked by visitors at Kilauea are: "Is the volcano dead?" and "When will the next eruption be?" The Volcano of Kilauea is not dead. The second question is not so easily disposed of, as the principles involved in trying to answer it are most complicated and intricate. To be able to predict earthquakes and volcanic eruptions has long been the aim of seismology and volcanology (see "Predicting Earthquakes," by T. A. Jaggar, in Scribner's Magazine, Octoebr, 1924). The lines of reasoning that have seemed most often to hit the mark are, first, to learn through local history the habits of the area in question, and second, to observe and correlate current symptoms and phenomena. The earth's forces slowly accumulate stresses that are deep beneath the surface, of which the indications are difficult to observe. Periodicity is a good hand-hold for prediction, particularly in dealing with volcanic eruptions.

The "Second Report of the Hawaiian Volcano Observatory." by Harry O. Wood, published in 1917 by the Massachusetts Institute of Technology, sets forth in considerable detail the "Cyclical Variations in Eruption at Kilauea." Here the habits and history of activity of the volcano have been systematically studied. A great number of natural phenomena have definite periods; cycles of similar action repeated again and again. Most familiar to us are day and night, summer and winter, high and low tides. Volcanic activity is probably the result of a combination of causes, many of which are of periodic nature. Tides are caused in the waters of the ocean by the gravitational attraction of the sun and moon. In the earth's stiff crust stresses are set up to resist these deforming attractions, in spite of which a slight tide also exists in the solid earth. These earth stresses and tides doubtless affect volcanic action, and have seasons of greater intensity just as the ocean has spring tides. If the action of a volcano depended upon only one such simple periodic cause, it would perhaps erupt with perfect regularity. But there are probably many causes, some orderly and periodic and some irregular, few of them well understood, and it is the combined result of them all that is reflected in volcanic action. Cycles of gas pressure accumulation and release, of chemical reaction, and of geyser-like action in slow subterranean flow of viscous magma; slow changes due to isostatic adjustment; accidental effects as choking of vents, or draining off of lava through newly formed earthquake cracks; these are some other suggested causes. Periodic effects combined, in general, yield a periodic resultant with a cycle long in time, as only occasionally will the individual effects work together in harmony. Thus if observations are studied over a considerable length of time, and periodicity is discovered, periods of equal time may be projected into the future as a basis for forecasting.

Tidal effects, semi-monthly and semi-annual in period, are to be expected, and appear to have been recognized in observation. Thus Mr. Wood suggests that early summer and winter are times favorable to eruption, while early spring and fall induce quiet. An effect having a seven-year period seems to exist, perhaps being correlated with latitude variations (see Volcano Letter No. 129, June 16, 1927). The combined resultant of these and other periodic effects has been estimated to have a cycle 130 years long; a result derived by independent investigators, and apparently justified by observation.

The history of Kilauea reveals other quiet periods like the present one. Old residents here remember the relatively dormant period between 1894 and 1907, when people were asking then, just as they are now, "Is the volcano dead?" Could they have then foreseen the high lava activity of 1920, and the explosions of 1924, the question would have seemed ridiculous. The present quiet phase is but part of the cycle of the volcano; history repeating itself. As time goes on, a longer recorded history will be available for the study of periodicity; the symptoms of accumulative and accidental effects will become better understood; causes will be recognized, and forecasting will rest on a firmer foundation. R.M.W.

ALEUTIAN STATION NOTES

From Alaska, Dr. Jaggar reports favorable weather and convenient transportation. The cooperation of other Government Departments, and of individuals, is making a success of his reconnaissance (see Volcano Letter No. 128, June 9, 1927). His trip is covering the Aleutian Islands and the Alaskan Peninsula as thoroughly as may be in the time at his disposal, both by land and water. The Coast Guard cutter takes him to Attu and to the Pribilof Islands, arrangements have been made to go to the far west Aleutian Islands. He will go around Pavlof Bay by power boat, and expects to explore Pavlof Volcano. He has been into Bristol Bay and back to False Pass. It is expected that a second seismograph will be installed at Unalaska. R.M.W.

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No. 132 RELEASED WITHOUT COPYRIGHT RESTRICTION July 7, 1927

KILAUEA REPORT No. 808

ENDING JULY 6, 1927

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

New lava began to flow into the pit just before 1 a. m. on the morning of July 7. The Kilauea Report, as follows, had been prepared but had not been sent to press. It applies to the last week, and is here presented as a preface to the events of July 7:

Avalanchings have continued this week at Halemaumau, particularly at the northeast, where cave-ins have formed a large bay. Dust from slides can very frequently be seen there. The northeast talus has much new debris. Many slides are also occurring at the southwest rift tunnels. Several wide, gray streaks on the south-southwest talus, three of them reaching to the foot, mark the courses of tumbling bowlders. The north wall of the pit has fresh scars. A pinnacle and several overhanging blocks at the north-northeast are about ready to fall.

The cracks developing parallel to the east and northeast rims of the pit of Halemaumau, first mentioned in Volcano Letter No. 130 of June 23, have continued to widen steadily. These cracks in which movement has been noted vary in distance from the edge of the pit, few of them being back more than 50 feet. There is about 1,500 feet of ground along the rim that has shown motion in this manner. Avalanching has been considerable during the past months at the northeast rim of the pit, and it seems as if the ground that has been gradually falling away there has been acting as a keynote to the horizontal arch of the pit walls. The gradual disintegration of this keynote has thus allowed this long section to slump inward slightly. The widening of these cracks suggests the probability of increasing avalanching on the east and southeast sides of the pit, which have heretofore been more stable than the other sides. This is the part of the rim most frequented by visitors, and it has been thought advisable to warn them to cross these fresh cracks with caution. Measurements are being made to determine the rate of motion.

During the week ending July 6, the seismographs have recorded 10 very feeble local earthquakes. In addition to these, on July 3 at 12:15 a. m. Hawaiian Standard Time, there is a very faint trace of a teleseism. No phases are distinct enough to indicate the distance.

Microseismic motion has been somewhat more feeble than normal. Tilt has accumulated slightly towards the east.

The foregoing report was prepared on July 6. Early in the morning on July 7 the night watchman at the Volcano House saw a glow at the pit, and awakened the people at the hotel. Mr. James K. Tsuchiya spread the news through the neighborhood. The lava probably came into the pit shortly before 1 a. m. People who were awake at midnight have reported nothing unusual. There was no disturbance to awaken people, and the fountaining in the pit probably began gradually. The seismographs show two very feeble local earthquakes at 11:12 and 11:46 p. m. July 6, which in no way differ from the many recorded during the last months. Harmonic tremor commenced rather definitely at 12:32 a. m. July 7, and probably marks the beginning of release of lava, though perhaps at the very beginning it was coming up through cracks or loose talus, so that glow was not immediately visible. The night watchman was inside the hotel until nearly one o'clock, when he was due to make his regular inspection of the premises. He saw a rather faint glow, which brightened rapidly as he watched it, and he then notified the manager of the hotel. By a few minutes after one, there were many witnesses, and the first cars reached the pit at about 1:40 a. m.

There are four fountains of lava, nearly in the line of the 1920 rift; that is, along the NE and SW diameter of the pit. The one to the southwest is a short distance up the talus slope, just beneath the 1920 rift tunnels. From it a river of lava is running down the talus to the lake forming on the floor of the pit. The second fountain is near the base of the big SW talus, and from it two short lava rivers are flowing down. The third fountain, smaller than the others, is near the edge of the lake, and at the bottom of the same SW talus. The fourth fountain is on the other side of the pit, near the bottom of the NE talus, and its source is below the level of the lake. The three larger fountains are spouting lava over 100 feet into the air, and all are rapidly building spatter cones. The level of the lake, now of irregular shape, is about 1,500 feet long and 900 feet wide. It is slowly rising, as the fountains feed it. The surface is rather placid, being broken by the usual red cracks between the slowly moving blocks of the cooler crust. Around the rim of the pit, new "Pele's hair" can already be found, and a small amount of light, forthy spatter has been brought up by wind and deposited near the edges of the pit.

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No. 133 RELEASED WITHOUT COPYRIGHT RESTRICTION July 14, 1927

KILAUEA REPORT No. 809

WEEK ENDING JULY 13, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Lava is still flowing into the pit, though perhaps with diminishing activity. The flowing from the southwest cone is gradually filling the lake through channels that are crusted over and invisible. The flow shows glowing cracks, and occasional red toes of liquid lava are thrust out. At night the crack patterns are most interesting. There has been only a little glow from the pit during the latter part of the week.

The seismographs have recorded 20 earthquakes during the week. One of these, at 3:21 a. m. July 7, a little over two hours after the outbreak of lava in the pit, was moderate; all the others were very feeble. The moderate shock had an indicated distance of 35 miles. It was reported as felt in many parts of the Island of Hawaii. A perceptible earthquake was reported in Kona at 20 minutes after midnight, July 7. A preliminary trace of harmonic tremor occurred at 10:55 p. m. July 6, and lasted 17 minutes. Harmonic tremor definitely began at 12:32 a. m. July 7, and the lava broke out a few minutes later. At 1:25 a. m. July 8 the harmonic tremor faded out, though there were a few recurrences for a few minutes at a time during the rest of that day. It has not been strong enough to show anything but very feeble traces since the 8th. Tilt has been slight to the NNW.

NEW LAVA IN HALEMAUMAU

The coming of lava into the pit of Halemaumau occurred just in time so that the beginning of the flow was described in the last number of the Volcano Letter. The lava spouted into the pit very vigorously during the first few hours, but began to show diminishing energy during the day, and the small fountain ceased action about 5 p. m. July 7. The lake formed on the bottom of the pit rose to an elevation of 2,480 feet above mean sea level, the old floor level being at 2,392 feet. The lava in the lake was quite fluid, as the waves induced by the convulsions of the northeast fountain could be seen to cross to the opposite side of the lake. During the early morning hours of July 8 two more fountains ceased action, and the molten lava of the lake partly drained out, perhaps flowing down the vent of the northeast fountain when the active lava retired at that place. When daylight came, it was seen that the cooled surface of the lake had collapsed about 10 feet, leaving a shore line bench around the edges. A sector of spatter on this bench and adjacent talus indicated about where the northeast fountain had been. Two little cones mark the site of the short-lived small fountain, and a larger spatter cone, whose summit elevation is 2,520 feet, marks the position of the fountain at the base of the southwest talus. These cones are above the lake, so that the collapse did not disturb their formations as it did in the case of the northeast vent. The remaining action was confined to the southwest fountain, which had built around itself a spatter cone about 40 feet high above the talus upon which it is built, and its summit elevation was then 2,602 feet. Down the side of this cone, from a low edge of the hole in its summit, lava was pouring in a large, steady stream. The lava was building a steep delta down to the edge of the collapsed lake, and was beginning to flow out on top of the depressed lake surface.

The more quiet phase thus begun on the morning of the 8th has continued since. Lava has been flowing uninterruptedly from the cone, but it has been becoming less and less spectacular. The spatter from the fountain encased within the cone has built the cone higher, and it has capped itself over. The lava stream gushing forth from the base of the cone has gradually built itself a roof. Occasional interesting action is seen when this stream becomes clogged and the lava breaks out and flows on the surface for a while; or when the cap of the cone collapses or is blown off, and a glimpse is obtained of the energetically boiling lava within. The lava from the cone forms a miniature pahoehoe flow which is gradually covering the surface of the collapsed lake. The front of this flow has progressed slowly, by uneven spurts, so that by July 13 it has reached the site of the dead northeast fountain, and has covered most of the surface of the collapsed lake; the northwest bay being still uncovered. The southeast shore line bench of the lake has been covered by the flow, as the flow is higher here near its source. The flow has not yet reached the elevation of the bench at the east and north sides of the lake, though the collapsed part of the lake is covered on these sides.

Action so far is of a minor sort only, when compared to the usual lava displays of Halemaumau in past years. The new lava in the bottom of the pit, including lake, cones and delta, covers an area of but 30 acres. This outbreak is much the same as that which occurred in 1924, about two months after the explosive eruption. At that time lava came into the pit on July 19, spurting from a source on the southwest talus. Lava continued to flow, but with diminishing vigor, till July 29, when it ceased, and there has been no active lava in the pit until the present outbreak. The present active cone is not far from the position of that of 1924.

The very energetic manner in which the lava first appeared a week ago perhaps represents the effervescence due to the sudden release of pressure upon breaking through into the pit. The steady persistence in the activity of the one remaining cone is an encouraging sign for continued activity, though action does not seem as strong on the 13th as during the preceeding days of the week.

R.M.W.

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No. 134 RELEASED WITHOUT COPYRIGHT RESTRICTION July 21, 1927

KILAUEA REPORT No. 809

WEEK ENDING JULY 20, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

The flow of lava into the pit of Halemaumau has been diminishing during the week. The volume of new lava poured into the pit on July 7, the first 24 hours of the outbreak, represents about half of the total accumulated to date. The flowing from the southwest cone has been continuous, though fluctuating in amount, until July 19. The top of the cone has in general remained open towards the southwest, parts of its walls or roof being blown off from time to time. On July 19 the flow ceased during part of the day, though lava flowed from the cone at 3 p. m. and during the evening at about 9 p. m. Inspection of the pit on the morning of July 20 showed no lava flowing; no active lava was visible down the throat of the cone, and only a very thin trace of blue fume was issuing from its mouth.

The number of earthquakes recorded during the week ending July 20 is 18. These were all local and very feeble. Harmonic tremor does not show on this week's seismograms. In addition to the above local earthquakes, a feeble teleseism is recorded; its long wave beginning at about 1:34 p. m. July 14. Tilt has accumulated moderately towards the northwest.

SOME ALEUTIAN VOLCANOES

In a wireless message from Dutch Harbor, Alaska, Dr. Jaggar tells of a most interesting fortnight spent in the western Aleutian Islands. He went with the Coast Guard Cutter to Attu, and returned to Dutch Harbor July 8, having seen some 20 big volcanoes on the trip. He is high in his praise of the region as a field for volcanological study. Gareoli, an island-volcano over 5,000 feet in height, is a cone from which yellowish steam is issuing. Tanaga, a wonderful composite cone covered with cinder, is the eastern neighbor of Gareoli. Semisopochnoi, to the west of Gareoli, is shown on the chart as having "burning volcanoes." The present report speaks of sedimentary rocks, such as sandstones and conglomerates, in abundant occcurrence on the south side of this Aleutian belt, which are perhaps comparable with the rocks found near Unga.

Bogoslof Volcano is of especial interest. The island, which is the top of the volcano, has changed its formation many times. Passing ships have reported from time to time the appearance of new summits, or the disappearance of old ones, and an occasional eruption has been witnessed from a distance. Sidney Powers, in the "Geographical Review" September, 1916, gives a brief sketch of the history of the volcano. He gives the date of the first formation of the island as 1768. Another island developed nearby in 1796, and still another in 1883. These were at first separate islands, the last mentioned being a precipitous plug pushed up from a volcanic orifice to a height of 800 feet above sea level. These islands changed in form during the years up to 1906, when another plug, 2,000 feet in diameter and 400 feet in height above the ocean, was pushed up into the group. A few months later this was partially blown away, and still another plug rose by its side, being in turn partly destroyed by an explosion in 1907.

In the Technology Review, Vol. X, No. 1, is the "Journal of the Technology Expedition to the Aleutian Islands, 1907," of which expedition Dr. Jaggar was himself in charge. Bogoslof was visited in August, 1907, and the Journal has a number of photographs of the steaming summits, which at that time had become joined together by volcanic additions and by sand and gravel bars into a single island. Sketch maps show the development of the island as reported by various observers up to that time.

Activity since 1907 has been only casually observed by passing ships or by distant witnesses on the nearer neighboring islands, Unalaska and Umnak. Dr. Jaggar's recent visit has shown him the result of the many active phases since 1907. He reports a new steaming lava dome, 1,200 feet in diameter and 200 feet high, which is surrounded by a salt lagoon, in which the water is warmed to 75° Fahr. Around the lagoon is a complete ring of gravel and sand, which forms the connecting link between the summits that were separted by open channels prior to 1906. New Bogoslof or Grewingk Island, the northern peak that appeared in 1883, he reports much changed in form since 1907. Old Bogoslof, the peak of 1796, is now surrounded by a high bank of gravel. The island is tenanted by great numbers of sea-lions, a count up to 400 having been made. Murres and other nesting birds are present by the million. The latest phase of volcanic activity probably began about July, 1926, and increased thereafter with occasional explosions which were seen from distant villages on the neighboring islands. This recent activity was probably very similar to the eruption of 1906. There is no continuous accurate record being made of these phenomena.

This is all but a sample of the area of volcanic and seismic activity that the region has to offer. Katmai and the Valley of Ten Thousand Smokes, Pavlof Volcano and many others are available for study and research. Dr. Jaggar suggests that Dutch Harbor, on Unalaska Island, is an ideal place for a Government scientific research station, not only for the study of volcanology and seismology but also geology, biology and botany. For these investigations, and for coast, geodetic and topographic surveys, such a station would be an admirable base for the whole Aleutian belt. R.M.W.

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No. 135 RELEASED WITHOUT COPYRIGHT RESTRICTION July 28, 1927

KILAUEA REPORT No. 810

WEEK ENDING JULY 27, 1927

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

There has been no renewal of flowing lava in Halemaumau pit. Glow and fumes are absent from the southwest cone, but at night there is still some glow to be seen in the cracks of the pit floor. Steam vents in the pit are quite active, particularly on the south and northwest taluses.

There is considerable working of the walls of Halemaumau, most of this being on the northeast side. The ground back of the north-northeast and northeast rims is breaking up, forming many small new cracks as well as widening the old ones. Debris falling from this side of the pit has covered a very large section of the new floor and partly filled the depression between the north-northeast and northeast taluses. Frequent avalanching has occurred. On July 21 at 9:10 a. m. a cauliflower dust cloud rose from the pit, hanging over it for about five minutes. At 2 p. m. July 22 there was dust from slides at the west boss, and stones could be heard falling there. On July 24 dust hung over the pit in varying quantities all day, and there was almost constant avalanching from the north-northeast wall. The two bowlders on the north-northeast talus, which have served as landmarks, have disappeared under new debris.

This spurt of avalanching, together with the widening of old cracks and the opening of new ones around the rim of the pit, is similar to the action noted in Volcano Letter 130, on June 21 and 22, which was at that time considered due to natural disintegration of the walls. There was then a very slight increase in the frequency of earthquakes, of which two gave indicated distances of 11 and 25 miles. About 16 days later lava came into the pit, and it seemed that in some way the presence or release of active lava stabilized the walls, so that instead of the increased avalanching expected from the development of the cracks, there was in fact a decrease of avalanching. An avalanche was reported on July 18 in Makaopuhi Crater. On the 19th lava ceased to flow into Halemaumau. Now, on the 23rd to the 25th comes another spurt of avalanching and development of cracks at the rim, which is in turn about 16 days after the outbreak of lava. This time the avalanching is accompanied by a swarm of earthquakes, two of them feeble and three slight, definitely drawing attention to the presence of volcanic forces. Whether the possible changes in conditions at the pit will be towards increase or decrease remains to be seen.

During the week a total of 21 earthquakes have been recorded. On July 24 at 6:05 a. m. there was a slight shock that may have been felt. The next day, at 2:07 a. m. and at 6:13 a. m., there were slight shocks that were felt at the volcano and in Hilo, and possibly elsewhere. On the same day also, a feeble shock occurred at 11:56 a. m. On the 26th another feeble earthquake occurred at 1:29 a. m. All others in the above total were very feeble. Three of the stronger shocks had indicated distance of 25 miles. Tilt has accumulated very slightly to the west.

COAST RANGES FROM THE AIR

Through the courtesy of Major General J. L. Hines, Commander of the Ninth Corps Area, U. S. Army, San Francisco, California, the undersigned was permitted to make an airplane trip over the Coast Range mountains between San Francisco and Clear Lake during the forenoon of April 4, 1927. The plane was very successfully piloted by First Lieutenant H. A. Moore. The course taken was to Calistoga and thence just to the east of Mount St. Helena and north to the southeastern part of Clear Lake, Mount Konocti, with a fairly distinct crater remnant in its southern peak, was passed, and the return to San Francisco was made about 18 miles west of the outgoing course.

Deep erosion valleys that trend the same as the mountain ranges, that is, northwest-southeast, showed up very distinctly. Layers of rock that showed up as systematic bands were noted on the east slope of Mount Konocti. From the varying extent of the erosion it appeared that there was considerable difference in age between the different mountains. Most of the mountain ranges appeared to have steeper slopes on their western sides than on their eastern sides, as though they had been formed by some mighty force shoving at the country from the east.

The airplane method of making a reconnaissance in this country is especially time-saving, as on foot one encounters dense underbrush of live oak, manzanita, and poison oak.

R. H. Finch.

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No. 136 RELEASED WITHOUT COPYRIGHT RESTRICTION August 4, 1927

KILAUEA REPORT No. 811

WEEK ENDING AUGUST 3, 1927

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

Avalanches continue to be rather frequent at Halemaumau, some of them making considerable noise and dust. Slides are occurring on all sides of the pit, though the largest seem to come from the north walls. Steam vents are moderately active, the one on the northwest talus being very flocculent.

A circuit of the pit was made on August 3. A close view of the northeast wall, from the north side, reveals many loose blocks in the vicinity of the northeast dike.

During the week ending August 3, there have been 18 local earthquakes recorded. Of these, there were four that were perceptible, all the others being very feeble. The perceptible shocks were recorded at 11:31 a. m. July 29, 2:14 a. m. on the 31st, 8:40 p. m. August 1, and at 9:42 a. m. on the 3rd. The first three were of the barely perceptible sort, having indicated distances of 39, 16 and 15 miles, respectively.

The fourth earthquake, on August 3, was the heaviest registered or felt at the Volcano for some time. Both seismographs were dismantled, and the disturbance was felt by nearly everyone. Windows were rattled slightly, and a moderate avalanche which occurred at the time was probably precipitated by the shock. Captain R. V. Woods reports that his seismograph in Kealakekua, Kona, was also dismantled, and the earthquake was pronounced there the strongest for some time. It was strongly felt in Hilo, causing considerable excitement and a small amount of damage due to merchandise being thrown from shelves in a store. The seismograph at the Brother's School was dismantled, first indicating a distance of 34 miles from Hilo to the origin of the earthquake. The indicated distance from the Volcano was 16 miles. These distances are misleading if the origin of the shock was a general slip along the main Hawaiian rift. Other reports have not yet had time to come in, but it was undoubtedly felt throughout the Island of Hawaii, and probably on the other islands also. This earthquake seems upon preliminary inspection to have characteristics similar to that which occurred on March 20, 1927, and is perhaps stronger than that one. In both cases the seimographs failed to record the maximum intensity, as the early movements of the shocks dismantled the instruments. One of the seismometers that is being developed by Professor Kirkpatrick (see Volcano Letter No. 126 of May 26, 1927) indicates maximum acceleration in the E-W component of between 50 and 90 mm. sec. per sec.; degree of perception also suggests intensity No. 3 on the Rossi-Forel scale.

Since July 24, beginning as noted in the last issue of the Volcano Letter, there have been nine shocks of sufficient intensity to be perceptible. This is a very distinct and sudden increase in earthquakes of this type. Most of them have been felt all over the island. This latest shock is perhaps but one of the series, being featured by greater intensity.

There has been no sign of return of lava. Both Mauna Loa and Kilauea are being closely watched for symptoms that may be correlated with this increase of seismic action.

Tilt has accumulated moderately to the NW.

HOT SPRINGS IN THE COAST RANGES NORTH OF SAN FRANCISCO

A considerable portion of Napa, Sonoma, and Lake counties, north of San Francisco Bay in California, is covered with lava of comparatively recent geologic age. The lava caps most of the Coast Range mountains which traverse this region. At many places hot springs and geysers are to be found. The geysers, for the most part, are not natural in that their vents were formed by drilling through the material that confines the steam and hot water.

To ascertain whether there is any appreciable variation in the temperatures of the hot springs, it is a part of the work of the Lassen Volcano Observatory to make systematic measurements of their temperatures. The temperatures of nearly all springs in California were measured several years ago, and appear in Water-Supply Paper 338, Springs of California, by G. A. Waring, U. S. Geological Survey. There is thus a basis for comparison already established.

The temperatures of a majority of the hot springs in the above mentioned region were measured in March, 1927. It was found that some of the springs were hotter and others colder in 1927 than when they were measured by Mr. Waring in 1908.

Varying rainfall and weather conditions affect the temperature of many of the springs. In order to accurately detect slight variations in temperature the measurements should be taken at about the same time each year.

R. H. Finch

THE CHINESE EARTHQUAKE

The death toll, at first exaggerated, of the Kansu Province earthquake has recently been before the public eye in the papers. It has taken over two months for the details to get out to civilization. Seismologists the world over knew of the occurrence of the earthquake, and knew its position, within a few hours after it happened (see Volcano Letter No. 127, June 2, 1927). R.M.W.

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No. 137 RELEASED WITHOUT COPYRIGHT RESTRICTION August 11, 1927

KILAUEA REPORT NO. 812
WEEK ENDING AUGUST 10, 1927

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

The pit of Halemaumau is now comparatively quiet, conditions being apparently much the same as during the months before the July activity. Avalanching has been quite frequent, and new scars can be seen on nearly all sides of the pit. Cave-ins have so undermined the northeast wall that more or less continuous avalanchingg can be expected there for some time. On August 7 an observer on Uwekahuna Bluff saw blocks dropping from the usually stable southeast wall.

During a circuit of the pit on August 9 strong odor of sulphur dioxide was noticed at the north rim. This odor has been noticed at th s point many times before, but not so strongly. The bowlder marking the north rim station has fallen in.

The new lava floor is stained white at the foot of the southwest talus. Steam vents in the pit do not seem to change in any way.

Fourteen very feeble local earthquakes have been recorded during the week ending August 10. In addition to these local shocks, there is a feeble record of a distant earthquake at an estimated distance of 4,250 miles; the arrival of the preliminary wave recorded at 3:17 a. m. Hawaiian time, August 9. Two very faint traces, probably teleseisms, are recorded at 11:43 a. m. on the 5th, and at 1:45 a. m. on the 10th.

Tilt accumulated slightly towards the south during the first part of the week, but the motion then reversed, so that the net accumulation for the week is practically zero.

MIGRATION OF EARTHQUAKE REGIONS

The systematic progression of the epicenters of successive major earthquakes in a definite direction in the same zone has been many times observed. Along the whole length of a given fault or rift zone in the earth's crust stresses may slowly accumulate, finally producing fracture at some weak point. Such an earthquake releives the stress at that particular point, only to add stress at adjacent localities each way along the line of weakness. The next fracturing stress will so accumulate in one of these adjacent regions, making the progression along the fault. Thus the Kansu Province earthquake of May 22 is found to be in about the same latitude, but some 250 miles to the west of the similar great Chinese earthquake of Dec. 16, 1920. The westerly progression checks with the known east and west direction of the main faults.

A more general analysis suggesting the migration of whole seismic zones is briefly set forth in the paper "On a Long Period Fluctuation in Latitude of the Macroseismic Zone of the Earth" by Torahiko Terada and Naomi Miyabe (Proceedings of the Imperial Academy, Japan, May 1927). Earthquakes in certain regions have been divided into groups of fifty years each, and the mean latitude for the shocks of each group computed. Graphs of these means for the past several hundred years have been plotted for the following regions: (1) Eurasia; (2) North and Central America together with the West Indies; (3) South America; (4) China, by itself; (5) Japan. For comparison, there have also been plotted on the same time scale a curve representing tree growth and the curve representing the fluctuations in the rate of rotation of the earth as given by Prof. E. J. Brown (Volcano Letters No. 94, Oct. 14, 1926, and No. 129, June 16, 1927). Graphs (1), (2) and (4) are in remarkable agreement, showing most clearly a dim nishing north latitude from about 1725 to 1825, followed by increasing north latitude to the present time. Graph (3) seems to exhibit correlation if decrease of north latitude is accepted equivalent to increase of south latitude, suggesting migration of the same direction in the two hem.spheres. The curves representing tree growth and earth rotation also show remarkable correlation, as if the long period fluctuations in earth's atmosphere rate of earth rotation and position of earthquake zones may all be inter-related in some manner. Perhaps latitude variation and the long period of variation in volcanic activity may also be involved with the same suggested relation. The migration of the earthquake zones in Japan is represented by two graphs, giving the fluctuations in both latitude and longitude. The latitude graph does not show direct correlation with the others mentioned above, but a suggested explanation is given. R.M.W.

A MUSEUM FOR LASSEN NATIONAL PARK

A museum to make better known the natural history of Lassen National Park was opened with a formal dedication ceremony on July 4, 1927. It is located near the northwestern entrance to the Park. The museum was erected by Mr. and Mrs. B. F. Loomis as a memorial to their daughter Mae and they plan to turn it over to the National Park Service as soon as the boundary of the Lassen National Park is extended to include the area in which the museum is located. The most striking part of the exhibit is the pictoral history of Lassen Peak. There are pictures showing the condition of the peak prior to the outbreak in 1914, numerous ones showing the progress of the eruption, and others showing Lassen as it is today. There is a good display of the different kinds of lava to be found in the park and the mounted wild life exhibit is quite complete. R. H. Finch.

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No. 138 RELEASED WITHOUT COPYRIGHT RESTRICTION August 18, 1927

KILAUEA REPORT No. 812
WEEK ENDING AUGUST 17, 1927

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

Halemaumau pit has evidently settled down for a quiet period, following the spell of avalanching of several days ago. Four visits to the pit during the week fail to reveal any striking changes. There are a few new scars on the north and northeast walls, and the northeast talus overlaps the new floor a little more. Several bowlders have also rolled out onto the floor. Small slides can frequently be heard, but seldom can they be seen unless they make dust. The white stain on the lava floor has increased, some of it being slightly tinged with yellow. Steaming is very moderate.

During the week ending August 17 the seismographs have recorded but seven earthquakes, all local and very feeble. Tilt has accumulated slightly NNW.

WHAT IS EARTHQUAKE INTENSITY

The Rossi-Forel scale for grading earthquakes according to their intensities (see Volcano Letter No. 124 of May 12, 1927) illustrates the century-old practice among seismologists of making and using such classifications. The practice has been supported by some investigators and decried by others, but that it is generally accepted is shown by the fact that more than 27 such scales, all different, based upon seismographic measurements, arbitrary mechanical effects or personal emotions, have been constructed and used.

This confusion of scales would have been avoided if the makers had had any definite agreement or perhaps more definite ideas as to what they were attempting to grade. "Intensity," as applied to earthquakes, at first appeared to be a term without precise meaning, but the later scale-makers all agree that it is the destructive mechanical effect, rather than the degree of ensuing panic, which properly characterizes the intensity of an earthquake. But how is the destructive power of an earthquake to be stated numerically? Holden, in 1888, on the authority of Milne and other workers in Japan, introduced the idea that a destructive intensity scale was the same as a scale of maximum accelerations. The argument for this view was partly theoretical and partly the result of some approximately successful Japanese experiments. Accordingly Holden devised an absolute or dynamical scale, in which each degree meant an earthquake having a certain, stated, maximum acceleration.

Since Holden's work, scales similarly based upon maximum acceleration have been brought out by Omori, Cancani, Wood, Milne, McAdie, and perhaps others, but no one offered a conclusive demonstration that maximum acceleration and destructiveness really do go hand in hand. This is an important postulate and would seem to deserve investigation. As it is, the scales furnish us with many different answers to the question of what acceleration will be required, say, to knock down a given fence. One feels that there would not be so many if it had first been more critically asked whether or not there is any one unique acceleration which is necessary and sufficient to accomplish this destruction. The present writer believes that there is not, but that the acceleration required all depends upon the circumstances of its application; that is, upon the period and amplitude of the disturbance which brings it.

For example, let us consult some of the scales to learn what maximum acceleration will suffice to destroy an average frame house. Omori puts it at 4,000 millimeters per second per second; Wood gives from 1,200 to 3,000; Holden 1,200, as nearly as can be interpreted; while Cancani apparently considers 500 to 1,000 as sufficient. Nothing is said about periods or amplitudes. Now with these figures in mind take a C tuning fork, vibrating 512 times a second, and apply its stem to a door panel or a wooden table top. The wood is thrown into vibrations which can readily be felt with the fingers. With a little trouble the amplitude of vibration can be measured. It may be one one-thousandth of an inch or more, but to be on the safe side we shall here assume that it is only one tenth of this amount. Putting this into millimeters, and applying a formula well known to physicists, we obtain as the maximum acceleration of the wood particles 26,400 millimeters per second per second, or more than six times the highest estimate above for the destruction of wooden structures. It may be noted that the door or table survives the experiment unharmed.

This extreme case shows that the intensity-acceleration proportionality is certainly not of general applicability. A big accereation with a small period is harmless. Apparently the period should be given seperate consideration in the establishment of the true meaning of intensity. It would perhaps be more nearly correct to define intensity as a quantity proportional to the product (maximum acceleration) x (period). It is easily shown that this is the same thing as putting intensity proportional to the ratio of amplitude to period. This tentative suggestion, with any others covering this same question, await a test which can only come by systematic observation of the destructive effects of a large variety of accurately measured earthquakes.

Paul Kirkpatrick.

HAWAII TERRITORIAL FAIR EXHIBIT

At the Territorial Fair, which opens in Honolulu on August 29, there will be an exhibit of photographs and lava specimens from the vicinity of Kilauea Volcano. The Hawaii National Park will exhibit jointly with the Hawaiian Volcano Observatory. The Observatory will show a seismograph which was constructed in its own shop, and there will be a short moving picture shown of the 1926 Mauna Loa flow. In order to furnish information to those not already acquainted with the history and work of the Observatory, the Volcano Letter for next week will deal briefly with these subjects. A number of extra copies will be printed and furnished for free distribution to those interested at the Fair.

R.M.W.

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No. 139 RELEASED WITHOUT COPYRIGHT RESTRICTION August 25, 1927

KILAUEA REPORT No. 813
WEEK ENDING AUGUST 24, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Kilauea Volcano continues dormant, and very few changes are to be noted in the lava pit, Halemaumau. During a walk around the pit on August 18 a faint odor of sulphur dioxide was noticed at the fourteen-ton bowlder on the east rim and also at the north rim, and a few rock falls were heard. On August 23 the only changes appeared to be an increase of the white salt coatings on the north and northeast walls and of the white and yellow stains on the lava floor. A crack at the southeast rim seemed to have been in motion. Steaming was very slight. On August 24 there was increase of steaming due to the wet weather.

During the week ending August 24 there have been 26 local earthquakes recorded, all very feeble except one which was registered at 9:22 p. m. August 23. This was feeble and hardly strong enough to be perceptible. Its indicated distance from the Observatory is 25 miles. On August 17 a swarm of very feeble tremors was recorded, and a similar swarm came on August 20. Faint traces of tremor, occasionally visible between the counted earthquakes, suggests that each swarm represents a continuous though very feeble disturbance, perhaps similar to harmonic tremor. Very slight south tilt has accumulated during the week.

THE HAWAIIAN VOLCANO OBSERVATORY

The Hawaiian Volcano Research Association was founded in 1911 by business men of Honolulu as an organization to promote volcanological research, and to establish the Observatory at Kilauea. Professor T. A. Jaggar of the Massachusetts Institute of Technology was secured to take charge of the work; and additional funds towards the support of the project were also furnished through the Institute. The seismograph cellar and the main laboratory building were constructed in February, 1912, and detailed routine records of activity have been kept ever since. The station was transferred to the United States Government in 1919, and was operated under the Weather Bureau until 1924, when through governmental reorganization it was changed over to the Geological Survey under the Department of the Interior. The Research Association has continued its full collaboration throughout these different transfers. The Hawaiian Volcano Observatory, therefore, now represents this combination of interests. Professor Jaggar has remained in charge since the beginning; he is now Chief of the Volcanology Section of the Geological Survey, and a director of the Research Association. In the former capacity he is also in charge of volcanologic stations in California and Alaska. Under his direction the Observatory operates subordinate seismological stations at other places on the Island of Hawaii.

Kilauea Volcano is an excellent subject for volcanological study. It is an active volcano, yet being ordinarily non-explosive, it is relatively safe and may be studied at close range; it is accessible; its activities are confined to a region conveniently within the scope of a single station; Mauna Loa, also active, is close by and furnishes additional phenomena for study; there are great numbers of local earthquakes as clues to its moods; it is in the middle of the wide circle of earthquake zones defined by the shores of the Pacific Ocean; it is American territory.

The aims of the Observatory are: To keep detailed records of Hawaiian volcanism; to attract to Hawaii volcanologic specialists and scientists interested in allied subjects; to make available elsewhere the knowledge gained in Hawaii concerning volcanoes and earthquakes. The work of the Observatory is under the general heading of Geology. The mountain's structure, its features and faults, its interior mechanism, statistics of its eruptive habits, details of its individual lava flows and eruptions, the character of its ejected material—these are all main lines of investigation under the general heading. Various branches of science are used as tools for observation. Seismology is most important, as the local earthquakes and tremors are in fact the heart-beats of the volcano, and tilt is its respiration. Chemistry gives the analysis of lavas and gases, and is a key to some of the reactions within the volcano and to the behavior of lava at the surface. Astronomy, through the tidal effects of lunar position, helps in the study of the periodicity of eruptive phases. Geodesy provides methods for measuring the stretching, warping and bulging or collapse of the ground surface near the volcano, and also checks the tilt; gravity measurements indicate interior densities. Meteorology suggests correlations such as weather and barometric pressure with volcanic activity. Hydrography and topography show the shape of the volcano, and the former includes knowledge of tides and fluctuations in mean sea level. Engineering is represented by the boring of wells and holes in the crater floor, for the study of sub-surface strata and temperatures. Photography, microscopy, radio, all do their part.

The cooperation of the U. S. Coast and Geodetic Survey has been very valuable in furnishing precise levels from Hilo to Mauna Loa, in making gravity determinations at Hilo, Kilauea and on Mauna Loa, and in establishing a tide gauge at Hilo. The regular operations of that Survey, and of other organizations and individuals, give much data useful to the Observatory along the lines suggested above.

Results of the study of special problems, tabulations of routine observations and discussions concerning them, are printed in the regular publications and reports of the Observatory, or appear as articles in the scientific periodicals and bulletins. The Hawaiian Volcano Research Association has recently financed the erection of a Lecture and Exhibit Hall. Lava specimens, photographs and charts are exhibited here, and illustrated lectures are given by the Hawaii National Park and the Observatory in cooperation so that visitors may be as fully informed on the points of local interest as is possible in their sometimes too brief stay.

Kilauea and Mauna Loa are active volcanoes. Its history shows that Kilauea is visibly active during the greater part of its time. Most of the lines of investigation outlined above are important even though molten lava or other spectacular surface activity is absent. The volcanoes are at present quiet, and no "fire" is visible, so that visitors now seeing them for the first time are led to the conclusion that the preponderance of pictures of activity is deceptive. Photography is obviously most extensively used during the spectacular phases. The present quiet period seems long, but it is only a short phase when counted in terms of the active age of these volcanoes.

R.M.W.

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No. 140 RELEASED WITHOUT COPYRIGHT RESTRICTION September 1, 1927

KILAUEA REPORT No. 814
WEEK ENDING AUGUST 31, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Very few changes have taken place in Halemaumau pit. Conditions remain practically the same, except for occasional rock falls and avalanches. At 2:30 p. m. August 28 gray debris lay on the northern taluses, and at 3:10 p. m. a large avalanche dust cloud rose from the northeast corner of the pit. Two other slides just previous were noted by observers on Uwekahuna Bluff. At 11:50 a. m. August 29 avalanche dust clouds rose from the north, northeast, and east sides of the pit, and hung over it for several minutes. On August 30 at 9:35 a. m. a large, gray streak from a slide was seen to extend all the way from the west rim to the pit floor, and the northern walls were freshly peeled in several places. Rather continuous slides were occurring at the lower northeast corner of the pit. A section of a ledge southeast has fallen. A visit to the northeast rim August 31 shows the ground to be very loose there.

During the week ending August 31 the seismographs recorded 17 local earthquakes. One of these, at 8:10 a. m. August 28, was feeble and apparently not more than two miles from the Observatory. There are no reports of its having been felt. The other 16 shocks were all very feeble. There has been no accumulation of tilt during the week.

A REVIEW

The Bulletin of the National Research Council, Number 61, reporting the transactions of the American Geophysical Union at the meeting of April, 1927, contains a number of papers of very considerable interest. Already these papers are but brief abstracts, so that this still more brief review can hardly aspire to be more than a mere list of the subjects introduced. This Bulletin also contains the report of the delegates of the American Geophysical Union who went to the Third Pan-Pacific Science Congress at Tokyo in October, 1926.

The papers presented are grouped under general headings. Meteorology is represented by a "Symposium on Some Factors of Climatic Control," and by a number of papers on particular features. Terrestrial Magnetism and Electricity are discussed, and so is Oceanography. Volcanology, Seismology and Geodesy are of particular interest to this Observatory, and some of the features brought up by the papers under these headings are here outlined.

Under Volcanology comes a discussion of the investigation of hot springs by the Geophysical Laboratory. Phenomena in California, in Lassen Park and at the Geysers; in the Katmai region in Alaska; in the Yellowstone National Park; are compared as to range of seasonal temperature and as to materials brought to the surface with the water and steam. These considerations open the way for deductions on subterranean formations and conditions. Another paper points out the part played by gases in the phenomena of volcanism, commenting on the hypotheses of gas-heating and gas-fluxing, and refers to conditions at Kilauea. The presence of metals in various deposits placed by volcanic steam is touched upon. A discussion of conditions on the Moon is given, particularly the low value of lunar gravity and the lack of atmosphere, and the effect of these conditions upon the probable method of formation of the Moon's craters.

Reports of the work being done and the progress made in seismology by various organizations occupies considerable space. Improvement of instruments and the substitution of more modern seismographs for those of older design, the establishment of new stations, cooperation in centralizing the data, and early publication of results and summaries of earthquake information, seem to be the main lines of progress. The investigation of shifts and motions of the Earth's crust in relation to earthquakes is shown to be important, as through such measurements it may be possible to keep watch over dangerous fault zones. There are discussions of the travel of seismic waves through the Earth's surface layers, and concerning new phases observed in teleseismic registration.

The papers relating to Geodesy are numerous. Mention is made of triangulation by the Geodetic Survey of Canada at two places where the object is to discover and study earth movements in connection with seismic disturbances. The statement is made that "The geodesist has proved the theory of isostasy to be a scientific fact . . . . " The earthquakes of the St. Lawrence River Valley are supposed to be due to the recovery, by isostatic adjustment, of the area relieved of the weight of ice of the glacial period. A brief description is given of the methods, accuracy and preliminary results of the World Longitude-Net operations. In this work automatically recorded time signals and refined star transit observations were used simultaneously at stations scattered all over the world; the many different longitude differences to be harmoniously adjusted. The probable errors of these individual longitude differences, expressed in time, are given as amounting to only a few thousandths of a second. An interesting feature is brought out in the description of an adjustment made in the North American level net. The whole net was adjusted without the introduction of conditions for ties to sea-level. The result seems to indicate that according to spirit-leveling, mean sea-level is about a foot higher at Portland, Maine, than at St. Augustine, Florida; and nearly a foot higher at Seattle, Washington, than at San Pedro, California. The first order triangulation covering the western half of the United States has been re-adjusted, and one paper tells briefly of the loop closures; the mean of all the closures being about one part in 450,000, representing an error of about 14 inches per 100 miles.

In many of these abstracts reference is made to publications wherein these subjects are dealt with more in detail, and there are frequent references to forthcoming publications along the same lines which will soon be available. At this April meeting a resolution was adopted to find a way to have translated into English the many and valuable publications in Japanese that represent the current investigations in seismology in Japan. It is to be hoped that this may be done. R.M.W.

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No. 141 RELEASED WITHOUT COPYRIGHT RESTRICTION September 8, 1927

KILAUEA REPORT No. 815

WEEK ENDING SEPTEMBER 7, 1927

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

There has been considerable working of the walls of Halemaumau during the past week. One very large avalanche occurred on the northeast side at 2:20 p. m. September 1. On September 2 two large scars were seen where the northeast wall had peeled, and from 9:30 to 10 a. m. small slides were almost continuous on that side. At 3:45 p. m. the pit was full of dust from slides. A large avalanche dust cloud was reported to have been seen about 6:45 a. m. September 4. On the 5th new debris lay thickly on the north-northeast, northeast, and south taluses. Steaming activity varies little.

On September 2 the crack at the southeast tourist station had widened very perceptibly, and there were several small new cracks nearby. The following day several crack measurements were taken, and the large southeast crack was found to have widened more than half a foot since July 11. Another crack had widened nearly as much in the same period of time. While other cracks in the vicinity had opened, their movements were not as great. On September 5 the small new cracks were more pronounced.

Six very feeble earthquakes occurred during the week. In addition to these there was a swarm of very feeble tremors on September 1. Minute tremors came also on the 2nd, 3rd, 4th, and 5th. Accumulation of tilt during the week has been negligible.

JAPANESE SEISMOLOGICAL INVESTIGATIONS

More than any other nation, perhaps, Japan is vitally interested in earthquakes. The high activity of its seismic zones, bringing heavy earthquakes into densely populated regions, makes earthquake knowledge actually a life and death matter. It is the business of the Japanese seismologists to examine in detail the circumstances and meaning of every shock, to delineate the active faults, to detect where the accumulating forces and stresses may next produce fracture with resulting damage to life and property. On March 7, 1927, an earthquake occurred in Tango Province, Japan. It was recorded on the seismographs of observatories in many places, and the press reported it rightly as disastrous. In the "Proceedings of the Imperial Academy," 3 (1927), No. 4, Japan, is an abstract of the seismological investigation of this earthquake by A. Imamura and Nobuji Nasu. There were two faults produced at right angles to each other, the vertical and horizontal displacement along each one being measured at the surface. Changed elevations along the sea coast were also noted. These are not unusual movements and changes to be produced by an earthquake. One feature that seems particularly interesting is the reported apparent temporary lowering of sea level, two or three feet in amount, which took place two hours and a half before the earthquake. In the analysis of the shock, the authors explain this to be a temporary elevation of the ground, caused by the up-tilting of a block of the earth's crust under accumulating stress. This stress was then expended in producing the fracture, generating the earthquake and allowing this area to resume its former position without the permanent displacement exhibited at other places. Three portable seismographs were set up at the corners of a triangle covering the epicentral region. These instruments began recording only four or five days after the earthquake, and the after-shocks that were still occurring were carefully analyzed. It was thus possible to estimate the boundaries of the disturbed block and to suggest the sort of mechanism involved.

A few months ago Mr. Imamura published a description of a horizontal pendulum seismograph which could be adjusted to a free period as long as three and a half minutes. In a more recent paper in the "Proceedings" (3, 1927, No. 5), with the title, "On the Observations of Slow Earthquake Motions," he describes certain earthquakes as recorded on this instrument. The very slow natural period of the instrument has apparently made it sensitive to long period motions that have heretofore escaped notice in teleseismic registration. There are several records reproduced in the paper, plainly showing waves having periods in the various cases between 53 and 220 seconds, ordinarily with an amplitude of from 0.3 to 0.6 mm. These long period waves may be thought to be a result of the very long period of the horizontal pendulum making the records. It is hard to believe that this is so, however, when the period of the waves is not the same as the period of the pendulum. Mr. Imamura, in fact, discards one well-marked wave which has a period about the same as the pendulum, suspecting that it may have been caused by instrumental resonance. He then turned his attention to the records of ordinary seismographs for the same earthquakes, and found in several cases that the ordinary instruments showed traces of these long waves when attention was called to them by the records of the special instrument. This would seem to make it certain that the long waves so recorded are not fictitious phenomena resulting from the peculiarities of the instrument itself, but are in fact representations of real earth movement. R.M.W.

THE UWEKAHUNA SEISMOGRAPH

When the Uwekahuna Observatory was built, provision was made for setting up an exhibition seismograph. A small alcove at one side of the main room contains a pier which is founded upon solid rock and which does not in any way touch the foundations of the building. This space has so far not been utilized as the seismograph has not been ready. This instrument is one of modern Japanese make that was ordered by Dr. Jaggar when he was in Japan with the Third Pan-Pacific Science Congress last October. Delivery has been slow as Dr. Jaggar requested the makers to substitute cardan hinge supports for the heavy masses in place of the cup and pivot supports used in the stock instruments of this type. The seismograph has arrived in Honolulu, and will be set up at Uwekahuna in the very near future. It will be run continuously, and its records will be filed at the Observatory. It is expected that a study of these records will yield interesting information as to the seismic conditions at that place, which is much nearer to the pit than is the present seismograph station. R.M.W.

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No. 142 RELEASED WITHOUT COPYRIGHT RESTRICTION September 15, 1927

KILAUEA REPORT No. 816

WEEK ENDING SEPTEMBER 14, 1927

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

The avalanching activity at Halemaumau has continued with increased vigor. Probably the largest avalanche was one that occurred at 9 a. m. September 9 from about the center of the wall just west of the Kau rift tunnels, leaving a scar several hundred square feet in area. The many tons of debris dislodged have partly buried the southwest cone. This section of the wall is usually quiet, and avalanching there may be considered significant inasmuch as it may mean that the northeast-southwest rift line was in motion.

Many new scars made by slides are to be seen all over the northeast, north, and northwest walls. Some very large slides have come from the northwest wall which, until recently, has been very quiet. A rather loud avalanche was reported to have occurred from the north wall about 9:30 p. m. September 12; also continuous small slides on that side. On the afternoon of the 13th several noisy slides from the north wall were seen from the Uwekahuna Observatory.

A circuit of the pit made on September 12 disclosed a few changes. An immense bowlder that hung under the northeast rim has fallen, and nearby is a slim pinnacle which appears ready to topple over. Dirt has been dislodged by the widening of a crack through the north-northeast fault cliff.

During the week ending September 14 there have been 19 very feeble local earthquakes recorded on the seismographs. Tilt has accumulated moderately to the NNE.

THE HILO SEISMOGRAPH STATION

The Hawaiian Volcano Observatory has for several years operated subordinate seismological stations on the Island of Hawaii. They have been found very useful in locating the epicenters of near earthquakes. The instruments at the Observatory usually give the distance to the origin of an earthquake, but only in exceptional instances can reliable direction be derived from the records. Thus the actual position is difficult to definitely determine from the records of a single station. But with other stations recording distances to the same shock, it is possible to quite accurately plot the position of the origin. The value of the data supplied by these outlying stations certainly warrants the making of any improvements possible in them.

About the first of this year a well equipped machine shop was added to the facilities of the Observatory. Among other things this has made possible the construction of better seismographs for these subordinate stations. A reasonably simple design was adopted for a two-component type, and already three sets have been made, and a fourth is partly constructed. The first of these three is the one installed by Professor Jaggar this summer in Kodiak, Alaska; the second is being held for a probable second station in Alaska; the third has just been installed in Hilo, Hawaii. One of these instruments was placed on exhibit at the recent Territorial Fair in Honolulu. In these instruments the heavy mass is a 27 inch long section of 8 inch iron pipe, with end plates welded top and bottom, and filled with sand, weighing approximately 225 pounds. The mass is slung as a horizontal pendulum by means of short piano-wire links at the top and bottom. These links on the base side are fastened into an upright bar which is in turn supported by a plate arranged to be bolted to the wall. The bar can be adjusted to secure the proper inclination of the support axis. The center of gravity of the upright heavy mass is out 8 inches in front of the axis of support. To the front of the heavy mass is bolted a tubular aluminum boom 41 inches long with wire guys to stiffen it, and with a fine pivot at the outer end. The recording mechanism consists of an aluminum drum about 11 inches in diameter and 12½ inches long, to carry smoked paper. The drum is rotated by an escapment clock, which gives the paper a speed of 30 mm. per minute. Both components of the seismograph record on the same drum. The writing point is a fine steel needle in jewelled bearings that rests upon the smoked paper with its own weight only, and is fastened to the long arm of a magnifying lever. The short arm of the lever is coupled to the pivot at the end of the heavy mass boom by a light aluminum bar with jewelled bearings. The pendulums will first be tried with a free period of seven seconds. The magnification is 160. Oil damping is employed to steady the heavy masses. These instruments are intended to be hung on the wall, so that the only pier necessary is the one to support the recording mechanism.

The single component instrument that has been in operation for six years at the Brothers' School in Hilo has been replaced by one of these two-component instruments just described. Brother Albert will continue in charge of this station. A completely new housing has been made in the back corner of the school grounds, far from the disturbances of street traffic and school activity. This new seismograph cellar is reinforced concrete of monolithic construtión, walls and roof being five inches thick. The inside dimensions are eight by nine feet, and the floor is about seven feet below the outside ground surface. The walls are set on solid rock, as is also the pier in the middle of the room which carries the recording mechanism. The building is turned so that its 9 foot length is in a northeast-southwest direction. A flight of narrow stairs, partly outside and partly inside, leads down through a low door into the cellar. The instruments are hung in the corners of the room; the east-west component pendulum in the south corner, and the north-south component in the west corner. The axes of the instruments are therefore at 45 degrees with the walls of the building. A ventilator is arranged to carry off the smoke from the smoking lamp. The temperature of the room seems to vary through a daily range of only about five degrees Fahrenheit. Notes as to the behavior of this new installation will appear in future issues of the Volcano Letter. R.M.W.

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No. 143 RELEASED WITHOUT COPYRIGHT RESTRICTION September 22, 1927

KILAUEA REPORT No. 817
WEEK ENDING SEPTEMBER 21, 1927
Section of Volcanology, U. S. Geological Survey:
R. M. Wilson, Temporarily in Charge

Numerous slides have occurred from nearly all sides of Halemaumau pit. Most of them have been from the north and northeast walls, though the northwest wall has also been very active. Crack measurements taken on September 17 showed that there has been a general increase in the width of all cracks on the east side and that the southeast ledge was fast separating from the main rim, having moved about eight inches in a week. The observer could see the dirt settling into the southeast crack and hear the rocks adjusting themselves to the movement. At 1:30 p. m. September 19 the ledge fell with a roar resembling an explosion, tearing away a great strip of the rim. A disturbance recorded by the seismographs about this time may have been caused by this avalanche. This and several other avalanches were seen and heard from the Uwekahuna Observatory.

The walls of the pit are very dark and reddish from the recent rains. Steaming is moderate at all vents.

There have been 28 very feeble local earthquakes recorded on the seismographs during the week ending September 21. One of these was an extended disturbance of small amplitude covering more than four minutes of time, which occurred at 5 p. m. on the 14th.

During the week no material tilt accumulated up to the 17th. On this day a definite spurt to the south-southeast began, lasting for two days, making the net accumulation for the week moderately south-southeast. On these same two days the records show the presence of an unusual amount of short-period tilting, causing the seismogram lines to crowd and overlap.

LOCAL SEISMIC PERIODICITY

A few weeks ago a rough analysis was made to determine whether the very feeble local earthquakes recorded at the Hawaiian Volcano Observatory inclined to a greater frequency at any particular time of day. The afternoon hours seemed to contain the greater percentages, as was stated in a previous issue of the Volcano Letter.

During the last ten months these feeble disturbances have seemed to come in waves of increasing and decreasing frequency, the time interval from crest to crest of increased frequency being about two weeks. So another preliminary analysis has been made to determine whether these recurring waves show real periodicity. It is a question whether the investigation should be based merely on the number of shocks, or whether intensity should also be considered. One heavy shock probably releases as much accumulated stress as would several smaller ones. No attempt has been made therefore, in this rough review, to make a quantitative computation of the energy displayed by the various disturbances. Instead, the crests of seismic activity have been selected merely by inspection of the records to find at what times activity is most apparent.

The short period of time covered by the inspection, and the crudeness of the method used in reducing the records, prohibit a definite and final statement of results. It seems apparent however, that there is a true periodicity present, and there seems to be a correlation with the phases of the moon, as would be expected if luni-solar gravitational attraction is considered as a factor. The maxima of this periodic local seismic activity seem to come when the moon is at first or last quarter, and the times of lesser activity when the moon is either new or full. July 7, 1927, when new lava came into the pit of Halemaumau, seems to be timed as one of these crests of activity. The evidence of periodicity seems more pronounced since the July eruption, and the last noted crest of seismic activity occurred about September 16.

R.M.W.

HORIZONTAL GROUND MOVEMENTS

An interesting development in the recent work of the Observatory is the detection of horizontal earth movements in the vicinity of Halemaumau. Marked points located in 1920 have been re-surveyed during the last year. Progress of the work has been mentioned from time to time in the Volcano Letter. Preliminary computations have just been completed, and comparison made between the 1920 and the 1926 results. It has become apparent that motions of considerable magnitude have taken place during this six-year interval of time. The points surrounding the pit have converged, agreeing with the general collapsing of the region around the pit that has already been detected by the re-running of spirit-level lines. The horizontal movements of the ground, within a zone of two miles radius about the pit, do not in all cases converge radially towards the center of the pit. This would be expected if the collapse were centralized at the pit. Instead the movements seem to indicate that the collapse was more probably along an elongated belt, perhaps determined by a fault line. The points within this zone show movements of from two to five feet. There are two points near the pit, less than a mile apart, that have approached each other, one moving three feet and the other five feet, so that the distance between them has become eight feet less than before. The line between these two points forms one side of a triangle that was used in the triangulation. In the triangle, the angle opposite this side has changed more than two minutes of arc. Since in both the 1920 and the 1926 surveys an accuracy represented by an average triangle closure of three seconds was attained, it is evident that real motion has taken place. This line is the one that joints the marked point at Uwekahuna and the one near Little Beggar, and the angle is that measured at the mark at the Observatory between these two points. If motion of the same sort continues, or if the movement reverses, it is evident that a re-measurement of the angle at the Observatory will detect it. If the approaching together of these two points represents a collapse of the area around Halemaumau, as seems to be the case, then variations in the angle spanning them should immediately indicate further collapse or recovery. In other words, fluctuations in this angle should be an important clue in detecting changes of volcanic phase in Halemaumau.

R.M.W.

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No. 144 RELEASED WITHOUT COPYRIGHT RESTRICTION September 29, 1927

KILAUEA REPORT No. 818

WEEK ENDING SEPTEMBER 28, 1927

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

Avalanching at Halemaumau has continued to be frequent. There has been so much sliding since the July lava activity that the new floor of the pit is now well overlapped with debris on all sides. The slides have occurred mostly from the northern walls, eating away the rim to such extent that the pit is constantly enlarging itself in the direction of Volcano House.

At 5:20 p. m. September 21 the prolonged roar of an avalanche was heard from the Observatory, but the weather was so foggy that no dust could be seen. The next day new scars were seen on the south, east, northeast, north, and northwest walls, and a coating of new debris lay on the north-northeast talus. A section of the east rim has collapsed. On September 24 more new debris was seen on the northern taluses.

On September 26 the pit was quiet and steaming was very slight. The character of the weather has a great deal to do with the amount of steaming. On September 28 a light rain was falling, and there was a considerable increase in the volume of steam escaping. The wet weather also has its effect on the colors of the walls, so that on this day there were very pleasing contrasts of deep red and light and dark gray colorings. A large scar near the top of the north wall may have been made at 1:10 p. m. September 26 when dust was observed. There were also fresh scars on the northeast wall.

Twelve local earthquakes have been recorded during the week ending September 28. These were all very feeble, excepting two which occurred at 3:03 p. m. and 4:11 p. m. on the 27th. The first of these was feeble, its origin apparently about 28 miles from the Observatory. The second was slight, its origin being about 14 miles away. There have been no reports yet received that these shocks were generally felt, though the latter was noticed by a few persons in Hilo. Microseisms were slightly stronger than usual on the 26th and 27th. Tilt has accumulated moderately to the NNE.

LASSEN REPORT No. 11

Mineral, California, September 7, 1927

R. H. Finch, Associate Volcanologist

A description of two lava flows from Cinder Cone, about 10 miles northeast of Lassen Peak, was made by J. S. Diller as far back as 1891. Diller stated that the youngest of the flows occurred in the 19th century something like 50 years previous to his writing. There are indications that there were at least three flows, and Diller's conjecture that the youngest occurred about 100 years ago is probably correct. The age of the oldest of the flows is not known, although it may be about 300 years. One of the older flows crossed a lake, making two new ones—Butte Lake and Snag Lake. The latter takes its name from the many snags still standing in the water, though snags are also found in Butte Lake. The bed of the old lake that shows in many places well above the level of the present lakes indicates that the ground in the vicinity of Cinder Cone was first upheaved and later sank. The weight of the lava flows, in places over 100 feet thick, might well be the cause of a sinking.

The last flow covers but little new ground, lying almost entirely on preceding flows. Both weathering and tree growth point to the fact that there were at least three flows and that the youngest might possibly have occurred within the memory of some people still living. A preliminary investigation by Mr. A. E. Jones, who worked as seismologist at Lasse Volcano Observatory during the summer of 1927, by means of the magnetic properties of the flows ("Telling the Age of Old Lava Flows," Volcano Letter No. 45, November 5, 1925), places the youngest flow about 1832, and the next youngest about 1795.

R. H. Finch

EARTHQUAKES AS CATASTROPHIES

A short review of the notable catastrophies that occurred in the world from September 1, 1924, to August 31, 1926, appears in "The World's Health" (Paris, July, 1927). M. Raoul Montandon, the editor-in-chief of "Materiaux Pour l'Etude des Calamites," in this review distributes according to time, and according to place, 551 disasters that have afflicted mankind in this two year period. In kind, they are represented as follows: Earthquakes, 66; volcanic eruptions, 4; avalanches and landslides, 9; floods, 197; cyclones, hurricanes, typhoons, 148; droughts, 23; tidal waves, 8; fires, 48; famines, 17; plagues of locusts, 31. Their distribution is given as: Africa, 35; North America, 75; Central America, 19; South America, 38; Asia, 97; Europe, 249; Oceania, 38. Summer is apparently the most hazardous season.

These figures are based upon reports published in the press, and Journalism is prone to inaccuracy in stating damage to life and property. It is therefore difficult to draw a fine line in selecting the happenings that are of sufficient magnitude to be classed as catastrophies. Yet in the case of the earthquakes, the figures above agree remarkably well with the statement of Montessus de Ballore that of the 30,000 earthquakes which may occur in a year, 31 will be to some extent destructive.

In dealing with a summation of calamities of such varied kind, it will be difficult to make correlations as to general cause, though it is suggested that solar activity and sun spot years may have something to do with some of them. There is of course one factor that must be considered in connection with all catastrophies; that is, the density of population. A tremendous earthquake, an extensive flood or a violent hurricane can only be counted as a catastrophy when man and the works of man are present to suffer destruction. This factor probably accounts for the large percentage of catastrophies that these figures give to Europe.

R.M.W.

Professor Jaggar has completed his season of volcanologic reconnaissance in Alaska. He made a short visit to the Lassen Volcano Observatory in California, and is now in Washington. It is probable that he will arrive in Honolulu on October 18.

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No. 145 RELEASED WITHOUT COPYRIGHT RESTRICTION October 6, 1927

KILAUEA REPORT No. 819

WEEK ENDING OCTOBER 5, 1927

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

Halemaumau pit has taken on a somewhat new phase in regard to the restlessness of the walls. The heavy avalanching so prevalent during the period of the equinox has practically ceased, and now there are only numerous small slides. These are rather continuous, often so small as to be barely perceptible. They seem to be occurring from nearly all sides of the pit, but are concentrated mostly southeast and northwest. The fine material thus deposited on the northwest talus has made a wide streak its full length. Slides at the top of the northeast talus have eaten a hole into the wall similar to that just above the northwest talus.

Few other changes have taken place in the pit. The white and yellow stains on the floor increase in the vicinity of the southwest cone. Steam escapes from the smaller cone in irregular puffs, and all vents are moderately active.

During the week ending October 5 the seismographs have recorded 22 very feeble local earthquakes. On September 30 there was a period of continuous harmonic tremor, beginning feebly at 9:30 p. m. and increasing in strength until about 10:40 p. m., when it began to fade out, disappearing from the records at 10:50 p. m. This type of disturbance is of especial interest, as in the past it has been closely associated with the presence of active lava. There are, however, no other symptoms of renewed activity. It is interesting to note that this spell of harmonic tremor, with the small group of very feeble spasmodic tremors that closely preceeded it, represents another crest of seismic activity that comes just two weeks after the last crest noted, confirming the idea of periodicity (see Volcano Letter No. 143, September 22, 1927).

The two earthquakes on September 7, mentioned in last week's Kilauea Report, were also well recorded on the seismographs in Kona and Hilo. The plotting of distances has shown that the second one originated not far from Ainapo, on the southeast slope of Mauna Loa.

Tilt for the week has accumulated very slightly to the east.

VOLCANOES AND SUBMARINE EARTHQUAKES

Disturbances of the surface of the ocean, attributed to volcanic or seismic causes, have been noted at various times. In the "Bulletin Volcanologique" (Italy, 1926, Nos. 9 and 10) is given a series of reports of such occurrences, and other instances are noted in the Seismological Report Supplement for 1924, published by the U. S. Coast and Geodetic Survey. These phenomena are observed and recorded by ship's officers or other persons aboard vessels at sea. Some of the descriptions are very meager, merely mentioning that shocks were felt, or that the surface of the ocean was disturbed. It seems doubtful that the vibrations of an earthquake, which are elastic vibrations in a solid body, could be propogated through sea water and reach a vessel as a perceptible shock or tremor unless the water were shallow or the disturbance great. It is easier to understand that a submarine eruption should disturb the surface of the sea, causing it to heave or seethe, and perhaps bring up sediment from the bottom. In two of these reports the heaving, seething and discoloring of the ocean's surface is described, but in neither one is the feeling of shock or tremor mentioned. Those reports mentioning perceptible shocks say nothing of the water surface, or say that nothing unusual was observed.

It is difficult, save in one or two doubtful cases, to correlate these disturbances with earthquakes as recorded upon seismographs at the time. A volcanic eruption might well be a slow outpouring of lava, producing convection currents with resulting disturbances at the surface, yet which would not send out seismic waves of sufficient intensity to be recorded at any great distance. On the other hand, a tectonic earthquake violent enough to be felt as a shock through any great depth of sea water should certainly send out seismic vibrations (along the earth's solid crust) over distances great enough to record on many of the world's seismographs.

When the ocean surface shows disturbances, as seething or sediment, water temperatures should yield interesting information. In the few cases here reviewed no such temperatures were recorded. R.M.W.

AN ELECTRICAL ACCELEROMETER

Juichi Obata (Proceedings of the Physico-Mathematical Society of Japan, May, 1927) describes an electrically recording accelerometer. Minute earth tremors can be detected with this instrument, as the magnification can be made great. A simple pendulum is held about 10 degrees out of vertical by a prop bearing against a thin metal diaphragm. Horizontal acceleration of the apparatus in the plane of the pendulum and prop will cause the prop to bear more or less heavily against the diaphragm which is used as one element of an electrical condenser. The second element is so placed that any variation of the pressure of the prop will vary the distance between the elements, and so vary the capacity of the condenser. The condenser is connected up electrically as part of an oscillating circuit containing an ordinary radio vacuum tube. Changes in the capacity of the condenser induce changes in the grid potential of the tube, thereby altering the plate current and causing a galvanometer to register.

The dispalcement of the diaphragm necessary to register on the galvanometer is so slight that relative motion within the apparatus may be neglected and the readings may therefore be regarded as representations of true acceleration. The sensitivity of the arrangement in this simple form is stated to be such that one millimeter galvanometer deflection is produced by an acceleration of 0.4 cm. per sec. per sec. Greater magnification may be secured by the use of additional tubes to amplify the electrical impulses issuing from the first tube, just as in a radio receiving circuit. R.M.W.

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No. 146 RELEASED WITHOUT COPYRIGHT RESTRICTION October 13, 1927

KILAUEA REPORT No. 820

WEEK ENDING OCTOBER 12, 1927

Section of Volcanology, U. S. Geological Survey:

R. M. Wilson, Temporarily in Charge

Conditions at the volcano are much the same as last week, with numerous small slides from the walls of Halemaumau pit and only an occasional avalanche. These slides are mostly from the northwest side, where they can be heard nearly continuously, and much fine material lies at the foot of all the walls.

Yellow stains are quite pronounced on the smallest of the cones active on July 7, and in spots on the south and east taluses. A bright yellow area of sulphur crystals lies at the foot of the south talus. Higher up this talus is streaked with wet steaming places.

There were 23 very feeble local earthquakes recorded on the seismographs during the week ending October 12. One of these, at 10:25 a. m. October 5, was recorded just at the time of a large avalanche in the pit, and is probably a record of the vibrations caused by the falling rocks. Microseismic motion has been normal. Moderate tilt towards the NNW has accumulated during the week.

ISOSTASY AND GRAVITY

If the earth were so simply constructed as to have no irregularities of surface or composition; if it were a perfect mathematical body, then many present scientific problems would not be crying for solution. It might then be a true spheroid of revolution, all its surface at a single elevation, and, at any particular point on its surface, its radius, its curvature, the value of gravity, would all be easily computed by simple formulae dependent upon latitude. Such is not the earth upon which we live. Science does use, however, as a basis for many calculations, an imaginary mathematical spheroid, chosen of such dimensions that it represents as nearly as possible our actual earth in shape.

Mean sea level represents the nearest natural approximation to the spheroid. Imagine perfectly calm oceans, and think of their surfaces as continued even under the land areas at the same natural level that the water would assume if it had free passage there. This smooth and continuous sheet of water surface would be the geoid, and is the surface of zero elevation. The geoid is the slightly irregular figure of which the spheroid is the idealized mean. At all points on the geoid the plumb line hangs exactly perpendicular to its surface. The plumb line is deflected from the true vertical by certain local conditions. Thus at one side of a high mountain range, a plumb bob would be subject to greater horizontal components of gravitational attraction toward the high country than toward the lower country on the other side. This implies that the geoid surface would slope up toward the high country, relative to the spheroid. In general the geoid surface would thus be above the spheroid for land areas, and would be below the spheroid for ocean areas. Dr. William Bowie gives the result of a computation along 700 miles of a parallel of latitude, one end over land and the other over water, taking account of land elevation, ocean depth, and isostasy. It appears in this particular case that the geoid should be some 60 feet below the spheroid at the water end of the line, and 15 feet above at the land end.

Isostasy, briefly, tells us that in general the earth's crust considered for a thickness of some 60 miles, is of the same weight per surface area, everywhere. While high elevations like mountain regions imply thicker crust, the thickness is compensated by lesser density. It is thought that this crust rests upon a layer in the earth's structure that is, through heat and the tremendous pressure upon it, maintained in a state of high viscosity. This layer must be elastic, as it transmits earthquake waves, but because of its viscosity it slowly flows as a very thick fluid under the great pressures put upon it. If a mountain range could be lifted from one place, and set down in another, it would press down the crust of the earth under its new position, forcing out from underneath some of this viscous layer, which would flow beneath the area relieved of the mountain's weight, lifting this place and again restoring balance. Mountain ranges are not moved outright, yet through long ages great amounts of material are shifted from place to place on the earth's surface through stream erosion and deposition. This accommodation of the crust and its supporting layer to such shifts of weight is called isostatic compensation. The crust, being brittle, yields by successive fractures to these deforming forces, causing earthquakes.

On a perfect earth, such as that suggested above, the value of gravity would be easy to compute for any chosen point, once fundamental values were determined. Observed values would agree with computed values everywhere. Such simplicity is not attainable on the real earth. Thus when a value of gravity is observed (see Volcano Letter No. 106, January 6, 1927), there must be many corrections applied; for the elevation of the station, for local topography, for general irregularities of the earth's surface distant even to the antipodes, and for crustal density as suggested by isostasy. An observed value, so corrected for all known variations of the real earth from the perfect one, should agree with a value computed for the corresponding point on the perfect earth. A discrepancy represents, probably, the omission of some unknown factor in applying the corrections to the observed value. Such discrepancies are called the anomalies of gravity. Dr. Bowie indicates that the correction for the elevation of a gravity station should not be the elevation above mean sea level, or the geoid, but should be taken as the elevation above the true spheroid (see American Journal of Science, September, 1927). The corrections show isostasy and gravity to be in harmony.

A very real usefulness of gravity observations comes through the study of these anomalies. For, if a corrected observation gives a value too great, so that the anomaly is positive, it is an indication of a geologic formation of unusually great density not far beneath the surface, or of unusually small density if the anomaly is negative. In Japan, earthquake regions are so investigated to search for hidden faults and dykes, or to detect shifts or intrusions of magma beneath a volcano. R.M.W.

SAMPLE COPY

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No. 147 RELEASED WITHOUT COPYRIGHT RESTRICTION October 20, 1927

KILAUEA REPORT No. 821

WEEK ENDING OCTOBER 19, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

Recent visits to Halemaumau show the pit to be quiet. Slides are not so numerous as last week, and steaming changes little. At 10:20 a. m. October 17 there was a small slide at the north corner which made dust, and about 3:30 p. m. October 19, slides occurred at the south corner making a bright red scar visible from the Uwekahuna Observatory. There is fresh yellow sulphur at the base of the southeast talus.

Crack measurements along the east rim of the pit show little movement, but on October 19 small new cracks were seen in the dirt back of the south station.

The seismographs have recorded 18 very feeble local earthquakes during the week ending October 19. A perceptible shock occurred in Kona, local to that place, at 6:01 p. m. on October 16. Tilt has accumulated slightly to the NNW.

ERUPTION OF MAGEIK IN ALASKA

The Seattle "News-Tribune" carries an Associated Press dispatch of the date September 30 stating that Mageik Volcano of the Katmai group erupted explosively "late in August" (1927). The authority quoted is Captain Harry W. Crosby, President of the Crosby Fisheries, who spent the summer aboard his schooner-cannery "Salmon King" in the northeast arm of Uganik Bay on the northwest side of Kodiak Island. Mageik and Martin were two volcanoes seen by Dr. Jaggar to be steaming, looking northwest from Shelikof Strait on May 18, 1927. Both took part in the great Katmai eruptions of 1912. Mageik is forty nautical miles from the middle of Shelikof Strait, and sixty miles from the Crosby anchorage in Uganik Bay.

Thousands of tons of pumice stone and ashes were reported by Crosby as showered over an area 50 miles square. The article quotes him:

"We were about 50 miles off the Alaskan Peninsula in clear weather, when suddenly we noticed a gigantic puff at the top of Mageik. Soon the air was filled with volcano ash, and it began to rain pumice stone. After the explosion, the volcano smoked like a factory chimney. A short distance from the ship we found large quantities of pumice stone, some pieces as big as your first, floating on the ocean.

"We scooped up a bushel or more of the stones and brought them to Seattle. For five days the eruption continued, and the mountain was still smoking when we left for Seattle.

"Each morning while we were off the Alaskan Peninsula, the decks and rigging of the ship would be covered with the fine powdered volcanic ash, some of it so white that it resembled snow. The first duty of the crew in the mornings would be to sweep the decks clear and to dust off the rigging.

"The eruption followed a period of unusual weather, a great calm with scarcely a breath of air, and a depressing atmosphere. The air was full of white volcanic ash for a week, and thousands of tons of pumice stone fell around us."

No dates or ship's positions appear in this article, but apparently the vessel did not sail until five days after the major explosion. Captain Crosby is a reliable commercial man, navigator and fisherman of many years' experience in Alaskan waters. T.A.J.

ALEUTIAN VOLCANOLOGY

The foregoing account illustrates how much is needed a reliable scientific station for collecting and verifying reports of activity from the forty-five potentially eruptible volcanoes of the Aleutian volcano chain, extending from Mount Spurr to Buldir. When Dr. Jaggar was at Naknek May 24, 1927, the teacher there, who had been to the Valley of Ten Thousand Smokes, reported that a trapper in January, 1927, had seen an ash eruption from one of the Katmai hills, and that two trappers were missing who had gone into that region. This is in the same district as Mageik.

Here, then, are two accounts, both incomplete as to hours and dates and places, suggesting that ash and pumice eruptions are being renewed in January and August, 1927, for the Katmai volcanic system.

Bogoslof was found in lava eruptivity when Dr. Jaggar on the "Unalga" visited and made landing on the islet July 6, 1927. This was in the technical sense that a pile of steaming hot lava was slowly heaving itself from the submerged crater above the sea-water. The salt lagoon surrounding the lava heap was warm. Fresh bombs and bomb-pits lay about. The records of mariners for a year past told of explosions in July, August, September, and November, 1926, at Bogoslof.

After this visit came a telegram from Captain Cochrane, commander of the Bering Sea Patrol, dated July 27, saying, "One of Akutan whalers reports Bogoslof active on July 26." The word "active" here certainly means another explosion. Where was the whaler; how far away; what direction was the wind; what was the hour; what happened? Such are the details needed by science.

Now we get Mageik exploding a month later. Fortunately a small sidelight is thrown on this volcanic action of the Katmai group by the new seismograph at Kodiak village. While it was being installed, July 30, at 7:10 a. m. Kodiak Time (ten hours slower than Greenwich), a local earthquake was sharply felt. At 5:52 a. m. August 11 a slight east-west swaying shock was felt and was registered by the seismograph so as to indicate an origin distance of 35 nautical miles; duration of registered motion three and one-half minutes.

Coinciding with "late August" of the reported Mageik eruption, the Kodiak seismogram of 7:18 a. m. August 28 exhibits a feeble local earthquake with preliminary phase indicating a distance of 30 nautical miles; duration of motion about one minute.

Summing up, we have (1) Bogoslof piling lava July 6 and exploding July 26: (2) Earthquakes at Kodiak originating 30 to 40 miles away at intervals of 12 and 16 days after July 30: (3) Explosion of Mageik the end of August and first days of September. Kodiak is 93 nautical miles from Mageik and about 35 miles from Shelikof Strait, where there is probably a northeast-southwest fault. T.A.J.

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No. 148 RELEASED WITHOUT COPYRIGHT RESTRICTION October 27, 1927

KILAUEA REPORT No. 822

WEEK ENDING OCTOBER 26, 1927

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

There are evidences in the Halemaumau walls of slides west and northwest during the past week, and some dust has been seen rising once or twice. In general, however, the pit has been very dry, quiet and free from steam.

During the week ending October 26 there were 20 local earthquakes recorded, and one teleseism. All the local shocks were very feeble, with the exception of one which was feeble, yet perhaps of sufficient strength to have been felt, though no reports have been heard of it. This one took place at 6:20 a. m. October 24, possibly through trigger action, superimposed upon the diminishing waves of the teleseism.

Tilt has accumulated moderately to the ENE during the week.

RECORD OF ALASKAN EARTHQUAKE

The preliminary phase of the distant earthquake recorded at the Kilauea Observatory has a feebly registered beginning at 5 h., 37 m., 48 s. a. m. October 24, and confusion at the beginning suggests that there were two individual shocks at the origin, separted by a few minutes of time. The distance to the origin, doubtfully indicated, is 2,800 miles, and the time of the shock at that place approximately 5 h., 30 m. a. m. A report from Petersburg, Alaska, states that an earthquake occurred there at 6:51 a. m., which appears to check closely with the computed time and distance above, and broke windows at that place.

The long wave phase here was large, lasting more than an hour and a half. The records indicated a heavy shock, which if under the ocean would have caused a tidal wave. Warning was therefore issued, but no tidal wave occurred, as the epicenter was not under the ocean.

This earthquake was well recorded on the newly established seismograph in Hilo, and also on the instrument on the other side of the island in Kona. These three instruments agree in showing a waxing and waning in amplitude of the long wave phase, periodic in nature, approximately two and a half minutes in cycle; the effect persisting through several cycles. This perhaps has meaning if the shock was a double one, as it suggests interference between two wave trains of slightly differing periods, starting from the two separate shocks. R.M.W.

THE ULTRA-BASIC MAGMAS

A generalization of far-reaching importance to volcanology is made by N. L. Bowen (American Journal of Science, August, 1927) to the effect that the porphyritic crystals in a basaltic lava, calcic feldspar and olivine, are virtually foreign to the liquid magma in which they occur, considered as a liquid melt. That is to say, all approach to ultra-basic chemical composition in porphyritic lavas, glassy rocks and fine grained dyke or sill rocks, resides in the effect of these phenocrysts on the analysis. The lavas of glass or fine-grained uniform crystalline material without phenocrysts, equivalent to the groundmass of the porphyries, never "remotely approach ultra-basic compositions."

The larger or more crowded the phenocrysts the more the approach to such extreme rocks as peridotites or anorthosites. When the crowding reaches the stage of a completely crystalline gabbro extremes of basicity may be attained never approached by effusives. Here the porphyritic and gabbroid rocks of Mull, for instance (see Volcano Letter No. 7, February 12, 1925), show feldspar phenocrysts four-fifths anorthite feldspar. Normal basaltic feldspar is only fifty per cent anorthite. Likewise normal basaltic olivine reaches only ten per cent of the rock. When an extreme type from Juan Fernandez analyzes 53 per cent normative olivine, it proves to be crowded with great porphyritic crystals of olivine, in a matrix of plagioclase and augite.

Bowen concludes that "the process of accumulation of crystals is not supplemented by significant re-solution of the accumulated crystals." He believes that ultra-basic liquids do not exist, corresponding in composition with the coarse granular or porphyritic rocks. Liquidity ceased with the crystallizing out of the porphyritic or coarse granular basic plagioclase and olivine. These represent chemical excesses incompatible with flowing liquids. "As the amount of accumulated crystals increases the mass becomes less capable of being poured out as a lava and to some extent of forming minor intrusives, and the extreme types occur only as a major intrusion." Only some pocket or part of a major intrusion can be the locus of accumulation of basic plagioclase crystals or olivine crystals.

Speaking of the feldspar, the following is Bowen's conception of how crystal accumulation starts and how it feeds the flow of porphyries. A rock that is "always porphyritic in its finer crystallizations" has no liquids corresponding to it in bulk composition. No matter how rapidly chilled and solidified, some of the feldspar remains as porphyritic crystals. These never were in solution in the matrix liquid that forms the groundmass. They were once in solution in some large mass of liquid of another composition, where they crystallized out and accumulated, presumably by a movement of crystals under the action of gravity either upward or downward. "No doubt other crystals were separating at the same time, but their motion differed either in magnitude or in direction."

"If the mass thus enriched in accumulated crystals is injected into surrounding rocks, or is poured out," it gives a basalt with porphyritic crystals. "If on the other hand it cools where it had its origin, or is moved elsewhere as a large mass, the continued outgrowth of crystal boundaries gives a gabbro" with porphyritic tendency lost or obscured.

The meaning of this for Hawaiian lava flows which show large porphyritic white feldspar crystals or green olivines, is that these minerals are lifted in a current of normal basaltic liquid from a region of partial crystallization deep underground. And that when the Kilauea lava lakes or the Mauna Loa fountains are fluid and splashing, if we could strain the molten glass through a metal screen, we would capture these crystals completely formed and probably not forming at all at the moment of capture. Both Kilauea and Vesuvius show included large lumps of granular crystalline olivine. These must be pieces of completed segregations of the excess basic matter of the deep major intrusion. All of this entirely agrees with the presence of crystalline olivine gabbro and porphyry so abundantly shown at the bottom of Halemaumau after the collapse of 1924. T.A.J.

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No. 149 RELEASED WITHOUT COPYRIGHT RESTRICTION November 3, 1927

KILAUEA REPORT No. 823

WEEK ENDING NOVEMBER 2, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

Changes in Halemaumau have been slight. On October 29 in the early afternoon the pit was dry and sunny, and the rain of the previous night had not increased the visible steam. There were slight steam jets in the upper parts of the northern, western, and southern talus slopes. The north floor cone steamed a little and showed increase of yellow stain. The middle cone showed only once a slight vaporing. Some feeble rock sliding was heard towards the north. On October 31 dust from numerous northern avalanches was observed at the pit morning and afternoon. In rainy weather, which brings out the rock colors, at 2 p. m. November 2, the pit wall was very brilliant with red oxides in contrast to the blue black of the new lava floor. The central and northern cones were giving off vapor, and the vapor on the debris slopes was condensing. Some sliding was heard at the southwest. The walls show more iron oxide color at the bottom than at the top, and more of this red dust on the lower western wall than on the eastern.

The number of earthquakes registered on the seismographs at the Observatory during the week ending November 2, is 9. Seven of these were very feeble. One which occurred at 2:38 a. m. October 28 was recorded as feeble here, but was stronger in Kona, being felt there as an 8-second tremble with a rumbling noise. It was recorded on the Kealakekua seismograph, and also on the Hilo instruments, the combined records showing that the origin of the shock was about four miles east of Kailua, Kona, on the southwest slope of Hualalai. Another earthquake was 19 miles from the Observatory. Tilt during the week has accumulated slightly towards the SW.

CRATERS MADE BY METEORITES

A remarkable report from Russia ("Science" Oct. 14, 1927, p. 352) states that the Soviet Academy of Sciences "has discovered the resting place of a large meteorite, estimated to weigh nearly half a million tons, which fell in a remote district of Yenesei Province, Siberia, in the summer of 1908. The site of the fall occupies over a mile in diameter in almost inaccessible terrain in a marshy forest. The meteorite fell in pieces, so that the ground is pitted with deep funnels from 50 to 100 feet in diameter. The forest for over fifteen miles around the place was completely leveled and the fallen tree trunks scorched. The fall, nineteen years ago, was registered on the seismographs at Irkutsk, 900 miles away, and in the towns of Kirensk and Ilimsk, about 250 miles distant. T.A.J.

SILENT ZONES AROUND EXPLOSIONS

It has been known for many years that great volcanic eruptions are sometimes heard several hundred miles away, when at places near at hand almost nothing is heard. Dr. Omori mapped these phenomena as recorded at various distances from Asama Volcano, and discovered that there are zones of audibility and zones of silence at different distances. Experiments are now to be made in England by firing big guns and broadcasting the sound by radio ("Science" July 15, 1927, p. xiv). People at all distances who are equipped with radio receiving sets may hear the guns by radio and then several minutes later hear the actual sounds as they arrive through the air. Dr. Whipple, of the Kew Observatory, reports that at a place 80 miles from the guns he has heard the sounds about 11 minutes after the firing. He says that it is agreed that such long-range sound records are produced by a layer of the atmosphere some 25 miles or more above the earth's surface, where the temperature is relatively high, and the sound waves are refracted down to earth again. The so-called Heaviside layer is known to reflect radio waves from the upper atmosphere, and this sound effect may depend on something similar. Through such a layer a sound inaudible 20 miles away might by reflection and refraction be heard at a distance of a hundred miles. During the Pelee eruptions in Martinique of 1902, it was positively proved that explosions from the volcano unheard at Fort de France, 12 miles away, were heard at Barbadoes, 150 miles away directly to windward.

T.A.J.

A VIBRATION MICROPHONE

"Science" reports (July 15, 1927, p. xiv) that the Type H inertia microphone of the Bell Telephone Research Laboratories has been modified so as to record selectively minute vibrations of the walls of a safe, while refusing to pick up sound waves or such noises as are made by a heavy truck rumbling by the building. It is said that when this instrument is placed in a bank vault, it is unaffected by subway trains rumbling by, but is instantly affected by anything which touches the safe itself, however slight. The instrument is said to be small and compact, several may be placed at strategic points liable to burglarious contacts, and the slightest local disturbance summons the police.

It may be inquired whether this instrument would not be of great value in local seismometry so as to transmit, say from small drilled wells in the rock, the times of first vibration of earthquake at different places to a central station. T.A.J.

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No. 150 RELEASED WITHOUT COPYRIGHT RESTRICTION November 10, 1927

KILAUEA REPORT No. 824

WEEK ENDING NOVEMBER 9, 1927

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

There has been little in the behavior of Halemaumau pit to justify the excessive spasmodic trembling of the seismographs. On November 5 in clear, dry weather, the pit was quiet with only small patches of visible vapor Slight sulphur stain has developed at a wet steam vent 200 feet up the south talus. In the afternoon there were slight slippings of debris at the south and north walls. On the 7th at 1:15 p. m. a considerable avalanche fell at the northeast. At the same place another sent up dust about 8:30 a. m. the 8th, the dust hanging over the pit for a quarter hour. Today, the 9th, there is new debris on the NE, N and SSW slides, and some dust has arisen at the north.

During the week the Observatory seismographs have recorded 68 very feeble local earthquakes, and one moderate distant earthquake. The number of local shocks is a definite increase over the general average for the past months. The numbers increased during the first days of the week, reaching a climax in frequency on the afternoon and early evening of November 5, this swarm then coming to a surprisingly abrupt halt at 9:40 p. m. On the 6th there was none recorded. The 7th and 8th together produced but six shocks, suggesting a return to the same general average as before.

The teleseism occurred in the early morning of November 4. The preliminary was recorded at 3:28 a. m., the ensuing phases suggesting a distance of 2,400 miles. The other instruments on this island, at Hilo and Kealakekua, also have good records of the shock. Before news of the earthquake was issued, a report came from Hilo that at 9 a. m. there was observed at the end of the breakwater a slight unusual rise and fall of water level. This may perhaps have been a small tidal wave resulting from the shock, though the tide gauge records have not yet been inspected. Press reports indicate that the shock was strongly felt in California, and that trains were delayed for an hour or so north of Santa Barbara.

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

ISOSTASY, EARTHQUAKES AND VOLCANOES

Referring to Omori's view that earthquake centers are not deeper than 27 kilometers below the surface of the earth, William Bowie writes (Isostasy in Geophysics and Geology, Journal of the Washington Academy of Sciences, March 4, 1927):

"The four major causes of earthquakes would seem to be (1) the breaking of crustal material caused by the weight of sediments, (2) the breaking of rock as the crustal material is pushed up under the area of erosion to restore the isostatic balance, (3) the breaking of the rocks as the result of the expansion of the crustal material under an area which had previously undergone heavy sedimentation, and (4) the breaking of rock caused by the contraction of crustal material under an area which had previously undergone erosion during an extended time.

"According to the Pratt theory of isostasy, the overflow of lava from a fissure or from a volcano is probably caused by an expansion of the crustal material below. No extra mass has been added to the prism of the crust involved. It is merely a case of fluid material from some depth within the crust being raised to the surface, increasing the volume of the prism and decreasing the density. Whatever processes cause the uplift of a mountain system undoubtedly cause the volcano and the lava overflow.

"It would seem that the earth is gradually losing heat as the result of erosion and sedimentation. As the eroded material is carried away, the prism of the crust beneath is forced up to restore the equilibrium. Erosion may have occurred to the extent of five or ten miles before an uplifted area is baseleveled. In such a case every element of the crust beneath would have been raised to a position approximately equal to that distance and would have been brought to a region having a much lower temperature than that of the region from which it came. Eventually there would be a loss of heat at the surface, and the material of the prism would be cooled down by 100° to 300° C., depending on how far the crustal material had been pushed up. That heat lost would not be compensated by heat gained in other places. The areas of heavy erosion later become synclinoria into which sediments are deposited. The sediments accentuate the synclinoria, resulting in a pushing down of crustal material into hotter regions. Eventually this material takes on the temperature of its new position, expands to form mountain systems or plateaus, and again loses heat at the surface. What maintains the heat of the earth no one knows. There have been many theories, including the one now advocated by many, that the disintegration of radioactive materials replaces heat in sufficient amounts to cause the surface of the earth to remain at a practically constant temperature. Be this as it may, we cannot escape the conclusion that the raising up of crustal material under areas of erosion brings hotter material to the surface with a consequent loss of heat.

"It is rather difficult to see how a volcano could come into being out in the middle of an ocean, but, in general, volcanoes are merely a part of a region that is higher than the surrounding bottoms of the ocean. The Hawaiian Islands, for instance, occupy a long stretch extending for some 1,200 kilometers, while the average width of the pedestal on which the islands rest is of the order of magnitude of 140 kilometers. There must have been light crustal material where the islands now are at the beginning of the sedimentary age, and the uplifts and subsidences of the Hawaiian area have been the result of erosion, sedimentation, and to a certain extent of the accumulation of rock from coral growth. It is very difficult to explain a chain of islands out in an ocean without assuming under it crustal material which has been lighter than normal density from the beginning of the sedimentary age."

The recent determinations of gravity on the Island of Hawaii by Major Bowie's associates have shown positive anomalies or excess densities everywhere on the island, anomalies growing greater at the summit of Kilauea than at shoreline, and still greater at the summits of Mauna Kea and Mauna Loa. Dr. Bowie points out that there is an outstanding average positive anomaly over the sea bottoms as shown by reductions of Dr. Meinesz's pendulum work in a submarine. The Island of Hawaii, then, shows gravity conditions similar to those of the great ocean bottoms. This does not quite agree with the above assumption of "crustal material lighter than normal density." It may be, however, that the Hawaiian ridge began with the piling up of light siliceous lavas, and is now subsiding with heavy gabbros crystallizing in its core. T.A.J.

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No. 151 RELEASED WITHOUT COPYRIGHT RESTRICTION November 17, 1927

KILAUEA REPORT No. 825

WEEK ENDING NOVEMBER 16, 1927

Section of Volcanology, U. S. Geological Survey:

T. A. Jaggar, Volcanologist in Charge

The "blue black" of the new lava floor of Halemaumau, described on November 2, was obliterated under tan-colored dust about November 10. In the night between November 10 and 11 numerous earthquakes were registered, and at 2:40 p. m. of the last date rocks were sliding from the south wall, which was streaked with dust, and the lava floor of the pit was thickly coated with it, especially at the south. The northeast corner showed a new scar. A crack had widened at the east rim. At 2:50 a somewhat continuous slipping of stones occurred at the south, at 3:10 bowlders tumbled the full length of the south talus, and 10 minutes later there was more active sliding of fine and coarse material at the south. Much gray dust arose. The middle and north cone vents were steaming, and the southwest cone steamed in puffs.

At 11 a. m. November 13 the pit was quiet, but the floor dust was very thick under the southwest rift tunnels. A few stones were in motion at the south. The sulphur patches east were still yellow and not dust-covered. At 9:40 p. m. a noisy avalanche was heard, followed by a smaller one.

Today, the 16th, there was a little sliding south and northwest, but the conspicuous feature was the cracking of rim ground for fifty feet back at the south, with hanging edge blocks and freshly broken soil.

Evidences of increased local seismic activity continue. There have been 62 local earthquakes recorded during the week ending November 16, and one feeble teleseism. The local earthquakes were all very feeble with the exception of the one which was felt in Hilo at 6:10 a. m. on the 11th. This one was slight in Hilo, and even weaker at the volcano, being barely above the very feeble class at the latter place. It appears to have originated beneath the east flank of Mauna Loa. The shocks included in the above count show character in that they tend to come in swarms, and many are of the small spasmodic tremor type. One such swarm, five tremors within ten minutes, culminated in the earthquake just described. Another more marked swarm, between 1 a. m. and 1:50 a. m. November 16, includes 21 separate very- feeble earth quakes. The distant earthquake is too feebly recorded to indicate the epicentral distance; the preliminary phase apparently began at 10:07 p. m. on the 24th. Microseismic motion increased in strength during the 15th, and was still strong on the morning of the 16th. Tilt during the week has accumulated moderately to the northeast.

FALCON ISLAND

Press reports in England describe new heaping-up of the volcano Falcon Island in the Tonga group, about 30 kilometers north of Honga Hapai. The British warship "Laburnam" on October 8 describes the volcano erupting every 20 minutes, and forming an island 1,730 yards long N-S and 1,430 yards E-W. The crater is said to be 305 feet above sea level. The eruptions each last about one minute and consist of "columns of steam and lava." The sides have a gradual slope.

Falcon is like Bogoslof in its record of rising and being washed away repeatedly. It was a shoal in 1867, smoking 10 years later, erupting 11-13 October, 1885 along a northeast line two miles long, with great ejections of cinder and ash. The island formed was 150 to 300 feet high and over two miles long. In 1889 it had a cliff 150 feet high, in 1892 it was only 27 feet high, and in 1894 it was a mile and one-half long 20 to 50 feet high, and very hot in places, with a lake in the center four to five feet deep. In 1898 and 1900 it was only a shoal, and it was reported to have disappeared in 1913 (J. A. Thomson, N. Z. Journ. Sci. & Tech., Dec. 1926). T.A.J.

VIENNA EARTHQUAKE

The press reports a strong shock in Vienna at 8:49 p. m. October 8, upsetting old houses, stopping clocks, breaking chimneys, cutting off telephone and telegraph communication, stopping tramways, and starting panic in the theaters. An oil fire was started in a suburb. Village houses were damaged in lower Austria, and the people camped in the open.

An earthquake in a large city like Vienna always leads to thoughts of New York, and the following is of interest in this connection ("Gas Logic," published by the Consolidated Gas Company, New York, October, 1927, page 13):

"The nearest Manhattan ever came to the source of an earthquake was the tremor which shook Long Branch, New Jersey, on June 1, 1927. But it was the Charleston, South Carolina, quake of 1886 that destroyed New York's equilibrium. The upper west side of the Island was greatly affected especially in Harlem, where entire blocks of buildings shook to such an extent that mortar dropped from the brick walls, furniture rocked, and pictures fell from the walls." T.A.J.

THE ALASKA EARTHQUAKE OF OCTOBER 24, 1927

Seattle newspapers report that this earthquake was severe in Juneau and Sitka, with north and south movement at Juneau lasting 30 seconds and followed by three lesser shocks. Sitka reports two heavy shocks at 6:59 a. m. and five minutes later, respectively. The Sitka seismograph pens were flung to the southeast. Windows were broken at Petersburg. Telegraph cables were broken near Wrangell and between Juneau and Skagway. The epicenter is located on land in the basin of the Alsek River, about 100 kilometers east of Yakutat (Jesuit Seismological Association, Preliminary Bulletins). The various northwestern American seismographs were dismantled, and seismometrically the earthquake was very big. The two shocks check with interference phenomena shown by our record at Kilauea (Volcano Letter No. 148). Apparently heavy fault movements occurred from the Fairweather Range southeastward, and our expectation of a tidal wave would have been abundantly verified if the disturbance had been under the ocean a few miles to the west. T.A.J.

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No. 152 RELEASED WITHOUT COPYRIGHT RESTRICTION November 24, 1927

KILAUEA REPORT No. 826

WEEK ENDING NOVEMBER 23, 1927
Section of Volcanology, U. S. Geological Survey:
T. A. Jaggar, Volcanologist in Charge

Halemaumau remains dormant and the spell of excessive seismicity has waned, probably following the fortnightly law (see Volcano Letter No. 143, September 22, 1927). Some noise has been heard and avalanche dust has been seen over the pit, but mostly it has been quiet.

On November 19 at 4:15 p. m. rocks were heard falling once or twice at the north, and fresh brown debris lay on the northeast talus. Recent rains had washed into puddles some of the floor dust which had discolored the lava. Much dust was seen blowing away in clouds at this time, for several days, at the west rim of Kilauea Crater, owing to strong northeast wind.

Today, the 23rd, a little steam is rising at the hole in the middle floor cone, and the northeast talus has fresh dark red fragments from a wall scar of the same color above. It is noteworthy that the cracks of 1924 at the road terminus now steam hardly at all.

The seismographs at the Observatory have recorded 33 very feeble local earthquakes and one teleseism during the week. On the 17th, at 5:02 a. m., and again at 5:50 a. m., there occurred prolonged tremors, lasting about 5 minutes in each case. At 3:55 p. m. on the 18th, and at 12:11 p. m. on the 19th, there were other similar tremors of several minutes duration. These seem to suggest disturbances due to avalanches rather than harmonic tremor. The distant earthquake was very feebly recorded, its long wave phase beginning at about 8:45 p. m. November 18. No estimation as to distance could be made. Microseismic motion was strong on the 16th and 17th, but diminished to normal amplitude during the following days. Tilt has accumulated moderately to the NNE during the week.

GASES OF MT. PELE'E IN MARTINIQUE

Thorough chemical analysis of five specimens (Gases of the Mt. Pele'e Lavas of 1902, by E. S. Shepherd and H. E. Merwin. Journal of Geology, February-March 1927) representing the old and new lava of Mt. Pele'e for the great eruption of 1902, which destroyed St. Pierre, reveals remarkable uniformity of siliceous hypersthene andesite, with free silica in the form of tridymite in the groundmass. The analyses show almost no change of composition as between the old peak and the fresh lava of 1902. The glassy forms of the rock contain more gas than the crystalline ones. Silica averages 63 per cent, and the normative quartz 21 per cent. It was found that the determination of water from rock powder gave excessive values as compared with melting chips in vacuo. The powder takes up water.

The total volatile constituents amount usually to from 5 to 7 Cc. per Gm. of rock, one exceptional glassy shell of a bread-crust bomb giving 26 Cc. per Gm. Water vapor averages about 80 per cent of the total gas volume at 1,200° C., and carbon dioxide 9 per cent. Chlorine is 0.6 per cent, fluorine 2 per cent by volume, large because of its small atomic weight, though amounting to only 0.005 per cent of the weight of the rock. Sulphur and carbon monoxide are about 1 per cent each, and hydrogen about 0.3 per cent. Hydrogen is notably more abundant in the glassy specimens. Water is at a maximum in the glassy shell of the bomb (96 per cent). At 1,000° C. each cubic meter of issuing lava has 50 cubic meters of gas, or a minimum partial pressure of 50 atmospheres. Even the pumice contains nearly 7 Cc. of gas to the Gm., showing that it had not yet parted with all its volatile constituents.

The excessive gas in the shell of the bread-crust bomb reverses Lacroix's explanation for the cracked crust. He thought the shell cooled suddenly, expelled its gases, and so produced shrinkage cracks. Shepherd and Merwin explain the bread-crust as having cooled before vesiculation gets under way, so as to imprison the gases. The more slowly cooling interior allows vesicles to go on forming with a swelling which cracks the shell. This gas evolution in large blocks may continue for days and reduce them to piles of detritus. Crystallization throughout the mass may liberate heat and so maintain the vesiculation temperature. Such a rock would be instable if suddenly erupted into a region of low pressure.

"The conditions under which bread-crusting can occur are very limited. Possibly a temperature change of 100° or less determines whether a bomb shall develop a bread-crust surface, or completely expand to pumice."

The fluid mobility of a glass is much greater when it contains gases, and gas-charged glass will flow at about 900° C, whereas the hardened threads left after frothing require 1,250° C. to melt them.

"It will be noted that the relationships between temperature, viscosity, volatile content, and gas pressure in relation to the magma, are complex. Increased concentration of volatiles implies a reduction in viscosity accompanied by an increased pressure if the temperature remains constant. Increase of temperature implies rise in pressure and decreased viscosity, and vice versa. A crystallizing rock, by concentrating volatiles in the mother-liquor, raises the pressure and lowers the viscosity, with, however, two opposing forces: the increase in viscosity due to lowering temperature and in some cases increased silica content of the mother-liquor." The increase of silica increases viscosity unless the glass is at the same time enriched in gases.

The authors explain the down-rushing ash clouds of Pele'e as having at least 70 cubic meters of gas at a pressure of 50 atmospheres at 1,200° C. for each cubic meter of lava. The gas was chiefly steam. The heavy rumbling explosions accompanied a forceful ejection laterally of a momentarily glowing mass of lava from the wall-crack where the lava dome made contact with rock substratum. This emulsion "was possessed of ample energy to keep it well stirred and prevent its coming to rest until the gas evolution had quieted down by cooling." The internal partial pressures of the volatiles in the glass are estimated at over 100 atmospheres where they lifted the heavy spine that rose continuously in the Pele'e dome.

"For its explosive impetus each eruption depended upon the available mobile vesiculated lava and carried with it material less vesiculated which supplied energy gradually to the cloud after it detached itself from the peak." This shows the importance of preliminary vesiculation to produce the phenomena of eruption. T. A. J.

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No. 153 RELEASED WITHOUT COPYRIGHT RESTRICTION December 1, 1927

KILAUEA REPORT No. 827

WEEK ENDING NOVEMBER 30, 1927

Section of Volcanology, U. S. Geological Survey:

T. A. Jaggar, Volcanologist in Charge

Halemaumau pit remains quiet. Visits to the pit November 27 and 30 in the forenoons showed that rain produces visible vapor from the rock walls in places and great increase of visibility of floor vapor. There have been little slides making dust from time to time, chiefly from the northern walls.

During the week the seismographs recorded 20 very feeble local earthquakes.

Tilt during the first part of the week accumulated moderately to the SSE, but partly recovered this motion on the 28th and 29th, so that the net accumulation for the week is only slightly to the SSE.

KODIAK STATION REPORT

October 31, 1927

The first shocks recorded on the seismograph installed in Kodiak, Alaska, last summer, were mentioned in Volcano Letter No. 147, October 20, 1927. The instrument was started August 8, and there were four earthquakes recorded during the remainder of the month. In September, there was but one very feeble shock recorded. Microseismic motion is usually slight, but occasionally increases in intensity over a period of one or two days. Thus September 2, 17 and 23 were days which show records of strong microseismic motion, perhaps caused by wind or stormy weather.

October was a more active month. There were 11 local earthquakes recorded, and an excellent record was obtained of the big earthquake which occurred in southeastern Alaska on the 24th. The local shocks were perhaps too small to be perceptible, though the ones which came at 1 a. m. on the 23rd and at 11:50 p. m. on the 31st may have been felt. These earthquakes appear to have taken place 28 miles and 22 miles, respectively, from Kodiak. Some of the others showed distances of 30, 37, and 101 miles to the epicenter. During the month there were three periods of increased microseismic motion, perhaps caused by stormy weather. These came on October 3, 14 and 27.

The earthquake of October 24 recorded its preliminary wave at 6:01:44 a. m. Kodiak time (16:01:44 Greenwich Civil Time). The secondary wave came at 6:03:12, the long wave began at about 6:03:41, and the maximum motion was at 6:07:30. The resulting indicated distance is 510 miles from Kodiak to the epicenter, which is in good agreement with the scaled distance to the origin as now known. The indicated time at origin of the shock is 5:59:56, which also is in very good agreement with the time determined by the various other observatories. Details of this earthquake have been mentioned in Volcano Letters Nos. 148 and 151. R.M.W.

LASSEN REPORT No. 12

Mineral, California, November 18, 1927

R. H. Finch, Associate Volcanologist

A wireless set for time service was installed in June at the Lassen Station, through the good offices of Charles A. Huff of San Francisco. During the summer months many tourists visited the observatory. Mr. Finch worked on construction of a portable seismograph for installation eventually near Lassen Peak. The National Park road to the peak is advancing rapidly. Messrs. C. A. Anderson and Howell Williams, graduate students in geology from the University of California, were among the visitors to the laboratory, and Mr. Williams spent three weeks at work in the district, studying the petrography and mapping Chaos Crags and Chaos Jumbles near Viola. Mr. Austin E. Jones on July 9 became temporary assistant and seismological observer, remaining until the end of August .

During July and August explorations were made and photographs taken by Messrs. Finch and Jones at Lassen summit, Brokeoff Mountain, Magee and Prospect Peaks. Notes were made on faults and fresh-looking lava flows, having in view the mapping of several of the latter. It looks as though there had been one or more lava flows per century in the Lassen country for many hundred years past. Measurements were made of temperatures of hot springs at Supans, Bumpass Hell, Morgan's, and in the Upper Warner valley. Mr. Jones made preliminary tests of the age of the Cinder Cone lava flows by magnetic methods (see Volcano Letter No. 144, September 29, 1927).

It is planned to equip the observatory at Mineral with a new two-component Hawaiian seismograph uniform in mechanism and constants with the instruments at Hilo and Kodiak, and to make the present Lassen seismograph, built by Mr. Finch, an exhibition instrument in the Loomis Memorial Museum at Manzanita Lake.

Among the activities of the Lassen Volcano Observatory is weather recording, a matter of considerable importance in relation to hot spring work, seismology, and on account of the excessive snow falls of winter. The U. S. Weather Bureau has kindly furnished the equipment of a regular cooperative observing station; maximum and minimum thermometers, and a rain gauge. The road between Mineral and Red Bluff was kept open in 1926-27, excepting for two weeks in February. The inner roads were blocked with snow between mid-January and April 25, sometimes five feet deep. This winter marked the opening of Mineral as a place for winter sports, the Sunday afternoons showing 50 or 60 cars parked by the store, whither people from the valley came for snowshoeing, sledding, tobogganing, etc.

The Lassen seismographs gave very large records of the Alaskan earthquake of October 24, 1927, as well as the one off the coast of California on November 4. The needles of each component went clear off the sheet during the two earthquakes. The Omori tables seem to work for California earthquakes as the distance indicated from the Mineral seismographs agreed with the records from Berkeley and Santa Clara. The depth of the California shake appears greater than the average for this region.

On October 20, 1927, three sharp local shocks occurred. The first was the strongest and made windows rattle and buildings creak within a range of 15 miles from the peak. All shakes were preceded and accompanied by rumbles. These shakes occurred distinctly before fall rains had set in. The earthquakes mentioned in first Lassen report occurred on October 13, 1926, after there had been some heavy rains, only a few days before the shaking. There is a saying current here that with a wet fall there are many earthquakes and with a dry fall but few. The saying may be founded more on fancy than on fact.

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No. 154 RELEASED WITHOUT COPYRIGHT RESTRICTION December 8, 1927

KILAUEA REPORT No. 828

WEEK ENDING DECEMBER 7, 1927

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

Two visits to Halemaumau show little change over last week. No avalanches have been noted, and only a few slides have occurred. One small slide was observed at 11:40 a. m. December 6 at the lower part of the northeast wall. The north wall has a few new scars. At 10 a. m. December 7 the pit was quiet, wet from the recent rains, and full of color. Steam vents were very active, particularly at the center cone.

The week ending December 7 is of considerable seismological interest. The instruments recorded 98 local earthquakes during the week, of which two were slight but perceptible, the rest being very feeble. This unusually large number is due to a series of small shocks of the spasmodic tremor type, beginning at 5:58 a. m. on December 3, increasing in numbers on that day to a maximum frequency at about 6:30 p. m. At this time they were occurring at fairly regular intervals, on an average of six minutes apart. They then became less frequent, but the series persisted during all of the next day, coming to an end at 2:27 a. m., December 5. These spasmodic tremors were on the whole very similar to one another in character, intensity and individual duration, though toward the end of the series their intensity was somewhat diminished. The total number of tremors counted in the series was 76, of which 47 came on December 3. This is the greatest number for any one day since the tremendous numbers which occurred during the Mauna Loa eruption in April, 1926. Treated as earthquakes, some of them displayed a preliminary phase from which distance could be estimated. From the average of these it would appear that the disturbance was about 18 miles from the Observatory. Phenomena of this type are distinctly of volcanic origin. Careful attention was therefore paid to Mauna Loa and Kilauea, for other possible symptoms of outbreak. No other signs of activity were observed, however. The fact that harmonic tremor, which comes hand in hand with eruption of lava, was totally absent from the records, served to diminish the idea of immediate activity. The suggested crisis is apapparently past, as the instruments are now recording nothing unusual. The occurrence of such phenomena, however, is sure evidence of volcanic life within the mountains of Mauna Loa and Kilauea, which in time may be expected to display itself at the surface.

The two earthquakes that were of slight intensity, and were perceptible, came at 10:09 a. m. December 1, and 7:37 a. m. December 6. The first of these was reported felt both in Hilo and at the volcano. It was well recorded on the seismographs at these places, and a very feeble record was made on the instrument in Kona. These records combine to indicate that the origin was near the Puna rift line ,about 12 miles east of the volcano. The second slight shock was apparently local to the volcano, as the motion broke abruptly into maximum amplitude, without appreciable preliminary phase. It was felt by a number of persons in this vicinity, and was accompanied by a rumbling noise. It was followed four minutes later by a very feeble after-shock.

Microseismic motion has been normal during the week, and tilt has accumulated moderately to the NNW.

HILO STATION REPORT

A description of the Hilo seismographic installation appears in Volcano Letter No. 142, September 15, 1927. The instruments are of the same type as those installed at Kodiak, Alaska. The more important recordings of the Hilo station have been mentioned from time to time in the Volcano Letter, when they have had a bearing on the data obtained at the Hawaiian Volcano Observatory. The Hilo station is about 23 miles in air line distance from the Observatory, so that in general the stronger local shocks are recorded at both stations. This is a convenient arrangement, since by plotting indicated distances it is possible to determine the point of origin of many of the local earthquakes. The plotted distance from the Kona station aids in such determinations. This is a well known method, and has been used for a number of years here. The new installation at Hilo is somewhat more sensitive than the old instrument, making possible the plotting of more of the feeble shocks.

During the month of October, 1927, there were recorded at Hilo 13 local shocks and one teleseism. The recording of the distant earthquake (October 24) has already been described in Volcano Letter No. 148, October 27, 1927. None of the local earthquakes was reported as perceptible there ,and they were with one possible exception of the very feeble class. Of the 13, nine were recorded at the Observatory also. There was strong microseismic motion on the 17th and 18th.

The November records show 12 local earthquakes, 10 being very feeble. The other two were slight, but were perceptible in Hilo, and occurred at 6:12 a. m. November 11, and at 9:13 p. m. on the 21st. There were nine of the 12 recorded also at the Observatory. In addition to the local earthquakes, there were three teleseisms recorded, one at 3:35 a. m. November 4, which has already been mentioned, another very feeble trace is shown at about 9 p. m. on the 17th, and the third was a slight but definite record of long waves at 8:48 a. m. on November 18.

The Hilo records are exceptioanlly free from such bothersome disturbances as diurnal tilt, traffic movements, or pen displacements due to room or instrument temperature changes. The massive construction of the concrete walls and roof of the seismograph cellar, combined with the fact that the structure is set deep into the ground and is in a location shaded by trees, is perhaps responsible for the small temperature range within the instrument room. The situation is distant from any highway, and local external disturbances are infrequent.

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No. 155 RELEASED WITHOUT COPYRIGHT RESTRICTION December 15, 1927

KILAUEA REPORT No. 829

WEEK ENDING DECEMBER 14, 1927

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

At Halemaumau on December 10, at 2 p. m., one small slide of rock was heard. A slide was heard from Uwekahuna December 13 at 3:55 p. m. Today, December 14, about noon small rockfalls occurred every 5 or 10 minutes at the northeast, north and south walls. The air was perfectly still, and no other noise, such as hissing, was heard. Recent avalanches have scarred the walls all the way to the upper edge NW, NE and SW. The heavy rains now wet the entire north sill, which was formerly so hot that it resisted soaking. There are, however, large dry patches at the top of its east end, in the wall above that point, and on the north side of the west boss.

The total number of earthquakes registered on the seismographs at the Observatory during the week ending December 14 was 21. These were all very feeble at this place. One at 4:13 a. m. on the 10th had an indicated distance of 37 miles, and was reported as perceptible in Hilo.

LASSEN REPORT No. 13

Mineral, California, November 25, 1927
R. H. Finch, Associate Volcanologist

Between 9 and 11 p. m. November 24, nine local earthquakes were recorded on the Mineral seismographs. Three were perceptiple. The perceptible quakes and some of the unfelt ones were accompanied by deep rumbling noises. The occurrences of single earthquakes seem to be well distributed throughout the year, while the earthquake "swarms" appear to be confined to the winter months. It will be interesting to watch in the coming years to see if this relation continues.

CENTRAL OREGON VENTS

Dr. E. T. Hodge, investigating fossil forests in the volcanic strata of central Oregon (New York "Times," October 2, 1927), doubts the evidence reported in the nineteenth century by Russell that the lava welled from fissures, and says that "with the exception of one place in the eastern John Day country, he has not found any of the postulated fissures." Instead of this, the lava welled from craters, and in some instances the flow virtually buried these craters, erosion removing further evidence. He pointed to the many craters in the Deschutes country as proof of the crater theory. T.A.J.

ERUPTION OF SOLFATARA

The report in the newspapers (Seismological Despatches, Georgetown University) dated at Pozzuoli, Italy, August 1, 1927, is extraordinary if true. It states "in sympathy with Vesuvius, the volcano known as the Solfatara today resumed violent activity for the first time recorded since the year 1198. It hurled skyward from the center of its semi-extinct crater quantities of blazing hot, but dry, sand." T.A.J.

THE PALESTINE EARTHQUAKE

A very serious earthquake in the Holy Land occurred just at the time when Kilauea was last in action. The "Richmond River Express" of September 16 (Richmond, Australia), cites a letter giving details. The writer, Mrs. Drayton, had been having her house newly decorated; "we had just finished putting up a bed, when there was a most terrific noise like hundreds of tube trains approaching at once. The house commenced to rock, and I was thrown over against the wall—gazing upwards. Saw the ceiling at an angle of about 45 degrees. The plaster began to fall. We bolted for the children, fled from the house, and stood in the road.

"When we eventually crept gingerly back again we discovered that we had not one whole wall or ceiling, and all our six weeks decoration had gone for nothing in 10 seconds—less than 24 hours after the work had been completed. It was a very upsetting experience. I am quite certain that I had never before felt real fear—air raids in London and submarines left me cold compared to this. The casualties are 200-odd killed and 385 seriously injured, and about 100 minor injuries in Palestine. Then 68 killed in Trans-Jordania, and about 500 injured.

"Nablus suffered very heavily. Government House, on the Mount of Olives, was damaged to the extent of £50,000. Lord Plumer was on leave, and if he had been here would probably have been killed.

"We had another less severe shock on the following Sunday, the 17th, and several minor tremors. Although the loss of life was not very severe in Jerusalem, the damage to property was considerable, the houses of three senior British officials fell down and others have been condemned. In the Bennetts' house, on the opposite corner to ours, the cistern burst and the place was flooded, they being away on leave." T.A.J.

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No. 156 RELEASED WITHOUT COPYRIGHT RESTRICTION December 22, 1927

KILAUEA REPORT No. 830

WEEK ENDING DECEMBER 21, 1927

Section of Volcanology, U. S. Geological Survey:

T. A. Jaggar, Volcanologist in Charge

At Halemaumau pit December 12 at 2 p. m. there was nothing new in evidence, no slides were heard and the slopes appeared undisturbed after excessive recent rain.

During the week there were 37 local earthquakes recorded on the Observatory seismographs. All of these were very feeble with the exception of one which occurred at 3:37 p. m. on the 18th. This one was feeble, but was felt locally; the origin of the shock was apparently within two miles of the Observatory. Two earthquakes were felt in Hilo on the 15th, one at 2:07 a. m., the second and stronger one being at 6:01 p. m. Distances indicate that these shocks originated on the northeast rift of Mauna Loa.

Tilt has accumulated during the week moderately toward the NE.

A WHEELED BOAT FOR VOLCANO EXPLORATION

Aleutian Island explorations in 1907 led the writer to wish for a wheeled boat that would beach itself. The father to the wish was the experience in a schooner of nearly landing at Vsevidof Volcano, finding no anchorage, and being forced to go to sea. In 1927 he tried a low-geared small motor car with balloon tires on tundra and beach of the Alaskan Peninsula. Traveling was practicable, but inlets, rivers, and rocky stretches were obstacles. Again the beach boat became desirable, a boat motor-car that would launch itself, and resume land travel along favorable beaches. The beaches in many volcano lands are nearly continuous, and the shore line is a natural highway. Where storms and fogs are frequent, life at a shore camp, with gasoline power, electric lights, electric or gasoline heating, and tent extension of the vehicle, is more flexible than in a boat cabin restricted to safe anchorages, which are few and far between.

Numerous patents have been obtained for amphibious boats, and the Mobile-boat of Powell in Chicago is to be tried out next summer in Alaska. This is a Ford truck chassis with steel boat body and twin screws. At the observatory shop at Kilauea, we have converted the Alaskan motor car of 1927 into a car-skiff for experiments in traveling along the shores of Hawaii and camping on the beaches. The principles of the new beach boat differ from that of Powell: a 16-foot flat-bottomed skiff by Kneass of San Francisco has a Ruckstell-Ford car chassis of 1926 mounted on oak timbers inside, and a Smith "Formatruck" chain drive rear axle has been adapted to support a stern extension of the skiff on double springs, using the Ford wheels. The Ford front axle and steering-gear are adapted to the bow of the boat. We thus get a substantial lorrie with a skiff body.

For the water drive, the counter-shaft holding the front chain sprocket of the driving mechanism carries two light steel paddle wheels 24 inches in diameter expected to be about one-third immersed. These paddles are removed and carried inboard during land traverses. The balloon-tired land wheels will be largely submerged when the boat is in the water, the rear ones continuing to revolve. The land wheels necessarily cut down the speed in water, but act somewhat as low ballast, and the disc surfaces oppose lateral leeway. The disc front wheels act as rudders in the water with the same steering wheel as on land. By jacking up the boat in shallow water, removal of 10 bolts aft and five forward, sets free all the running gear, which may be left on the beach or stored inboard for a long water run at higher speed than otherwise.

Tests of the boat-car on land have been satisfactory, and the water test will be made in a few days. There remain the various adaptations to sounding, camping, cooking, protection against the weather, winch, stake, and cable contrivances for hauling the car over steep or rough land, and tests of caterpillar chain treads, mud hooks and the like for driving through soft ground. All of this work, under the Hawaiian Volcano Research Association, is in sequence upon a long series of experiments in driving over desert and lava whereby cross-country cars have been used for many years at the Observatory. Much of this work was necessitated by the requirements of drilling for temperature measurements. Heavy drill rigs of three different types have been hauled, and 34 bore-holes have been made, mostly on the lava floor of Kilauea Crater.

It is planned to do practical work in exploring the Kona coast with the beach-boat. There is great volcanologic interest in sounding and dredging at Hoopuloa and Alika where the recent Mauna Loa flows entered the sea, and it is reported that the U. S. Coast and Geodetic Survey is about to begin operation with the U. S. S. "Guide" mapping in detail the west Hawaii harbors. The best of these is Kealakekua, where in 1876 there was submarine eruption, and pumice was reported to float up hot. Dredging would be of interest here. Echo and wire sounding admit of important experimental work in volcanology, with a view bottom such as the Alika flow, what is the character and density of the underwater rock, and how can it be diagnosed by sounding apparatus as different from the sea-bottom round about? If by noise, or feel, or sampling such a flow can be outlined, an important scientific advance can be made. For where are there other such submarine lava flows? They may be found off the Puna and Kau coasts. There have been many occasions when the sudden drainage of lava from Halemaumau pit led to suspicion of submarine quiet flow. Here is where it behooves volcanology to join hands with oceanography.

The first Kona expedition will be directed to exploring and collecting the Hualalai and Mauna Loa lavas of North Kona where the many flows have entered the sea. For this country now the Geological Survey has admirable topographic maps, and there are numerous beaches here and there to serve as landing places for making camps. The 1859 flow built out much new land and its lower fields have never been explored geologically. T.A.J.

The "Palestine Earthquake" described last week occurred July 11, 1927, at 1:10 p. m. Greenwich time (3:10 p. m. Palestine).

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No. 157 RELEASED WITHOUT COPYRIGHT RESTRICTION December 29, 1927

KILAUEA REPORT NO. 831

WEEK ENDING DECEMBER 28, 1927

Section of Volcanology, U. S. Geological Survey

T. A. Jaggar, Volcanologist in Charge

After a week of excessive rainfall, wherein Halemaumau pit has been continuously full of vapor, the scene from the edge today, December 28, at 3:15 p. m., was of a faintly visible cauldron with hundreds of vapor jets on the bottom blown from the west, and many others on the walls. Avalanches were almost continuous, several moderately strong ones occurring within a 15-minute stay. They were mostly from the northern walls, but occasionally rocks fell at the south. The bottom did not appear changed in configuration, and the rock sliding was probably due to undermining occasioned by the excessive washing-out of the finer material.

During December to date rainfall has amounted to 42 inches at the Observatory, and the daily rainfall, beginning December 21, was 1.85, 3.00, 0.95, 2.00, 7.80, 4.50, and 7.45 inches. This was one of the heavy winter "Kona" storms from the southwest.

The Observatory seismographs have recorded 30 local earthquakes during the week. These were all very feeble with the exception of one, classed as feeble, which occurred at 8:57 a. m. December 21; its origin was about 14 miles from the Observatory. It has not been reported as perceptible. In addition to these local shocks, there was a period of definite though very feeble continuous tremor, beginning at 1:38 p.m. December 21 and lasting 25 minutes. A teleseism was recorded on the 28th, the preliminary wave beginning at 7:59:12 a. m. Other phases indicate the distance to the origin to be 3,440 miles. The time at origin, in Greenwich Civil Time, resulting from this data, would be December 28, 18:20:10.

Microseismic motion showed increase on the 25th, reaching its maximum amplitude on the 27th, although on that day the wind had moderated locally. Tilt has shown a strong spurt toward the SSE, the accumulation for the week being approximately 3.0 seconds of arc in that direction.

MUD RAIN DROPS FROM BRISBANE

Richards and Bryan describe (Proc. Roy. Soc. Queensland XXXIX No. 5, 1927, 54-60, 2 plates) lithified tuff or ancient volcanic ash containing "mud balls." The Brisbane turf is Upper Triassic, unconformable above schist. The base of the section is an agglomerate with schist and rhyolite fragments. The tuff is well known about the city of Brisbane, but the pisolites are found only at Castra, 12 miles away. Portions of the tuff are believed to be water-laid, for it is underlain by fresh water lacustrine sediments and grades above into shales. The pisolitic ash described and figured is in all respects exactly like the modern hardened mud raindrops that accompany such explosive eruptions as those of Kilauea in 1790 and 1924, or Vesuvius in 1906. It is of great interest to find it in ancient fossilized form in hard rock.

The Brisbane pellets are compared with marbles or beads. The largest are 25-30 mm. diameter, and these are abnormal. (Compare Bull. Haw'n Volc. Obs'y June, 1921, Fig. 21 and p. 102.) The balls occur scattered in the lower and middle portion of the Castra section, crowding certain layers. (Compare 1790 ash with [illegible] nts, Kilauea, Bull. Haw'n Volc. Obs'y, July, 1921, Fig. 22 and p. 114.) Most of the Brisbane spheroid[illegible] were 3 9 : m. diameter, some are flattened and egg-shaped, internally they are concentric layered, the skin is often discolored and harder than the rest, and the grain is finer than the matrix tuff. (Compare "Kilauea pisolites," Fig. 2, F. A. Perret, "Some Kilauean Ejectamenta," Amer. Jour. Sci. Art. LII, June, 1913, p. 612.)

The authors find parallels to the Australian mud-balls in the ejecta of Taal Volcano, 1911, and the mud-drops of Pelee in Martinique, 1902. These comparisons are entirely justified, and it may be said that all "cauliflower cloud" eruptions of recent observation have produced mud rains when the atmospheric condensation accompanied dense floury ash accumulation in the rain clouds. The condition for preserving layers of pisolites is when stiff mud-drops fall in light dry dust beds of previous eruption, and it is possible that the baking the dust has been subjected to, accounts for its cement-like quality in rapid hardening. The pisolitic ash of 1790 at Kilauea, where the footprints were hardened, was a mud when the footprints were made, and its upper surface crusted to preserve the footprints like a weak cement.

The presence of pisolites is a sure proof of direct subaerial ash fall, and each layer usually means a separate mud-rain shower. Such mud rains may occur many miles away from the volcano. T.A.J.

HEAT BY LAVA CIRCULATION

After discussing gas-heating and gas-fluxing, which he believes to be reasonable, but perhaps unnecessary, Shepherd (Section of Volcanology, 1927, Bull. Nat. Res. Counc. No. 61, p. 262, Washington, D. C.) suggests that these hypotheses were invented to explain an undrained lava lake, a closed system. If we assume the Kilauea lava lake to be a bubbling spring with many subterranean outlets, not from one magma chamber, but from numerous roots, he believes that the required heat could easily be supplied by "the rise of a few cubic meters of lava per second with only a two-hundred degree drop in temperature." The basaltic roots go to considerable depths, the acid volcanoes taking their origin among the more superficial roots.

In this connection a quotation from Tempest Anderson (Volcano Matavanu in Savaii, Quart. Jour. Geol. Soc. LXVI, 1910, London, p. 637) is relevant: "Matavanu is certainly a (lava) river. Kilauea may be a river, but is more probably a boiling pot. Does the lava of Kilauea at the times when the lake empties itslf periodically, say once in five years, also discharge itself into the sea?" T.A.J.

ERRATUM

In Volcano Letter No. 156, fifth paragraph of the article, fifth sentence should read: "Echo and wire sounding admit of important experimental work in volcanology, with a view to identifying a lava-flow bottom. Taking a known basalt bottom such as the Alika flow," etc.