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 1925

(Nos. 1 to 5[illegible])

P. 2

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TITLE PAGE AND INDEX FOR 1925

(Nos. 1 to 52)

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NO. 1 January 1, 1925

KILAUEA REPORT

DECEMBER 31, 1924
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

Other notices in the press than those mentioned last week indicate that the seismographs of the world are recording large earthquakes and Tokyo mentions a strong felt shock that did damage in Japan. Two slight records of distant earthquakes were made on the Kilauea seismograph December 27 at 1:01 a. m. and December 28 at 12:34 p. m. Thirty local shocks were registered, two of which were felt, respectively on the 25th and the 30th, both in the evening. Tilting was to the northeast, a direction favorable for rising lava, but no new sign of lava has appeared in the pit.

About half of the local earthquakes were of the prolonged type characteristic of Halemaumau avalanches, and such slides were observed or heard repeatedly during the week. They made no large dust clouds.

A noticeable change now seen at Halemaumau, and occasioned by the big avalanche of December 12, is the cessation of smoking of the north wall. This blue fume was in evidence all summer and autumn, coming from a solfataric patch in the upper wall. The avalanche in question stripped that wall, and left a surface whitened with sulphates, but if any fume remains it is now mixed with the steam at the base of the wall.

The avalanches of the past week have continued to strip the north wall and to pile up the debris below so as to cover with talus the bottom part of the big intrusive sill. A faint sulphur odor was detected at some of the cracks back of the NNW rim of Halemaumau. With the undermining of the rock slides these cracks have increased at the north, outlining freshly broken segments of the rim scores of feet back from the edge, and breaking the earth along new steamy cracks parallel to the rim in many places. At one of these big chasms the surface rock has all caved in revealing an inclined cavern below The hole is ten to fifteen feet across and plunges downward at an angle of thirty degrees, with a slope of caved debris on one side. The roof and sides are broken and so close to the pit rim, where avalanching is always going on, that the whole mass appears to be settling.

Some of the steam cracks near the rim at the west are continuous for long distances, with hot vapor rising in puffs.

During the gentle swaying earthquake of the evening of December 30 at 8:51 p. m. a pheasant was heard to squawk at the moment of the shock. In Japan slight forewarning of quakes has sometimes been given by pheasants.

CHILEAN VOLCANOES

There are some parts of the world of volcanology that yield very little published information and one of them is Chile. Dr. Karl Sapper of Strasbourg mentions 14 eruptions in 13 years between 1901 and 1913 (Summary of volcanic data, Beitraege zur Geophysik, 1915). The very names of these volcanoes are unknown to most of us. Huallatri and Isluga at the north vented light smoke and black smoke and fire in 1913, and these about 19 degrees S. lat. are as far south of the equator as Hawaii is north. Next come San Pedro and Antofalla which vomited smoke in 1901 and 1911. Moving south to 35° we find Cerro Azul and Descabezado making explosive eruptions in 1907 and 1913, the former a peak 10,500 feet high. Chillan in lat. 36° opened a new crater in 1906, and Llaima appears to be a formidable volcano that kept up action for five years from 1903 to 1908 with both explosions and lava. Maipo was active in 1905.

The Chilean district of about 40° S. near the port of Valdivia appears to be a lively volcanic neighborhood where Villarica was erupting and throwing stones from 1906 to 1908. In the same region Rininahue in April of 1907 built up a cone of lapilli and ash, and the dust fell at Valdivia. Calbuco and Huequi are a little farther south and were making explosive steam clouds and smoke cloud: in 1906-07.

All this shows that while there was no activity reported between 1895 and 1900, there were two eruptions in 1901, one in 1903, one in 1905, five in 1906 when Valparaiso and San Francisco had their earthquakes, four in 1907 when Jamaica had its earthquake, two in 1908 when Messina had its earthquake, one in 1911 and two in 1913.

Sapper shows that this 1906-07 time produced the most volcanic eruptions in nineteen years both for the whole world and for the Pacific half of the earth. Out of 414 eruptions between 1895 and 1913 there were 25 in 1906 and 31 in 1907. There were eruptions on Mauna Loa, at Bogoslof in the Aleutian Islands, at James in the Galapagos, at Vesuvius, on Savaii in Samoa, Kartala of the Comoro Islands east of Africa (1904), Namlagira, a lava maker in east Africa, Cotopaxi, Sangay, and numerous volcanoes of the Molucca-Philippine-Japan series. It is remarkable that this was also a period of some of the world's greatest earthquakes, including a big one in India.

It thus appears that certain years in the world's history are seismo-volcanic centers in time, just as districts are similar centers in place. About 1883-86 was another such time center with Java, Japan and New Zealand producing titanic eruptions, and in America came the Charleston earthquake.

T. A. J.

PERRET'S GREAT MONOGRAPH ON VESUVIUS

Those in Hawaii who remember Mr. F. A. Perret's fine work here dwelling on the rim of Halemaumau pit in 1911, and his wonderful faculty for making good photographs under adverse conditions, will wish to see and study the splendid volume by him just published, with noble pictures of craters, cones, cauliflower clouds, lava flows and avalanches of dust and debris. (The Vesuvius Eruption of 1906, Carnegie Institution, Washington, D. C. quarto, 151 pp. $4).

Mr. Perret discusses the preliminaries of that great eruption, presents a narrative and an analysis of every detail of its progress illustrated photographically, then recites the after effects as observed on the ground through the repose period of seven years, and finally gives most interesting account of the revival after 1913. For comparison with Hawaii this memoir is invaluable. In his last part he describes his instruments, comparative data of the 1872 eruption, and Dr. Washington discusses the petrology of the lavas. Dr. Washington has done admirable work in editing the volume, so as to introduce the vast experience of the Geophysical Laboratory of Washington in technical and bibliographic matters.

It is interesting to note that Perret says the "average interval between eruptions for Vesuvius during the 19th century was less than ten years." For Kilauea-Mauna Loa the cycle also is about nine years long.

T. A. J.

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NO. 2 RELEASED WITHOUT COPYRIGHT RESTRICTION January 8, 1925

KILAUEA REPORT NO. 678

WEEK ENDING JANUARY 7, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

Halemaumau, the active pit of Kilauea volcano, was left by the explosive eruptions of May, 1924 an enormous blank cauldron lined with broken rock. It is 1280 feet deep, oval in plan, and 3400 feet long. The lava returned to the bottom for a fortnight in July so as to make a rock floor. Avalanching from the walls has been the principal process of change in evidence since the first of August, when all flow of lava stopped. These slides have made the debris slopes grow. The walls are precipitous and unstable. The bottom yields much steam mixed with sulphur gas and hydrogen sulphide, but in fair weather all the walls are in plain view and no vapor rises above the pit rim. There are vaporing cracks moderately hot parallel to and near the rim.

During the past week avalanching decreased, but a pinnacle of poised rock at the south has fallen in . This was a conspicuous landmark, and all that is left is a slender spire surmounting a sheet of rock partially split from the face of the wall. Some of the steam-holes in the talus are dry, hence probably very hot, others are wet. The Observatory registered 22 local earthquakes and northeasterly tilt. Two noisy avalanches were heard the forenoon of January 3, and half the earthquakes recorded were of the avalanche type. At night no glow is discernible in the pit.

LOCATING EARTHQUAKES

An earthquake is a sudden bump or break or slip in a definite place within the crust of the earth. The jarring moves out from that place as waves in the rock. Some of the waves are like sound waves, some are like water waves and travel with different speeds. If a blast were fired in a lake, the sound under water would reach you before the surface waves from the explosion. So it is with an earthquake in solid sandstone or granite. And the delicate pendulum called a seismograph, scratching a straight line on paper all the time, with tick marks at the side from the minute hand of a clock, makes a wobbly mark the instant the quicker waves get to it, and a big zigzag mark some moments later when the surface waves arrive. In the case of big earthquakes the marks are registered even 7,000 miles away.

As the quick waves race in a straight line through the earth at a speed that is independent of the severity of the earthquake, and that speed is known by experiment; and the surface waves go more slowly, also at a known speed: it follows that the difference in time of arrival of the two, measured in minute tick marks on the paper will be the greater as the distance away is greater. This time-distance relation, or "duration of the preliminary tremor," has been worked out for all distances and published in tables. It is not quite so simple as told here, for there are two kinds of preliminary wave, but that all appears in the tables. The velocity of the most rapid earthquake waves averages over 300 miles a minute and the slowest waves can travel entirely around the world in about three hours.

The distance unit in the Zeissig tables, commonly used at most seismographic observatories, is 10 kilometers (6¼ miles), but these tables are mainly designed for big earthquakes many hundreds of miles away. At this Observatory Omori's tables, published in the Bulletin of the Imperial Earthquake Investigation Committee of Japan, Vol. 9, No. 1, p. 39 have been found much more satisfactory than any other. Omori's values are given to fractions of a mile. His fractions seem justified as it is easily possible to distinguish differences in shakes whose origins are only two and three miles away. The distances of quakes up to 40 miles determined from Omori's tables are from one to six miles less than those given in the Zeissig table. That Omori's tables are better than the Zeissig table for very local earthquakes, near a volcano at least has, repeatedly been shown here by the nice agreement between computed and actual distances of many quakes whose origins are known, as for instance by newly formed cracks at the center of disturbance. R.H.F.

HAWAIIAN SEISMOGRAPHIC STATIONS

The Volcano Research Association maintains three outlying stations on the island of Hawaii for registration of earthquakes, besides the main laboratory of the Observatory at Kilauea. The latter is now operated by the United States Geological Survey; it passed from the Weather Bureau to the Survey July 1, 1924. The outer stations are equipped with instruments built here by Dr. A. Romberg. They are at Kealakekua in Kona, Observer R. V. Woods: Hilea in Kau, Observer Ella W. Stephens; and Hilo, Observer J. B. Albert. The magnifications of the instruments are 25X and 50X (Kona). The Kona instrument also records tilt. Hilea gets the most small shocks (next to Kilauea), Kona next and Hilo fewest. Kona and Kilauea have horizontal pendulums, the others normal pendulums of short period.

The Volcano Research Association is working cooperatively with the Survey through the Observatory. Since 1920 it has built up the seismograph stations, conducted boring experiments at Kilauea, equipped a chemical laboratory at the Observatory, maintained a research fellowship at the station for a year, sent an expedition to investigate the Tokyo earthquake, assisted printing and publications, built an iron archives andoffice building for the Observatory and apparatus and books: and finally, the present campaign of the Association, which has been in progress for over a year, has in view supporting and promoting publication of th scientific results of the fifteen years of work at Kilauea done by its employees and by the government.

T.A.J.

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NO. 3 RELEASED WITHOUT COPYRIGHT RESTRICTION January 15, 1925

KILAUEA REPORT NO. 679

WEEK ENDING JANUARY 14, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in Charge

The past week has been a rainy one at Kilauea with 5:88 inches of rainfall January 6-9 inclusive along with strong northeasterly wind. This however occasioned no increase of avalanching at Halemaumau pit. Both the seismographs, which appear to record ordinary avalanches, and the daily observation visits have indicated that the motion of the rock slopes was much less than hitherto.

The number of local earthquakes registered during the week was thirteen. On successive weeks beginning with that ending December 3, the numbers per week were 19, 41, 50, 33, 30, 22, 13. The maximum of 50 was just at the solstice, when there was notable avalanching that stripped the northeast wall of the pit, and also one strongly felt earthquake.

During the rainy spell there were electrical storms and snow fell on Mauna Loa and Mauna Kea, covering the cones at the 10,000 foot level and above.

Visited after the rains on January 10, the bottom of Halemaumau was steaming vigorously and vapor rose even from cracks in the rocky wall all the way up to where they join the tangential steaming fissures on the rim. The increased volume of bottom steam made more visible the sulphurous fume that is mixed with it, giving the vapor bluish edges and leaving blue gas where the vapor dissipates above. From a northwest pocket of the bottom and from the south talus the densest volutes of steam go puffing upward. At the bottom pocket January 12 there appeared to be puffing.

A second visit at 6 p. m. the same day discovered no more such noises, nor were they heard on the following days. At dark no glow could be seen. The whitening of the walls on drying after rain was especially noticed above the hot intrusive bodies, as though these were still emitting acid gases.

THE INSIDE OF THE EARTH

The distance to the center is 3960 miles. The outer crust, it is commonly agreed, within a depth of 35 miles changes from granite to a heavier dark olivine rock. Below the crust lies a zone of these rocks 960 miles thick growing heavier. Then comes a shell of mixed rock and metal about 870 miles thick, the outer part silicates pocketed with nickel-iron alloy, the inner a metallic matrix containing scattered clusters of olivine crystals. The specific gravity of this shell (its weight compared with water) varies from 4 to 9 going inward. Ordinary lava averages about 3.

We have now gone down 1865 miles and arrived at a red hot stiff sea of metal. This is the central core, its substance like the nickel-iron meteorites, its diameter 4200 miles, its specific gravity 10. This it is that brings up the average density of the globe to 5.5.

All of this doctrine comes from up-to-date experiment, analysis, and computation by Williamson, Washington and Adams of the Geophysical Laboratory of the Carnegie Institution of Washington, Dr. A. L. Day, Director. (Journ. Wash. Acad. Sci. 1923, 413; 1924, 333, 435, and 459).

The arrangement in shells agrees with the analogy drawn from the metal and stone meteorites, with the weight, rigidity, and compressibility of materials required for the waves from big earthquakes to pass through the earth as they do; with the inertia of the earth in its rotation and tides, and with compression calculated as varying with depth. At the center of the earth the pressure is amout 22000 tons per square inch.

The earth is not conceived to be a big meteorite, but a planet of graded substance metallic to rocky from within outward. If torn to pieces the fragments would be meteorites of the iron, part-iron and stony sorts. A Greenland lava contains 31 per cent of metallic iron, showing that some pockets of the rock-iron mixture come within reach of volcanoes.

Chemically the nickel-iron at the center, by analogy with known meteorites, is free from oxygen and silicon, but contains sulphides, carbides and phosphides. In the next rock-iron zone, crystalline compounds of silicon, oxygen, iron and magnesium are formed in a mother liquor of metal. In the next zone outward this changes to basic silicate magma with only pockets of iron. Oxides like magnetite now appear also feldspars introducing aluminum and calcium, along with borides and nitrides. Lastly the thin outer crust brings in sodium in its lower part and potassium above, and finally free silica as quartz and free oxygen in the air.

The metals from inside outward are in the order of increasing affinity for silica and for oxygen and grade from electro-negative to electro-positive. Of the whole earth 99.60 percent consists, in order, of iron, oxygen, silicon magnesium, nickel, calcium and aluminum, with subordinate amounts of sulphur, sodium, chromium and potassium. These with hydrogen and cobalt are also the principal elements we know spectroscopically in the sun.

The amount of oxygen in the iron core is zero, in the crust it is 47 per cent. The iron in the core makes up 91 per cent, in the crust only 5 per cent. Has there been a progressive oxidation of an elemental sphere, and is volcanism the relic of that process?

The last paper by L. H. Adams calculates the temperatures in the upper 180 miles. Radio-activity, melting-points, viscosity and circulation from the days of an original molten surface play their parts. The magma crystalized from below upward, concentrating a residue of basalt 60 miles thick which crusted over. The crusts foundered and left a honeycomb with liquid layers of great size. The age of the earth since cooling began is placed at 1600 million years. Final concentration produced granite.

The increase of temperature downward in the upper crust is much more rapid than it is below. It comes out

at	12	miles	depth	500	degrees Cent.
"	32	"	"	1000	" "
"	79	"	"	1500	" "
"	135	"	"	2000	" "
"	183	"	"	2450	" "

which is less by 1000 degrees than the temperature of the carbon electric arc. T. A. J.

ERRATUM

A misprint in the sixth line from the end, last number of Volcano Letter, should read: The Volcano Research Association "built an iron archives and office building for the Observatory records, also an iron steam laboratory over the bore holes at Sulphur Bank, furnished the station with machinery and apparatus and books, and finally" entered on a campaign of publication.

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NO. 4 RELEASED WITHOUT COPYRIGHT RESTRICTION January 22, 1925

KILAUEA REPORT NO. 680

WEEK ENDING JANUARY 21, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

During the week at the Hawaiian Volcano Observatory on the rim of Kilauea crater the weather has been mostly without rain after the heavy downpour of the afternoon of the 15th when there was thunder and lightning. The wind has been fresh from the northeast, the barometer normal, and thermometer minimum 48° F.

The number of local earthquakes registered per week jumped from 13 to 27. Of the 27 for the past week three were perceptible. Fourteen of the shocks occurred in one day, January 17, about a half of them being of the avalanche type. Some noisy avalanches occurred at Halemaumau during the week but no very big ones. One distant earthquake was recorded at 2:45 a. m. on both the Kona and Kilauea seismographs January 18th, the indicated distance of origin being 3600 miles. From the 16th the tilting of the ground at Kilauea was northerly.

The pit Halemaumau, though devoid of active lava, performed peculiarly on the eve of Saturday the 17th, the day of the many earthquakes. On Thursday there had been a few avalanches. On Friday they were more numerous, and at 7 p. m. a strong roar from the pit was heard at the Observatory. The pit had been visited between 5 and 6 p. m. and about every ten minutes more or less, there was noticed an echoing hiss ending with the rattle of sliding rocks, like the steady puffing that had been observed the week before.

Steam obscured the west debris slope whence the noises proceeded, but some angular scarps in the gravel heap of the bottom were noted. There were small rock falls from the wall that made a different sound. The seeming hiss would prolong itself into the clatter of a sliding ribbon of talus, and while the moving fragments were not seen, the loud grating noise was believed due to the caving in of the northwestern and northern talus, the fragments sliding into a crack that was opening beneath. Possibly the lava column was disturbed below and made some kind of an opening.

Some hissing was heard again January 18th, but believed due to wind. Nothing more was heard of it. The northern walls have developed more white stain and the eastern wall has caved in so as to destroy the flag station. New cracks have appeared in the dirt back of the east rim.

A MODERN SUMMARY OF EXISTING VOLCANOES

It is no small task (see Sapper, Volcanological Review, III, 65, 1917) to compile from existing documents the number, kinds, activities, distribution, output and periodicities of the known active volcanoes. And there are some in remote lands, or under ice, or under the sea, which are unknown. Moreover many volcanoes exist which appear fresh, but no one knows their records. Of 202 volcanoes and lava fields mapped in Chile and Argentina, only 30 have active records. Of 165 volcanoes in Japan, 58 are ranked as active. Sapper makes the total number of active volcanoes on earth 430, of which 80 are submarine, as reported from time to time by mariners. Sixty-four per cent are in the northern hemisphere and thirty-six per cent in the southern. More than half of the total number lie within 30 degrees of the equator.

The Indo-Atlantic half of the world has only 94 active volcanoes as against 336 for the Pacific half. And most of these Pacific vents for the earth's internal fire are around the margin of the ocean, for only fifteen are in the middle. About 2500 eruptions are known to all history as hitherto compiled, and more than 2000 of these were about the Pacific.

As to the kinds of activity exhibited, to get reliable data on lava flows as contrasted with explosions or mixed eruptions, it is necessary to take a group of modern dates. From 1895 to 1913, of 396 eruptions in the world, 284 were explosive, 83 were mixed lava and ash producers, and only 29 were purely lava flows. Of the explosive, 255 or 90 per cent were from the Pacific border region. The Indo-Atlantic half of the globe has explosive, mixed and lava types all three, while the central Pacific rarely has explosive eruptions pure and simple. Since the year 1500 the total output of lava is estimated by Sapper at 12 cubic miles, and of fragmental material such as rocks, sand and ash 72 cubic miles. Of these last, 86% came from the Pacific Hemisphere.

The greatest lava-producers in single eruptions were the volcanoes Leirhnukur, Laki and Eldgja in Iceland, Lanzarote in the Canary Isles Kliutschew in Kamtchatka, Savaii in Samoa, and Sakurajima in Japan. Mauna Loa is possibly in this first class. In the second class of lava-makers are Etna, Vesuvius, Hecla, Kilauea, Asama, Mont Pele', and two Philippine volcanoes, Camiguin del Sur and Mayon. Other lava producers little known but important are Namlagira in central Africa, Kartala off the east African coast and Piton de la Fournaise in the island of Reunion.

A striking fact about lava outflow since 1701 is that high latitudes have produced twelve times as much lava per unit of area as the equatorial belt, whereas the equatorial region has produced eleven times as much explosive material as the latitude of Iceland. And the Iceland-Kamtchatka latitudes have produced twice as much lava as ash. Iceland alone in the eighteenth century was responsible for more than a third of the world's lava flows of the last 225 years. T.A.J.

FREQUENCY OF HAWAIIAN EARTHQUAKES

During the year 1924, 5877 local earthquakes were registered on the seismographs of this Observatory. Of this number, 772 were perceptible shakes, the remainder being detectible only by delicate seismographs. This is the largest number recorded here in any one year since the establishment of the Observatory in 1912 and is much above the yearly average.

The greatest number recorded in any one month was 3961 in May. The least was 21 in January. 1924, when the pit was full of lava. The large number in May accompanied the explosions and the collapse of the floor of the fire pit. This year confirms previous observations that seismic frequency and intensity are higher when the pit is quiet than when molten lava is visible. R.H.F.

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NO. 5 RELEASED WITHOUT COPYRIGHT RESTRICTION January 29, 1925

KILAUEA REPORT NO. 681

WEEK ENDING JANUARY 28, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The weather of the week has been fair with variable winds and calms, and one rainy day on the 26th. There are two conspicuous features in Halemaumau pit during the present quiet solfataric spell following the eruption of May, 1924, which change with the weather. One is the efflorescence of white sulphates on the walls after dry sunny weather, increasing the more such weather is prolonged. The other feature is the visibility and apparent density of the vapor jets about the bottom, and of the larger vapor cloud which condenses above the whole pit. In rainy weather the dense vapor of the small jets at the bottom may fill the whole pit and merge with the cloud above that rolls away to leeward. In sunny or cloudy weather this big cloud may be wholly invisible or merely shreds of rapid-rising cumulus high above the pit, and the steam jets on the bottom appear thinner, less flocculent and more idle in their rising activity.

At the beginning of the week after a dry spell the walls were notably white and chalky with magnesium sulphate, especially above the two ends of the hot north sill. On the 26th after a rainy day it was remarkable how these big areas of white stain disappeared.

This whitening is different from the true solfataric action of the live vents about the bottom depositing sulphur and sulphates yellow, cream colored or greenish or even pink, with hot steam making dry patches in the midst of stones dark with moisture roundabout. There are three such deposits at the base of the southeastern wall, eight patches in the talus west, south and east, and two stained areas fuming in the floor. These places are very hot, but they also become inconspicuous in coloring after excessive rains.

The vast pit of Halemaumau shows only gradual changes. Small rock slides have occurred mostly at the north intrusive sill. The peculiar sliding noise reported last week has not recurred, but in morning sunlight on the 25th a depression was detected about 20 feet wide extending N-S across the W side of the floor. The mud drainage was toward this place indicating extreme lowness, and here is the west pocket with salts and hottest and densest steam jets. The peculiar slides may have been into this depression.

The seismographs have recorded 11 local earthquakes, one of these January 26 at 6:42 a. m. showing indicated origin 11 miles from the Observatory, probably to the southeast. Tilting of the ground has been to the south-southwest.

Temperature measurements at vapor cracks from rim of pit outward from Halemaumau gave 162° Fahr. at south rim, 167° west rim, 169° southeast rim, 187° at a purring vent 100 feet back of southwest rim, 189° at road terminus 2000 feet back southeast and 194° at old sulphurous cracks south of Kilauea crater at the contact of lava and gravel. This last place was also blowing. If we go still farther outward to the Sulphur Bank at Volcano House we get 204°. Thus cracks are deeper and hotter the farther we go from the volcanic center.

A VOLCANIC OUTBREAK THAT SHOOK THE GLOBE

World-shaking earthquakes are well known. Sudden release of stress occurs somewhere in the earth, and a big earthquake is registered on seismographs thousands of miles away. It is commonly thought volcanoes have little to do with it. Many big earthquakes happen under deep oceans for the centers can be located by the seismographs. Of lava outpourings under the deep sea we know nothing; they may very possibly occur.

Dr. Tams of the Hamburg earthquake station (Volcanological Review, 1924, 137) shows that Katmai volcano in Alaska, in June 1912 produced eleven earthquakes which were well registered at St. Petersburg. The actual swing of the ground at the Russian station was from a thousandth to six-tenths of a millimeter. The instrument magnifies the movement and makes it visible as a written zigzag line. The Katmai earthquakes were registered at other stations in Europe, America, Asia and Africa. During the first three days of the tremendous explosions that gave birth to the Valley of Ten Thousand Smokes, two of the shocks were registered at Cape Town 11,000 miles away. Their centers were not right at the volcano, but at places 60 or 90 miles to the west.

All the centers located were notably along belts parallel with the line of volcanoes and 50 to 100 miles away. There were also big shocks in the Mt. McKinley range at the end of the line, and in the deep Aleutian trough of the Pacific.

Many earthquakes were strongly felt in towns near the volcano about the time of the disaster June 6th, 1912. The eruptions continued all summer with loud noises and numerous earthquakes. Dr. Griggs (Nat. Geog. Soc. 1922) and his colleagues estimated that six cubic miles of ash were ejected.

Mt. Katmai lost two cubic miles of rock unaccounted for in the ejecta. A big crater and many cracks remained, two new adjacent craters appeared, and in one of them stood an obsidian dome of new lava 200 feet high and 800 feet across. A fill of hot sand with hundreds of fumaroles occupied a valley representing a zone of fractures crossing the Alaskan peninsula. It was thought that a large body of siliceous lava underlay the peninsula and the earthquakes and eruptions accompanied movements of the earth's crust wherein tension cracks opened. It is a matter of theory as to which was cause and which was effect.

The seismographs of Europe were calibrated by the Sakurajima earthquake of 1914. This in Japan destroyed houses and lives. Registered in St. Petersburg it swung the pendulum four-hundredths of a millimeter. From St. Petersburg Alaska is the same distance away as Japan. Therefore Katmai earthquakes swinging the St. Petersburg pendulum twice as far and fifteen times as far as did the Sakurajima shock, were twice as big and fifteen times as big. In this way the size as well as the location of earthquakes in the Alaskan wilderness, were better determined in a quiet cellar in Russia than they could be by any evidence available in the region where they occurred.

Big earthquakes near volcanoes are not unusual. The Sakurajima eruption was itself a trigger that turned loose the big shock in South Japan. Large earthquakes near Etna in Sicily at times of eruption have been recorded on the seismographs of Europe. And lastly, the big lava flows of Hawaii in 1868 were preceded by an earthquake of the globe-shaking variety which was felt 300 miles from the volcanoes.

T.A.J.

SAMPLE COPY

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THE VOLCANO LETTER

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NO. 6 RELEASED WITHOUT COPYRIGHT RESTRICTION FEBRUARY 5, 1925.

KILAUEA REPORT NO. 682

WEEK ENDING FEBRUARY 4, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

The crater pit Halemaumau of Kilauea volcano remains quiet so far as lava activity is concerned. After January 29th, however, there was some revival of avalanching from the walls of the big cauldron, which is 1280 feet deep. Along with this came tremors recorded on the seismograms at the Observatory 2.1 miles from the pit. The number of local tremblings was 34, but of these only eight had amplitude enough to be conspicuous on the record sheets, and but few of these seismic movements had the sudden beginnings of local earthquakes. They begin as small quick tremors sometimes a half-minute before they develop gradually an amplitude sufficient to be read without a magnifier. Their correlation with avalanching may be caused by settlement or uplift under the pit, or the avalanches may directly cause the tremors. On the evening January 30th a small earthquake was followed by the squawking of a pheasant and then by a roar from the pit.

Two very slight distant earthquakes were registered respectively at 7:19 a. m. January 30th and 10:48 a. m. February 2nd. Tilting of the ground has been away from the pit toward the east and north.

On January 29th fresh cracks in the ash southeast of Halemaumau showed that wall of the pit to be working. On the 31st fresh sulphur deposit was noticed at the bottom on the south side. There were dusty avalanches February 1st and three pronounced quakes on the following night were coincident with strong avalanche signs discovered the next morning at the southwest wall. Adjacent to the tunnel of the Kau Desert rift, in the wall of the pit, the whole upper part of the precipice was freshly broken away, and one of the signal flags was gone. On the bottom were fresh fragments, and clouds of dust had powdered all the solfataric deposits, obscuring them. The ash was newly cracked for 100 feet back all along the southwest side. All that region is heavily crevassed back from the rim.

February 3rd and 4th the slides decreased and the pit was quiet. With sunny weather the gravel fields of 1924 debris northeast and the southwest of Halemaumau appear white with efflorescence of salts.

VOLCANOLOGY IN JAVA

The most colossal explosive eruption in all histroy is believed to be the Tambora outbreak of 1815. This volcano is on the island of Sumbawa east of Java. As is so often the case, it was supposed to be extinct. It began to throw out ash in 1814, became violent April 5, 1815, reached its maximum April 10, and became quiet by July 15. The top of the cone was destroyed and lowered from a height of 13,000 to 9,000 feet. The crater pit left was four miles across and 425 feet deep. The current estimate for rocks and ash ejected is 36 cubic miles. Ten thousand people were killed by burial under ash, and drowning by engulfment in the sea-waves, and 37,000 by famine and disease. The crops of the neighboring islands were buried under two feet of ash, and the houses necessarily crushed. At the height of the eruption the whole mountain was covered with showers and blasts of glowing gravel and sand, but not lava flows. The coast was reported lowered 18 feet, and elsewhere harbors had shoaled.

The volcanoes of the Dutch East Indies have produced vastly more explosive matter than all the rest of the world. There are at least four hundred of them, of which 80 show activity, and about 36 have had explosive eruptions, which ravage fearfully the fertile lands of Java and Sumatra.

Excellent topographic maps and investigations by the Office of Mines of the Dutch government at Batavia have been made for many years, but a new Volcano Committee was organized in 1919 under the direction of Dr. Kemmerling, and now under Mr. Taverne. Six memoirs on volcanoes have been issued since 1918, with colored maps and photogravure illustrations. A new one in press exhibits volcano studies made from airplane by Mr. Taverne. (G. Kolff & Co., Weltevreden, Java. Vulkanologische Mededeelingen Nos. 1-7). The photography, press work and engraving (done in Amsterdam) are admirable. Some of the large-scale maps would be improved if ruled scale, and contour interval, were given, and all these books need index maps to locate the small maps.

The first memoir deals with Sumatran volcanoes, caldera lakes and hot springs. The second is on Kelut volcano, which took 5500 lives in 1919 by throwing out its crater lake. A tunnel is beiog driven to drain it. Merapi in Java forms the subject of the third; this volcano ejected incandescent blasts in 1920-21. In the fourth the Bromo-Smeru country is described, with its saud-sea in the Tengger. The fifth deals with the northeastern archipelago, Minahassa and the Sangi islands, where the crater lake and mud eruptions of Awuh are like Kelut. And the sixth, with airplane illustrations, describes the outbreak of Galunggung 1918, with lava in the form of an andesite dome. T. A. J.

ENGINE-MADE EARTH SHAKINGS

A measure of the sensitivity of a delicate seismograph is shown by the fact that as soon as the Fairbanks-Morse oil engine of the Kilauea Volcano House electric-lighting plant was started in December 1921, the operation of the engine was recorded on the seismographs of the Observatory about 800 feet away. Variations in the engine-speed or changes in load as well as exact times of starting and stopping were duly recorded. The engine record on the seismograms was shown as about six very minute vibrations per second. This corresponds with the number of explosions of the engine per second. Originally the engine exhausted into a steam crack adjacent to the power house, and when the exhaust was directed into the air in November 1924 the engine ceased to be recorded on the seismograph. R. H. F.

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NO. 7 RELEASED WITHOUT COPYRIGHT RESTRICTION February 12, 1925

KILAUEA REPORT NO. 683

WEEK ENDING FEBRUARY 11, 1925

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

Conditions remain tranquil at Halemaumau pit. In the seismological laboratory of the Observatory twenty-six local seismic movements have been registered, of which more than half were prolonged tremors such as usually accompany avalanches in Halemaumau. Ten of the earth movements occurred on February 9th. At 1:34 p. m. of the 8th a felt earthquake occurred, with so short a preliminary tremor that the center must have been within a mile of the Observatory. The tilting of the ground at Observatory has been very slight to the west.

The journal of events recorded shows nothing remarkable for the 9th except a brisk northeast wind that made dust clouds on the desert, kept the debris more or less in motion in the pit, and thereby perhaps occasioned some avalanches, as the wall material in places is nicely poised. About that time also the smell of spicy sulphur from the bright yellow patch at the foot of the east talus had become strong, and that solfatara had become particularly bright in coloring. There was more of the sulphur odor than of hydrogen sulphide.

February 6th was dry and avalanches had notched the wall NNE. On February 7th there were three noisy slides in the early afternoon. There was fresh debris left on the northeast talus, and sulphur crystals were bright colored at the steam patch at the base of that slope. On both the 8th and 9th strong odor of sulphur rose. Fresh movement of the cracks back of rim southeast was observed. There was continuous rattle of falling stones southwest on the 9th, and the wall at the SW rift showed signs of more stripping.

On the 11th there was breakage in the talus, like an incipient landslip under the big north sill. In the wall made by the sill itself two vertical cracks were seen. These gaped open a foot or more and extended up and down for from 50 to 100 feet. There were possibly some corresponding cracks in the lava floor. This region at the northeast end of the pit corresponds to the place newly notched by avalanching southwest, as though the rift belt were in motion.

ROOTS OF A SCOTTISH KILAUEA

An area eighteen miles square, seventeen authors and twenty-three years of work are the elements of a new publication of the British Geological Survey, J. S. Flett, Director (Mull, Sheet and Text 44, 1924, Stanford, London, 18s.). This is a model of condensed statement, and the colored geological map needs only intercalated profile structure-sections to make it perfect.

Central Mull, surrounded by fjords, with mountains 2000 feet high, is the relic of an ancient Kilauea lowered by ring faults and profoundly worn away. The original lava dome was several thousand feet above. The root of the volcano shows siliceous and basic intrusions in a young inner series of lavas, surrounded by older plateau basalts.

Three cycles of change are shown from a basaltic mother lava to later granitic intrusives, with gradations. Silica ranges from 45% to 70%. Olivine decreases from earlier to later lavas. Inside of an encircling zone of 15 miles diameter the olivine crystals show alteration by vapors. Enough gneisses and sedimentary rocks occur both as ledges and inclusions to suggest assimilation of these rocks in the magma. The Mull complex differs from Hawaii in its siliceous sediments and granitic intrusives.

The analogies with Hawaii are many. "Pillow" lavas, bulbous, with glassy shells, are mapped in thirty places in the Mull crater area, and are supposed to have flowed into a crater lake. They are like the glassy pahoehoe formed during torrential rainstorms in Hawaii. Very Hawaiian are the ring-fractures and dykes, suggesting the "wall-crack fills" of Halemaumau. The double crater, plateau lavas, explosion dykes, vent agglomerates and gabbro intrusions all have parallels in Hawaii. The dyke swarms trending in one direction suggest the rift trends that are so definite on Mauna Loa and Kilauea, often productive of fissure eruption in Hawaii just as in Iceland.

The cone sheets of Mull are hundreds of concentric dyke-like intrusions dipping funnel-wise toward the volcanic center. Upward pressure of magma at one point is believed to have produced the funnel fractures, but the Hawaiian sinks make such inward dipping fractures by inbreak when the lava column withdraws. The ring-dykes are vertical or outward dipping crescent bodies about the central vent. One of them is an almost complete fault ring of size and shape like Kilauea, filled as a dyke with augite rhyolite. Ring tendency appears also in border folds eight miles from the center. T.A.J.

MAGNETISM IN HAWAIIAN BASALT

The magnetic compass points due north at only a few places on the earth's surface. At other places it points either to the east or west of north by know amounts. This compass error, declination or variation as it is called, is not constant for any one place but is always slowly changing.

At the rim of Halemaumau, the pit in the crater of Kilauea volcano, the behavior of the compass needle is very erratic. At some places it may show 10° easterly declination, the approximate correction for the Hawaiian Islands, a short distance away a much greater declination, no declination at all, or even a westerly declination.

Some such variation in the compass needle is to be expected in a region whose rock contains as much iron as that of Hawaii. In certain localities the percentage of iron is higher than the average or an appreciable part of the iron is in the form of the magnetic oxide and there the compass needle is very unreliable as a direction finder. One such place was found in a kipuka (a small area of older lava or soil surrounded by new lava—an oasis in a lava flow) in the 1859 lava flow from Mauna Loa by E. G. Wingate while making topographic maps for the U. S. Geological Survey in 1923. In the kipuka the compass pointed 50° to the east of north. R.H.F.

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NO. 8 RELEASED WITHOUT COPYRIGHT RESTRICTION FEBRUARY 19, 1925

KILAUEA REPORT NO. 684

WEEK ENDING FEBRUARY 18, 1925

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

The conditions at Halemaumau pit remain as they have been, and the greater part of the local seismic movements registered at the observatory were of the tremor type associated with avalanches at the pit. Thirty seismic movements were registered, of local origin, of which twenty-three were of the tremor type without the marked phases characteristic of sudden local earthquakes. Of the sudden ones two were felt at Kilauea, one at 6:43 a. m. February 12, and another 11:52 p. m. February 17. The tilting of the ground was moderate to the SSW.

Events at Halemaumau have shown continued peeling of the pit walls. No further developments have been observed in the crack athwart the big sill in the northeast wall reported February 11. In the different lighting of a cloudy day, February 12, the upper part of this crack appeared to have a red filling but underneath it appeared as a dark crevice extending all the way down to the talus.

On February 14 in the forenoon it was discovered that the inner ledge with its loose blocks a few feet below the rim at the tourist station southeast had fallen in. There was no fresh cracking back of the rim but there had been such cracking the previous week, showing that that edge of the pit was in motion. The portion that had fallen was the thin edge of an upright slab which has been partially detached from the wall and hanging out into the pit ever since the May eruptions of 1924.

On the 15th a new upright crack appeared in the lower northwestern wall in one of the promontories or buttresses which are characteristic of the lower walls in several places. This crack bounded a semi-detached crag about 150 feet long up and down next to a depression occupied by the northwest talus slide. On the 17th this wall was working steadily and three avalanches were seen in the wall adjoining this crack. By the next day the promontory was stripped and the crack gone.

During the last three days with light southerly wind and in spite of dry weather the steam on the bottom of the pit has been voluminous and a new sulphur patch has appeared in the east talus.

COMPARATIVE VOLCANIC ACTIVITY

One method of measuring comparative volcanic activity of different Pacific regions is by the proportion of extinct volcanoes to the total number for each district. This is based on the theory that all volcanic districts are remnants of greater activity in the Tertiary age. The percentage of dead cones in a district is called the "index of decadence." The lower the index number, the higher the percentage of live vents, hence the higher the activity as compared with other places.

In Hawaii, counting only the five complete volcanoes uninjured by faulting or erosion, only one, Mauna Kea, is extinct. Index of decadence then is one-fifth or 20%.

Von Wolff (Vulkanismus, Vol. II, Enke, Stuttgart 1923) arrives at the following index numbers (the Hawaii number is ours):—

		Volcanoes	Extinct	Index Number
1.	Sumatra	117	106	90
2.	S. Japan	22	16	73
3.	Fuji cross-zone	40	25	62
4.	Kurile Is.	51	27	52
5.	Tonga Is.	15	5	33
6.	Hawaii Is.	5	1	20

The extinction becomes less and the activity greater as we get more and more into the ocean.

Comparing with this the number of historical "outbreaks," we get a different order (Schneider, Volcanic Phenomena, Borntraeger, Berlin 1911).

1.	S. Japan	160 eruptions
2.	Fuji Zone	101 "
3.	Hawaii Is.	31 "
4.	Sumatra	23 "
5.	Kurile Is.	18 "
6.	Tonga Is.	10 "

This list means in general that the oceanic volcanoes have fewer explosive collapses than the Pacific margin, and also that Japan has the most complete records. The 160 eruptions for south Japan concern only five active cones.

Both of these lists are unsatisfactory, as the perfection of records and comparative numbers are too various, and the definitions of "extinct" and "outbreak" are elastic. But they mark progress. T. A. J.

EROSION REVIVED BY ASH-FALL

An interesting effect of the dust from the explosions of Kilauea last May is still to be seen at the sand spit on the crater floor southeast of Halemaumau and at other places along the south rim of the crater. Formerly most of the rain that fell on this sand spit quickly sank into old ash beds. Now, owing to the somewhat impervious fine ash covering, a heavy shower develops rapidly flowing streams that cut into the old ash beds and in one place the road to the pit is eroded to a considerable extent. The increased run-off is still striking even nine months after the laying down of the dust. The first downpour, after considerable dust had been deposited and before much had been either washed or blown away, produced the most remarkable erosion effects.

R. H. F.

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NO. 9 RELEASED WITHOUT COPYRIGHT RESTRICTION February 26, 1925

KILAUEA REPORT NO. 685

WEEK ENDING FEBRUARY 25, 1925

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

There was less apparent avalanching in Halemaumau pit during this week than in the previous one, and much of the time during visits to the pit the big cauldron was quiet without any noise of sliding rocks. On a very dry day February 19 the steam jets at the base of the east talus were so thin that the vents amid the broken rocks could be plainly seen and it there appeared in three places that bright yellow sulphur crystals were being deposited. These solfataras had developed rapidly, for they were amid fallen bowlders of the December avalanches. The contrast between these deposits of pure sulphur and others pale greenish-yellow at the foot of the north and south taluses is striking. Probably the sulphur at the latter is mixed with sulphates, such as are very conspicuous in vertical streaks of yellow and white at the base of the southeast wall, and in sheets of waxy white salts at the steaming vents in the lava floor near the center of the pit.

After the recent avalanches the northwest wall was seen to be notched so as to make three jagged abutments. Frequent small slides at the north wall, the odor of hydrogen sulphide, and faint hissing from the bottom of the pit were reported on the morning of February 20. Another small slide at the pit was heard that afternoon, and about 8:45 p. m. three deep detonations were heard at the Observatory.

With the dry weather chalky salts have again appeared on the high walls. In three places on the bottom of the pit there are mud flats, two of them showing much white stain when dry. During this week vapor appeared more conspicuously toward the top of the several taluses and in the wall just above the talus than heretofore. The stripping of the southwest wall has so freshened the rift dyke above the 1920 tunnels as to show that it is double, with country-rock between the two members, and a dark red fill. This is quite different from what the same dyke becomes below the big tunnel. Here it is thick and whitish. On the 23rd distinct upright steaming cracks in the body of the north talus were observed, showing that the talus matter breaks as a cake. It is remarkable how the very hot steaming slopes south and west make no deposits, although close at hand others deposit sulphur and salts. The sulphur is confined to the edges of the lava that came into the bottom in July, 1924.

Seventeen local seismic movements were registered during the week, of which seven were without evidence of preliminary tremors. One about 10:18 a. m. February 18 was felt in Kohala, and a pronounced shock partially dismantlling the seismograph at 10:20 a. m. February 23 came from an origin indicated by the seismogram as 13 miles from the Observatory. A distant strong earthquake at 1:31 p. m. February 23 appeared to originate about 4250 miles from the station, but neither the time nor the distance accorded with the destructive shock reported from Seward, Alaska. Tilting was moderate to the NNW.

INTERNATIONAL VOLCANOLOGY

The first publication of the volcano research section of the International Geodetic and Geophysical Union has made its bow to the public. This quarterly bulletin was published in Naples, September, 1924, by the secretary-general, Professor A. Malladra, Director of the observatory on Vesuvius. (Bulletin volcanologique, Royal Vesuvian Observatory, Resina, Italy, 30 fr. per annum).

It is in French and Italian and deals with the meetings in Rome and Naples 1922, and the program of the Madrid conference 1924. The American committee was evidently active, and its personnel and recommendations reflect the recent Pan-Pacific Science conferences.

Plans are outlined for a Central Bureau of Volcanology, which has now been established at Naples; for subordinate branches, with international libraries, at the Hawaiian Volcano Observatory and at the Italian institute of Catania, Sicily; for international cooperation that will furnish information instantly by wire or post, through the Bureau or its branches, of new volcanic activity anywhere; for urging naval establishments and mariners to give information about marine or submarine volcanic happenings; and for the preparation by each nation of a topographic, historical and statistical catalogue and bibliography of its volcanoes.

On May 8, 1922, on motion of Professor A. Lacroix, President of Section, it was

Resolved:—"(1) That, by reason of the services rendered to date by the volcanologic observatories of Vesuvius and of Kilauea, facilities should be accorded them for continuation of their work, and an institute of the same kind should be established for the study of Etna and the Eolian Islands;"

"(2) That continuous observations of volcanic phenomena should be made at the island Re'union."

Other matters given attention were underground thermal gradients, volcano borings, utilization of volcanic energy; papers published are on the activity of Vesuvius and Etna, on a new cinder island off the coast of Cochin China, on the power plant of Prince Ginori Conti using natural steam in Tuscany, and on volcanic potash, alumina and silica obtainable in the United States and Italy; and a notice on the work of the late honored Professor A. Ricco of Catania, student of Etna, the first president of the volcano research section. T. A. J.

THE VOLCANIC DEATH-TOLL

Since the year A. D. 1500, 98 eruptions of 57 volcanoes have destroyed 190,000 people. Of these 176,500 died on the Pacific half of the earth. Tambora near Java in 1815 accounted for more than 56,000 victims; next came Krakatoa in the Sunda Strait in 1883, killing 36,400 mostly by a flood. This was set up by the collapse of the island, and engulfment of the sea; outgoing tidal waves swamped the fishing villages on the neighboring coasts of Java and Sumatra. Mont Pe'le' in Martinique and Soufriere in St. Vincent in 1902 together accounted for some 30,000 lives by ejecting fiery blasts and showers of stones. Ten thousand deaths each are credited to the volcanoes Laki in Iceland in 1783, Kelut in Java 1586 and Unzen near Nagasaki in Japan 1792. To these seven eruptions four-fifths of the death toll have been paid. These figures have nothing to do with the terrible earthquakes and consequent fires of volcanic regions, such as Tokyo in 1923 and Messina in 1908. These two modern earthquakes destroyed more than twice as many lives as all the volcano outbreaks of history. (See Sapper's catalogue of eruptions, Strassburg Scientific Society, 1917). T. A. J.

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NO. 10 RELEASED WITHOUT COPYRIGHT RESTRICTION MARCH 5, 1925

KILAUEA REPORT NO. 686

WEEK ENDING MARCH 4, 1925

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

T. A. Jaggar, Official in charge

The week has been rather quiet with reference to avalanching in Halemaumau pit, and on some days a visitor to the pit heard no rocks sliding at all. At noon of March 2nd however during fresh squally northeast wind and very dry weather, the northeast corner of the pit started caving away.

The air in the pit became charged with dust so that the whole orifice was outlined by the swirling veils. Occasional small individual clouds of dust rose, but nothing that suggested a big avalanche. The whole northeast talus next day was covered with fresh red rock fragments. In the middle of the wall above, about the eastern horn of the large sill, a notch several hundred feet high had been left, revealing red ochreous rock and white or greenish brown vein matter. The notched place was fissured up and down for hundreds of feet, the fractures appearing to trend in the direction of Keanakakoi.

Nothing but small slides have occurred during visits to the pit. There are six sulphur-lined holes venting steam in the east talus where the latter overrides the lava floor, and there is also sulphur at the top of that talus. The hotter looking vents, giving up dense flocculent steam south and west, deposit no sulphur. Irregular red bodies of large size, above and surrounded by the big sill north and the large intrusive mass west appear as though they might have been crags in an ancient pit of which the sills formed the bottom. The middle of the north sill has an upward extension in section shaped like a mushroom, with fossil talus slopes on each side. Right and left the sill rises into horns behind these taluses, suggesting the vents that we have seen so often breaking out from the top of a debris slope.

It is difficult to say what starts the avalanche notches to working as on March 2 mentioned above. The steep northeast and southwest walls have breakage lines up and down that the other walls do not have, possibly traces of the Kau Desert shear zone. The northeast wall has avalanched more than any other. It may be that this zone moves seismically. There have been 17 local shocks during the past week, 12 of them without earthquake phases, and one at 7 a. m. February 28 felt here with indicated origin 2 miles away. Tilt was moderate to the northeast.

MORE COMPARISONS OF VOLCANO DISTRICTS

Taking Sapper's data and combining his small zones into districts with a view to getting 18 to 32 volcanoes in each district, we have the following:

Activity by number of volcanoes active for aggregate length of volcanic zone.

	Total number active	District	One volcano active per length of	
1.	25	Iceland	25	kilometers
2.	26	Central America	45	"
3.	25	Aleutian Is.	50	"
4.	19	Java	55	"
5.	18	New Zealand—Tonga	77	"
6.	24	Kamtchatka—Kurile	85	"
7.	25	Japan	100	"
8	41	South America	104	"
9.	18	Mediterranean	120	"
10.	26	Sumatra—Sunda Is.	127	"
11.	32	Philippines—Molucca	138	"
12.	18	Atlantic Ocean	192	"
13.	25	Melanesia	224	"
14.	30	North America	275	"

The central Pacific islands (Juan-Fernandez, Galapagos, Hawaii, Samoa and submarine eruptions) number 15 or 16 known vents and in indefinite number of unknown ones. They cannot be treated by length of belts.

To one knowing the places, the order of this table as showing decreasing volcanic activity is no more satisfactory than Von Wolff's table by "index of decadence." Both are based on unproved theoretical assumptions. This one assumes that the number still smoking in a given distance is an index of the activity of that area. But it overlooks the fact that two regions may have the same number of active volcanoes for the same distance or area, yet the activity of the whole district may be much greater in the one than in the other. (See Sapper, Volcanological Review, 1917). T. A. J.

EARTHQUAKE IN ST. LAWRENCE VALLEY

Press reports of this week tell of a disastrous earthquake February 28 in eastern Canada, centering about the St. Lawrence, with the loss of at least three lives, and "scores of homes damaged by earthquakes and fire, and one church collapsed." The Saguenay river was near the center. This is a deep canyon forming a northern tributary of the St. Lawrence, below the Thousand Islands, with Tadousac at its mouth. It is well known earthquake district, and so is the Labrador, farther to the east.

This recalls the earthquake of 1663 in the same district, of which Clarke, state geologist of New York, writes that "no like catastrophic upheaval of the earth has ever occurred here within the memory of man." "With a roar as of artillery the earth leapt up, houses tottered, walls were split, river banks were levelled, new lakes were seen, two mountains were overturned into the river and dammed it; forests were swallowed up leaving what looked like ploughed fields; chasms of wonderful depth exhaled a foul stench, and rivers resembled in color streams of milk or blood." So run the old Jesuit chronicles. T. A. J.

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NO. 11 RELEASED WITHOUT COPYRIGHT RESTRICTION March 12, 1925

KILAUEA REPORT NO. 687

WEEK ENDING MARCH 11, 1925

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

The past weeks was rather quiet up to March 10th. On this day some of the most spectacular avalanches in several weeks occurred. One at 12:52 p. m. sent up cauliflower clouds that maintained a hard outline for some little distance above the rim of Halemaumau pit. There was another large avalanche at 5:09 p. m. that crashed to the bottom with a roar that was almost deafening to observers standing on the rim. The pit was more or less dusty all day from the many small avalanches.

At the same time as the increase of avalanching there was an increase in the number of earthquakes. During the past week 32 earthquakes were registered at the Observatory, 23 of which occurred between 10 p. m. of March 9 and 6 a. m. of March 11. Four of the earthquakes were of sufficient intensity to be perceptible. The one at 8:14 a. m., March 10, felt as a distinct vertical jolt, had an indicated distance of about 1 mile. Another at 1:06 a. m. March 11 with about the same indicated distance, dismantled the seismographs and awakened many people.

The tilt for the week as a whole was moderate to the east-northeast. Just preceding the increased earthquaking the tilt changed from moderate southeasterly to moderate northeasterly.

A heavy fall of snow on Mauna Kea and Mauna Loa that accompanied the general rainstorm of March 7 and 8, will help to increase the available water supply on the two mountains next summer.

Immediately following the rain storm a large portion of the walls of Halemaumau showed a deep red color, giving the walls almost a velvety appearance. The red color is probably due to rain water percolating through the rock and bringing some of the iron salts to the surface where they are oxidized to iron rust. The bright red color persisted for but a short time probably becoming obscured mainly by dust from avalanches.

EARTHQUAKES IN HAYTI

A welcome volume has just appeared on the geology of Hayti by geologists Woodring, Brown, and Burbank, who were loaned to the West Indian republic by the U. S. Geological Survey. Volcanic lavas poured out in basaltic floods from central vents when the land mass was greater than at present. This was in Jurasic time or earlier. Andesites and more silicious lavas came later. There is still younger basaltic series, with intrusive rocks, of age between Mesozoic and Tertiary. Then came later acid andesites and quartz diorites. All of this was amid marine and non-marine sediments with folding, metamorphism and faulting from Mesozoic times on, and present day features are many of them the products of late Tertiary crumpling.

This movement is still going on, earthquakes are frequent, and those that are felt generally in Hayti originate in the ocean troughs, more localized shocks are related to particular peninsulas, and the central mountains are mostly immune. This is like the situation in the Philippines and the continental island masses. The recent volcanic and sesismic geology are typically cordilleran and like Alaska and the Coast Ranges.

At the meteorological observatory in charge of Rev. J. Scherer, Port-au-Prince, is installed a pair of Bosch-Omori horizontal pendulum seismographs, magnification 40X, which is stated to be "useless for determining the direction and amplitude of local shocks." This machine ought to be ideal for local shocks, with suitable modification of speed of drum and damping such as a physicist-experimenter could easily devise. We suspect that the Bosch air damper is making trouble, and it should be replaced by two or three metal vanes in oil.

The attitude toward this instrument as quoted is typical of much amateur handling of seismographs, owing to unwillingness to experiment, and an unnecessary awe of the supposed constants of the pendulums.

There were seven disastrous earthquakes in Hayti between 1551 and 1908, none of them occurring in the central region. They usually were accompanied by flood waves. The chart shows from six to forty earthquakes recorded in different places between 1909 and 1922, of which from two to twelve at each locality represented general shocks of widespread importance. The northwest peninsula and the north side of the southern peninsula are the regions of highest seismicity. None of the recent shocks was accompanied by a sea wave.

Most of them have intensity II to IV (Rossi-Forel), but a few reach grade VI. A shock on January 15, 1922 cracked ferro-concrete houses. (Geology of Hayti, 1924, English and French editions, Department of Public Works, Port-au-Prince). T. A. J.

VISITORS AT THE OBSERVATORY

On March 10 and 11 the Observatory was fortunate in having as visitors the distinguished geologists of the Third Asiatic Expedition of the American Museum of Natural History, Dr. C. P. Berkey and Frederick K. Morris and the topographer, Major L. B. Roberts.

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NO. 12 RELEASED WITHOUT COPYRIGHT RESTRICTION MARCH 19, 1925

KILAUEA REPORT NO. 688

WEEK ENDING, MARCH 18, 1925

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

After the avalanching and earthquakes reported last week Halemaumau became more quiet and during the past week only thirteen earthquakes were registered at the Observatory. None of the earthquakes were perceptible at Volcano House and seven of them were without phases.

Some of the cracks concentric to rim of pit where there has been movement recently are quite hot. One of them that crosses the trail to the pit shows but little steam ordinarily but if a lighted match is held near it great volumes of steam become apparent. Smoke from a burning object affords an opportunity for the moisture to condense and if held near a hot crack that is already steaming vigorously there will be a great increase in visible moisture.

On March 13 the steam from the bottom, which is always present, rose in hard outlines as though with a greater velocity or hotter than common. During rainstorms and on rainy days the pit is often so full of steam that the bottom can only be seen occasionally.

The sulphur stained area near the southeast border of Halemaumau floor that was obscured by recent avalanches is again visible.

Tilting during the week was moderate to the south-southwest.

PHILIPPINE EARTHQUAKES

Recent papers in the Bulletin of the Weather Bureau, Manila, by Father Maso, show that 52 destructive earthquakes, or about two per year, occurred in the Philippines during the first 22 years of this century. The strongest originated in the Pacific and in the Celebes Sea. Shocks from the land or the shallow seas were of small extent. The damage was mostly to old or badly preserved buildings. Old tile roofs were particularly dangerous. Places in recent alluvial soils suffered most.

Shocks became more numerous from west to east, or in the Pacific direction, where the relief due to profound deeps is most pronounced. Shocks occur in clusters, calm years alternating with disturbed periods, and infested places likewise shifting. Manila had bad earthquakes in 1863 and 1880. 320 people were killed in 1863, and only about 20 in 1880. Houses of mixed construction, masonary below and wood above, resisted the earthquakes well.

The Agusan Valley in eastern Mindano is the most active region seismically. The earthquakes are most felt in the level marshy central part of the valley where there are lakes and where subsidence occurred during earthquakes of 1893 and 1894. Just to the east lies the great Pacific trough. A big earthquake occurred in this valley, July 12, 1911. T. A. J.

VOLCANIC ACTIVITY BY OUTPUT

		Cubic Kilometers Lava	Cubic Kilometers Explosive
1.	Iceland	15.5	10.0
2.	Central Pacific	10 plus	1.0
3.	Kamtchatka-Kurile	6.0	1.2
4.	Mediterranean	5.1	4.0
5.	Atlantic	4.5	2.2
6.	Japan	3.00	6.2
7.	South America	1.2	9.0
8.	North America	1.0	1.2
9.	Central America	0.6	44.0
10.	Aleutian Is.	0.5	2.5
11.	Philippines-Molucca	0.4	5.8
12.	Melanesia	0.1	3.1
13.	Java	0.1	10.0
14.	Sumatra-Sunda Is.	0.1	172.0
15.	New Zealand-Tonga	0.01	3.1

This table, arranged by decreasing lava production as estimated from eruptions since the year 1500 A. D., and exhibiting for comparison the production of explosive material, shows that lava and explosive material are at opposite ends of the series. Iceland, the Mediterranean and Japan indicate that both may be ejected in large quantities from the same region. Volcanologically this table is satisfactory. The oceans and sub-arctic regions are the great lava producers, the continental borders and the tropics produce much explosion. It is remarkable that the Americas fall together the Atlantic with the Mediterranean, and the Pacific island chains at the explosive end of the series.

Yachtsmen fond of exploring may with the new hydrophones make great discoveries of immense volcanic domes, as large as Mauna Loa perhaps, on the bottom of the oceans. A mountain 8000 feet high stands on the sea-bottom between San Francisco and Honolulu. (Data above arranged from Sapper). T. A. J.

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NO. 13 RELEASED WITHOUT COPYRIGHT RESTRICTION MARCH 26, 1925

KILAUEA REPORT NO. 689

Week ending March 25, 1925

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

The equinox produced no crisis at the volcano. Seismically the past week was the quietest since last November, only eight earthquakes being recorded. An earthquake with an indicated distance of four miles at 5:34 p. m. on March 20 was strong enough to be perceptible. The other seven shakes were very small, three of them being without phases. A distant earthquake with poorly indicated distance of 3600 miles from Observatory occurred at 10:28 p. m. March 21. A report from another station points to a possible location near Kamtchatka.

Some avalanching took place at Halemaumau, the active pit of Kilauea volcano, on March 20 and 21. The majority of the earthquakes for the week occurred on those days. Since the last named date the pit has been rather quiet. A large piece of the eastern end of the northern intrusive body broke off on March 20 making a gray talus slope below. On March 25 the northeast and north wall were avalanching slightly.

Tilting during the week was slight to the east-southeast.

A SHARP TRANSITION FROM FOREST TO DESERT

An interesting but often unnoticed sight on the road to Halemaumau in Hawaii National Park is the sudden change from forest to desert. The northeastern slope of Kilauea is forested and most of the southwestern slope is a desert. The zone of transition is near the summit of the mountain. Instead of being a broad zone that commonly separates forested from desert lands here the zone is narrowed almost to a line. In traversing a distance of 1000 feet one leaves a forested area and enters an open desert.

The change is due almost entirely to difference in rainfall nad not to volcanic fume as is sometimes supposed. The soil in the desert, volcanic ash, is the same as that of the forest. In order for fume to cause the sharpness of the desert edge there should be considerable westerly wind, but west winds are very uncommon at Kilauea. Southwest winds are not uncommon during winter months and occasionally trees are partially defoliated by volcanic fume near Volcano House but rapid growth soon covers up such effects. Stunted growths of ferns, shrubs, and trees are to be found on the lee, or fumy, side of the fire pit, occasionally less than half a mile away. The transition from forest to desert continues as a line extending for several miles down the mountain side.

The rainfall is controlled by topography and constancy of wind direction. In the forested area the air of the northeast trade winds is forced up the mountain slope and cooled off to produce rain. On account of thus losing moisture, air on the lee slope of the mountain is drier that it is on the windward slope. As soon as the air starts down the mountain slope its temperature rises and not only does the rainfall diminish but even the clouds tend to evaporate. R. H. F.

ANNUAL MEETING OF THE ASSOCIATION

The Hawaiian Volcano Research Association at its meeting in Honolulu March 12 reelected its Board of Directors. The officers are L. A. Thurston, president; C. H. Atherton and W. F. Dillingham, vice-presidents; L. Tenney Peck, treasurer; directors are W. R. Castle, Arthur L. Dean, W. W. Thayer. L. W. de Vis-Norton, Young Building, Honolulu is secretary of the Association.

Reports were read by the treasurer and the secretary, and addresses made by the president and by the volcanologist of the Hawaiian Volcano Observatory, who acts as scientific director for the Association.

At present the division of effort between the Government, through the United States Geological Survey, and the Association is as follows. The Government pays salaries, keeps daily journal and seismograms, prepares and issues the routine reports, maintains the plant, the routine, and expeditions when needed, and provides for the larger publications in Washington. The Association is improving the outlying seismological stations and operating them, building up the library of the station, providing for publication of a popular book on volcanism, printing the local publications including the VOLCANO LETTER, and is ready to assist in securing the services of cooperative workers in the chemical laboratory and in the laboratory for steam experiments built over the bore holes at Sulphur Bank.

The address of the Volcanologist was entitled "'National standards of volcano and earthquake research" and will be printed in the March Bulletin of the Observatory. The staff of the Observatory has succeeded in bringing the printing of the monthly bulletins nearly up to date, they are published and distributed to November 1924 inclusive, and ready for the press to February 1925. The December number will contain a discussion of "Volume relations of the explosive eruption." T. A. J.

TIDAL OSCILLATIONS IN HALEMAUMAU

Dr. Ernest W. Brown, in charge of the Department of Mathematics at Yale University and well known for his astronomical work as computer of the complicated motions of the moon, has published an analysis of the lava tide measurements of Halemaumau made by the staff of the observatory in 1919. He concludes that there is enough evidence of tidal effect to warrant repeating the work by a different method for a longer period. (American Journ. Sci. February, 1925). T. A. J.

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NO. 14 RELEASED WITHOUT COPYRIGHT RESTRICTION APRIL 2, 1925

KILAUEA REPORT NO. 690

WEEK ENDING APRIL 1, 1925

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

Halemaumau pit remains tranquil, after a week of extremely rainy weather, and by the wetting of the walls the red color of lava layers is brought into prominence. The reddening is due to oxidation of the iron in the rock, and above the several intrusive bodies is far more conspicuous than elsewhere. The bank of yellow and white sulphates at the base of the southeast wall lost all its color after the rains. The alums and other soluble salts at the edge of Kilauea crater were also washed down. There must be a concentration of these soluble products underground.

In the pit there has been very little sliding of debris. Some new fallen fragments were observed on the northeast talus. A dry patch with sulphur stain on the high north wall, where the rock all around was wet with rain, appears to mark the site of the blue fume vent which disappeared during a November avalanche. The steep cavern in cracked ground north of Halemaumau has recently collapsed, and is now close to rim of pit, so much has the edge caved away.

An examination of Keanakakoi gulch March 28th revealed new erosion and a new debris fan on the Kilauea floor. The 1924 ash both increased the run-off by its impervious surface and furnished cutting material to the water. New white spots on the Kilauea Iki floor are rain-wash hollows filled with ash-mud.

Fourteen seisms were recorded during the week, seven of which were without phases, and five very small were on March 31. A local shock at 12:30 a. m. March 29 was perceptible and had indicated origin distance of about one mile. Tilt was slight to the ENE.

ERUPTION OF BOQUERON, 1917

The republic of Salvador on the southwest coast of Central America contains ten active volcanoes along a zone of volcanic upbuilding over fault fractures between the Pacific coastal plain and the Guatemalan plateau. The zone trends curving into Mexico and Nicaragua with convexity toward the ocean as in so many of the Pacific chains of volcanoes. At the south end of the line is Coseguina and near the north end Santa Maria, both volcanoes that have made gigantic explosive eruptions in the last century. Salvador in the middle of the curve has a group of lava-making volcanoes rising to heights of 6000 feet from a plateau 2000 feet above the sea.

West of the capital San Salvador rises the volcanic peak of the same name 6400 feet above sea level, and a little lower on the west is an active volcano whose crater "Boqueron" contains a lake of water 1300 feet in diameter and 1200 feet below edge of its pit. In the district are other crater lakes and volcanoes such as El Playon and Izalco. El Playon produced a lava flow 3 miles long in 1659. Fiercely destructive earthquakes have wrecked San Salvador city twelve times, usually with volcanic accompaniments.

Beginning June 6, 1917 the volcano Boqueron achieved the thirteenth catastrophe, splitting open its northwestern flank, throwing forth a stream of rough aa lava, flinging up ash and cinder with thunderous noise, and wrecking towns and coffee plantations with a succession of earthquakes that lasted a week.

At 6:55 p. m. June 6 came a terrific shock of 15 seconds duration, fifteen towns were wrecked including the capital, 100,000 people were left roofless, several hundred were killed and many were wounded. Streams were dammed and deflected, water supplies were cut off, bridges fell, refugees in the country found the public ways broken and blocked, and mountain sides slid down. The district of wreckage was twenty miles across. In its midst stood Boqueron.

At the first shock buildings went to pieces, at the second landslips broke loose, and at the third the flank of the volcano exploded. The new crater fissure opened just above the plantation Las Granadillas. Nine craterlets formed in a row five miles long, the lowest "El Tronador" or the "thunderer" giving vent to a lava flow. The lava was at first so liquid that some people were caught and killed by it. There were houses only fifty feet from the place of outbreak, and these along with several plantations in the track of the flow were destroyed. The flow reached a length of four miles.

Cinder and ash explosions accompanied the outbreak, and mud rains fell at the city to add to the sufferings of the homeless population. The volcanic gases were strong, and the acid ash rain on bare-headed wanderers was said to cause the hair to fall out. The coffee plants were defoliated for miles around. Nine plantations were partly or wholly demolished. In them the explosive material averaged six inches in depth, but in Las Salinas the ash was four feet deep. In its deeper fillings the lava was 160 feet deep.

The crater lake at Boqueron showed boiling and wave motion, there were steam jets, incaving sides to the big crater, and cracks back from the rim. In June there was an apparent rise of lake level. In July the lake had sunk away and evaporated, white cauliflower clouds came through a bottom fissure, and then a circular cinder cone was built up. (Friedlaender, Volcanological Review, 1918).

T. A. J.

VOLCANOLOGY IN SALVADOR

We have received from Senor Jorge Larde' an account of the volcano Izalco (Government publication, San Salvador 1922). An observatory with seismograph has been established. Izalco is almost continuously active, the Republic is a stable well-governed little country, and with seismic and volcanic events numerous throughout the land, Salvador is an ideal laboratory of volcanologic science for any benefactor or institution wishing a place wherein to establish continuous work. The writer visited Salvador in 1910 and found it most hospitable and attractive. T. A. J.

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NO. 15 RELEASED WITHOUT COPYRIGHT RESTRICTION APRIL 9, 1925

KILAUEA REPORT NO. 691

WEEK ENDING APRIL 8, 1925
Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, Temporarily in Charge

The volcano continues to be rather quiet. Avalanches have been rather infrequent since the middle of March. During the past week the few avalanches noted occurred mainly on March 6, 7, and 8. Considerable steam arises from cracks concentric to the rim of the great pit in Kilauea crater as well as from the floor of the pit itself. The odor of hydrogen sulphide has been very slight during the last few days.

Not only is the pit quiet as observed by the eye but also the seismographs at the Observatory two miles away show less activity than at any time since the middle of November 1924. Only eleven earthquakes were recorded during the week, none of them being perceptible at the Volcano House. The tilt was very slight to the south-southwest. This is the usual direction of tilt for this time of year but the amount is smaller than usual.

During the recent rain spell one could frequently be in the midst of light rain at the hotel and observe dust clouds about three miles away in the desert.

THE VOLCANOLOGICAL REVIEW

Articles from the "Volcanological Review" have been quoted in the LETTER. The Zeitschrift fur Vulcanologie is issued from Naples, with the title in German, Italian, English, and French and printed in Berlin (Dietrich Reimer Co., Berlin, SW. 48. Wilhelmstrasse 29, 20 marks per volume). Dr. I. Friedlander is the founder and financier of the magazine at his Volcanologic Institute in Naples. The type is large, the paper heavy, the plates in heliotype and color, the substance sound, cosmopolitan and scientific. Four to six numbers are issued per year and the authors are of all nations, writing texts in any of the four languages. Six extra monographs, in part subsidized by the Institute, have dealt with volcanic bombs, the north Moluccas, Vulcano in the Lipari Isles, the Nyassa volcano district of Africa, the Cape Verde islands and some volcanoes of Iceland.

The seven volumes from 1914 to 1924 contain, by American authors; a description of the Teneriffe eruption in 1909 by Perret; another by the same author on Sakurajima; a discussion of lava tunnels in Hawaii by Hobbs; recent eruptions of Poas in Costa Rica by Tristan; new islands at Sakurajima by Powers, and articles by him on intrusions at Kilauea, and on Yakedake in Japan; and the activity of Irazu in Costa Rica by Tristan.

Hawaii is abundantly noticed with many reviews of work done here, descriptions of its peculiar stalacities, bombs, and small products, its fault valleys, the spacing of its volcanoes, its gases, its blowing cones, and by a special article by Friedlander on the island Kaula.

There are articles on the volcanoes in Java, the Moluccas, New Guinea, Central and East Africa, Iceland, Mexico, Nicaragua, Japan, Guatamala with its pairs of twin volcanoes, Lower California, and Italy, as well as reviews and descriptions of old volcanic districts in many parts of the world.

Of philosophical interest are the studies of hydrostatic equilibrium at volcanoes by Friedlander; of temperature and pressure inside the globe by Klussman; of the rift valleys and seismicity of Africa and the Red Sea by J. W. Gregory and E. Kreubel; of the spacing of volcanoes by Friedlander; of the geography of volcano distribution by Sapper, Arldt. and Schneider, of the crustal mechanism of granite intrusion by Cloos; of volcanic activity by Hempel; of earthquake depth by Quervain; of volcanic fault valleys, like the Haleakala gaps, by Friedlander; of magmatic distillation processes by Niggli; of volcanism and mountain building by Schwinner; of volcanic fault-block mountains by Reck; of volcanic gases by Salvatore, Friedlander, and Allen (review by Sonder).

No single publication in the history of science has done so much to establish volcanology on a sound and common sense basis as Dr. Friedlander's splendid publications, and as he is well known in Hawaii for his travels here, his interest in Kona, and the explorations of himself and his brother on Mauna Loa and Kilauea, these volumes should have a place on many Hawaiian shelves. T. A. J.

VOLCANIC ASH CEMENT

If one takes a walk into the desert to the southwest of Halemaumau he can not fail to notice the hard cemented crust that covers the ash from Kilauea in many places. The natural cementing action of the 1790 ash has preserved footprints of that time so that not only do the outlines of the feet show but also the individual toes.

The use of volcanic ash in cements was well known by the ancient Greeks and Romans and many structures made with this material and slaked lime as cement are in good state of preservation today.

Experiments on the nature of the cementing action of the 1790 ash from Kilauea made by J. C. Riperton of the Federal Experiment Station in Honolulu indicated that it is due to the formation of collodial or gelatinous compounds of silicon and subsequent dehydration. It should be noted that such an action is one of the explanations for the setting of Portland cement. R. H. F.

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NO. 16 RELEASED WITHOUT COPYRIGHT RESTRICTION APRIL 16, 1925

KILAUEA REPORT NO. 692

WEEK ENDING APRIL 15, 1925
Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, Temporarily in Charge.

Seismically the past week was the most active in a month. Of the 15 earthquakes that were registered at the Observatory, five gave records distinct enough for the distance away of the shaking to be calculated. The one at 1:37 a. m. April 9 awakened many people at the Volcano House and vicinity and dismantled one of the seismographs. The three local earthquakes on April 11 were at indicated distances from Observatory of 13, 6, and 2 miles respectively. The recording of earthquakes of such distances so close together may be taken as an indication of movement along either the northeastern or southwestern rift from Kilauea. A slight earthquake that awakened a few people near the Volcano House at 5:38 a. m. April 15 had an indicated distance to origin of 19 miles. The distance away of a slight distant shake at 2:31 a. m. April 11 could not be determined.

The resultant tilting for the week was very slight to the north-northwest, though there was a moderate southeast tilting on the 10th following by a rapid recovery or northwesterly tilting on the 11th.

The volcano as a whole has been rather quiet, though avalanches from the walls of Halemaumau can be seen and heard nearly every day. Most movements appear to be at the north wall above the large gray intrusive body there. In some places the accumulation of avalanche material is sufficient to bury a large part of the intrusive body. A sulphur stained area near southeastern border of the pit floor has been extending itself toward the center of the pit on the black lava fill of July 1924.

The brisk winds on April 15 stirred up heavy dust clouds in the Kau Desert and small ones on the Kilauea crater floor.

SUBMARINE LAVA FLOWS

Several submarine eruptions have been reported from different places off the coast of the island of Hawaii and other ones, not observed, have been surmised.

The northeast and southwest rifts from Kilauea and the southwest rift from Mauna Loa are known to terminate under the ocean and as lava flows are known to issue as fissure eruptions all along these rifts from the summit of the mountains to the shore it is easily possible that some of them still take place under the water.

The frequent withdrawal of lava from Halemaumau, the active pit of Kilauea, has sometimes been explained by assuming a submarine drainage. This may or may not be true as a subterranean flow within the northeastern or southwestern rifts might easily account for all the liquid lava that disappears from view.

In 1868 there was a withdrawal of liquid lava from Halemaumau followed by a profound collapse. A small amount of lava appeared along the southwestern rift about 10 miles from the volcano, and the ground was fissured at least as far as the ocean near Pahala. There are nothing but very meagre reports of the possibility of the lava appearing on the ocean floor along the extension of southwestern rift in this year.

In 1877 good observations were obtained of a submarine eruption from Mauna Loa but not along the well known southwestern rift. This eruption was in Kealakekua Bay almost due west from the summit of Mauna Loa. On February 24, 1877, following activity at the summit by a few days, there were earthquakes near Kealakekua Bay that left a visible fissure on land. Red, green, and blue lights, amidst steam, appeared about one mile off shore. The boats that were rowed through the scene of action were frequently hit by rising pieces of lava. These lava fragments, very light and frothy, were generally red hot when they reached the surface of the water but quickly cooled and sank.

One of the strangest accounts of a submarine eruption here is given on pages 245-246 in Vol. 2, Fire Fountain of Hawaii, by C. F. Gordon Cumming This eruption is strange because reported from a place where such an eruption might not be expected, off the northeast coast of the Island of Hawaii. The 1880-81 lava flow from Mauna Loa that started on November 5, 1880 was in progress and the entire Island was shrouded in smoke. About November 19 while the schooner Pauahi lay to, apparently near Honokaa, "The sea seethed and boiled, clouds of steam and masses of pumice were thrown up as in a fountain and the display lasted about three minutes." A similar display astern of the schooner immediately followed.

Hitchcock in Hawaii and its Volcanoes mentions a submarine flow off Puna in 1884 and another off Hilo in 1906 but gives no detailed information nor authority.

Submarine contours indicate numerous flows off the east and south points of the Island of Hawaii. The northeastern rift from Kilauea and the southwestern rift from Mauna Loa enters the ocean near these points respectively.

In 1922 and 1923 there were subterranean drainage and collapses of Halemaumau with very small lava flows appearing in or near Makaopuhi crater about eight miles away. In 1924 there was a profound collapse of Halemaumau and indications of a subterranean, possibly submarine, drainage in the northeastern rift. R. H. F.

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NO. 17 RELEASED WITHOUT COPYRIGHT RESTRICTION APRIL 23, 1925

KILAUEA REPORT NO. 693

WEEK ENDING APRIL 22, 1925
Issued by the Observatory, U. S. Geological Survey:
R. H. Finch, Temporarily in Charge.

There is but little change in visible conditions at the volcano. While avalanches occur nearly every day they are for the most part rather small and merely represent progress of the material in a steep wall toward a more stable angle of repose. None of the earthquakes during the past two weeks seem to have affected the walls of Halemaumau to any extent as there is no evidence of any appreciable movement along the cracks concentric to the rim.

The odor of hydrogen sulphide has been rather noticeable of late and occasionally one can detect the odor of free sulphur. When gases are emanating from a volcano during quiet spells hydrogen sulphide is usually conspicuous while with molten lava present sulphur dioxide is the most characteristic gas. Hydrogen sulphide is a combustible and explosive gas and sulphur dioxide is a burned gas.

Considerable sulphates in the form of white incrustations are to be seen on the walls of the pit as well as on the floor. The deposits on the floor area are for the most part, along three parallel steaming lines that trend northeast-southwest.

During rainy spells the pit is often so full of steam that one can scarcely see into the pit. The noise from a large avalanche at such a time is exceedingly wierd.

Seventeen earthquakes were recorded during the past week. The one at 8:52 p. m. April 20 which was felt locally had the appearance of a Mauna Loa shake. An earthquake that was generally felt at Volcano House at 12:29 p. m., April 16, had an indcated distance to origin of two miles from Observatory. Most of the other local earthquakes appeared to have their origins one to two miles away. A slight record of a distant earthquake was written on the Observatory seismographs about 5:30 a. m., April 19. Newspapers report a disturbance in Japan about this time.

Tilting during the week was moderate to the west-southwest.

THE ASH DEPOSITS AT KILAUEA VOLCANO

While excavating for a cesspool in the Observatory grounds on July 12, 1924, good evidence was obtained to prove that the ash surrounding Kilauea Volcano represents the deposits of several different explosive periods. While the deposit is frequently spoken of as "the 1790 ash," the majority of geologists who have worked around Kilauea assumed that it represents at least two or more distinctly separated explosive periods.

Hitchcock in "Hawaii and its Volcanoes," speaks of soil interbedded in the ash and calls the 1790 discharge comparatively mild. Dr. Sydney Powers (American Journal of Science, March, 1916) who was one of the first to make any extended study of the ash, found not only evidence of an appreciable time interval between the laying down of different layers (uncomformity) but also that the Keomoku lava flow from Mauna Loa, which occurred prior to 1790, overlies ash deposits. Prof. Sherzer (Science, April 20, 1923) thought that the ash deposits are the product of three explosive eruptions though it may well be that there were many more than this number.

At the base of Uwekahuna Bluff there is an ash bed (now nearly obscured by the lava flows of 1919) under nearly 500 feet of lava flows that must have been laid down long before the deposition of the oldest of the deposits that now compose the present surface.

An unconformity between a thin superficial layer and older deposits that can be traced up hill and down dale at the south side of Kilauea indicates that only a small fraction of the total ash beds represents the 1790 ash. When the 1924 explosion material on the crater floor shall have become buried by lava flows the only evidence left of the 1924 explosion will be a thin layer of ash outside the crater on the desert side and it will be difficult to find any separation between the 1790 and 1924 deposits.

The molds of several small trees or other vegetal growth were found in the excavation in a slightly eroded layer about two and a half feet below the present surface. Two feet or so below this layer other and larger holes were found that may well have had their origin in the decay of buried trees. In all about 15 well defined were strata noted. In several cases there were indications of deposits on old and weathered surfaces of previous ash layers. It should be noted that any explosive period may lay down several well defined strata.

As the tree molds were excavated in the rain belt and considering the natural cementing qualities of the ash as well as the fact that the thickness of each layer was quite constant it does not seem probable that much of the material was ever moved by wind after it was laid down. Owing to the flatness of the location and to the porosity of the ash the possibility of erosion and transportation by water to effect the burial of small trees or sticks may be dismissed. The only other explanation is that the vegetal growth was buried by ash during some explosion of an appreciably later date than the one represented by the layer in which the vegetation was growing. What the time interval between the deposition of these layers was is not known that it may well have been 65 or 130 years or more.

R.H.F.

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NO 18 | RELEASED WITHOUT COPYRIGHT RESTRICTION | APRIL 30, 1925

KILAUEA REPORT NO. 694

WEEK ENDING APRIL 29, 1925

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

Landslides were rather infrequent during the past week though very small rock falls could be heard every day. The place on the floor where the densest steam escapes at present is a little way up the south talus slope, to the left of the place where visitors usually stand. On dry days like April 24 and 25 great quantities of white salts that resemble a light fall of snow can be seen on the ash around pit rim. The spicy odor of free sulphur is now very noticeable.

Twenty-three earthquakes were registered on the seismographs during the week though none of them were felt locally. Of this number 19 occurred on April 24 and 25. Several of the shakes had the appearance of having had their origins along the northeastern rift of Mauna Loa.

Tilting during the week was moderate to the southwest.

FOUNDING A VOLCANO OBSERVATORY

The essential features of a volcano observatory are a volcano, an observer and the record made by the observer. For success there are needed two things more -enthusiasm in the observer and publication of his record. It is an error to suppose that the purchase and maintenance of expensive buildings and instruments are among first requirements. A physicist living continuously at Galapagos, or on Kamtchatka, or in the New Hebrides, and keeping a diary, is a potentioal observatory. Students of volcanism the world over want to see that diary. Essentials of the record are exact places, maps and photographs, correct times, and descriptions and measurements of all volcanic and seismic events describable or measureable.

It is this matter of measurement that leads the observer to equip himself with instruments. But the object is not the instrument, it is the measurement. Many measurements may be made with a foot-rule, a thermometer, and a watch. The good observer uses these tools all the time. A transit or plane-table is only an extention of the foot-rule, a seismograph an extention of observation with the watch. When an observer has to remain awake all night in order to record all the earthquakes, he bethinks him of automatic recorders.

There are over four hundred more or less active volcanoes in the world not being continuously observed. Twenty or more of these are splendid natural laboratories. Such volcanoes are Stromboli in the Lipari Isles, Izalco in Salvador, Villarica in Chile, Tanna in the New Hebrides, Akutan in the Alentian islands, Waimangu in New Zealand, Bromo in Java, Oshima in Japan, Lassen in the United States, Colima in Mexico. Continuity of action, hot gases, frequency of ground movements, representatives character and position—such are some of the qualities that make a given volcanic center attractive. It is not the highest or most famous volcanoes in a given belt that should be selected for steady work, but those that are practicable and reasonably free from danger. In many places there are hardships aplenty without seeking them in the scientific work.

One feature that is desirable is a settlement near at hand where reports may be published and mailed, where supplies may be obtained and where headquarters may be made in case the volcano district itself is wild.

Generally exploration is necessary in addition to routine cataloguing of events. A place like Salvador, for example, has a dozen volcanic centers, some of which occasionally break into activity, although Izalco is the most faithful of the outlets. A volcano observatory is always striving to see underground. Hence the observing of slight tilts, or changes of temperature, or tremors, and the employment of volunteer observers among planters, school teachers, ministers and government officials.

Any university or museum that can find a man willing to go to one of these countries and to live there and use his influence while there to promote volcanology and local seismology, will have taken the initial step in founding an observatory. Such a man is a missionary of science.

T. A. J.

THE 1823 LAVA FLOW FROM KILAUEA

A curious and rather unaccountable error has crept into the literature of Kilauea and onto the maps of the Islands of Hawaii. The westermost of the most recent lava flows from Kilauea that entered the sea or nearly reached it near Pahala is commonly spoken of as having occurred in 1868 though it really occurred in 1823. W. O. Clark, geologist at Pahala, called the attention of F. A. Danforth, topographer who was mapping in that region in 1920. to the fact that nowhere in existing literature could he find authority for dating the Keaiwa flow 1868. (See map of the U. S. Geological Survey, Pahala quadrangel). He also pointed out that the Rev. Wm. Ellis in his "Journal of the Tour Around Hawaii" definitely placed it in 1823. and that the Rev. Titus Coan's account did not make it 1868. Coan mentions small outbreaks of lava in 1868 about 11 miles southwest from Kilauea but says nothing about a large lava flow near the sea though he was specifically looking for lava outbreaks. In 1868 the inhabitants of Pahala saw glow from a lava flow to the northeast but no record is found of their observing a brilliant glow to the east, which they no doubt would have seen had the flow in question occurred in that year. The so-called 1823 lava flow does not reach the sea while Ellis describes the real 1823 flow as reaching the sea and destroying a canoe at Mahuka. Mr. Danforth pursued the subject farther and found an old cowboy who stated that the trial across the so-called 1868 flow was indentical with the present trail prior to 1868.

On the new topographic maps the real 1823 flow is called the "Keaiwa Lava Flow" and what was formerly called the 1823 flow, which is really prehistoric, is designated the "Kamooalii Lava Flow."

R. H. F.

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NO 19 RELEASED WITHOUT COPYRIGHT RESTRICTION MAY 7, 1925

KILAUEA REPORT NO. 695

WEEK ENDING MAY 6, 1925

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

R. H. Finch, Temporarily in Charge.

On May 6 there were some slight indications that Halemaumau, the great pit in Kilauea Crater, was a little hotter than during the past several weeks.

The heavy steam cloud rising from south talus noted in last weeks report has become less conspicuous. The lower part of a steam line in the southwest talus that extends all the way from the July 1924 lava fill to the top of the talus is steaming less than before as though the deposition of salts and action of steam on the rock had plugged up the steam vents in that vicinity. The walls and even the floors have been quite red. On May 5 the odor of hydrogen sulphide was quite noticeable after having been scarcely detectable for a few days. An avalanche of considerable size fell from the north wall during the night of May 4-5. The wall rock from where it fell appears to be very rotten.

Nine local earthquakes were recorded at the Observatory during the week. The one at 8:12 a. m. April 29 had an indicated distance to origin of three miles. Slight records of three distant earthquakes were recorded at the following times: May 3, 7:03 a. m. and 12:48 p. m.; May 4, 11:47 p. m..

Tilting was slight to the northeast. This indicates a slight tumescing in the top of the mountain. As rule during this time of year the top of the mountain is subsiding.

IZALCO VOLCANO

Attention has been called to Izalco as a place worthy of an observatory. It is representative of ten active volcanoes in Salvador and of a region producing destructive earthquakes. It is a cordilliran region of the same Pacific coastal zone with Seattle, San Francisco and Los Angeles, but with its volcanic gases more in evidence.

Izalco is much misconstrued in the stories about it. In an article published in 1923 appears the statement that in 150 years Mt. Izalco "has risen from the surface of a level plain that was devoted to stock farming, to a majestic height of more than 6,000 feet above sea level." In the same article appear two photographs of Boqueron activity in 1917, purporting to be Izalco. In 1917 Izalco was quiet. As to the stock farm story, Izalco as it is today was built up by lava flows and cinder on the southern slope of Santa Ana volcano, making a total accumulation of about a thousand feet. The writer quoted above failed to state that the growth started on a lava spur of the older mountain already 5,000 feet above the sea.

The year of first outbreak of the flank cone destined to become Izalco is commonly quoted as 1770, but Larde' corrects this. In 1524 there was a solftara there giving vent to a rill of boiling water. In 1576 this had disappeared. In 1636 there was a craterlet in action at the same place throwing up smoke and incandescent substances, but not yet an independent cone. Therefore as a matter of fact Izalco was born about the beginning of the 17th century.

The eruptions from 1636 on produced a confused mass of lavas and there was a culminating eruption in 1722. There was no very definite hill in 1753. Big eruptions in 1770 inaugurated more continuous activity and still more so in 1798, so that a true cone grew up that was worthy of a name distinct from Santa Ana, the mother volcano. By the end of the 18th century Izalco was in full blast as an independent lava factory.

We learn that the major activity of the 18th century began with eruptions in 1802, 1805, 1806, 1807, and 1825. In the last a river course was changed. There were bad earthquakes in 1830, 1831, 1860, 1861 and 1863. In 1840 there were three crater orifices, one of them quiet, one making dark blue fume, and an active one throwing up stones and black clouds. In 1854 there were explosions every five minutes and lava flows in motion. From 1856 to 1859 there was much extrusion and in 1859 there were earthquakes and an ash eruption. Churches and towns were damaged. From 1860 to 1865 there was repeated activity. Other eruptive times were 1867, 1868, 1869, 1870, 1873, 1874, 1875, 1879, 1880, 1882, 1883, 1885, 1887, 1889, 1890 (lava), 1891, 1894 (continual eruptions), 1895-97; at this time it was compared to Stromboli as the "Central American lighthouse." May, June and July of 1898 Izalco continued its extrusions, and an important eruption occurred in 1899-1900.

Inactivity lasted from March, 1900 to May 1902. Then came an outbreak, followed by lava flow in September. A crack opened from top to bottom of the cone. In 1904-05 there was activity. In 1907 this abated. New activity started 1912 and continued, there was a disastrous earthquake in 1915, and Izalco quieted again January 26, 1916. From October, 1920 to April 1921 there were new explosions, lava flows and hydrochloric acid gas. In 1922 there was only fume. (J. Larde, El Volcan de Izalco, 1923). T. A. J.

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NO. 20 RELEASED WITHOUT COPYRIGHT RESTRICTION MAY 14, 1925

KILAUEA REPORRT NO. 696

WEEK ENDING MAY 13, 1925

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

R. H. Finch, Temporarily in Charge.

The Volcano continues to be quiet. During the last few days, however, there was a slight increase in the number of avalanches. These avalanches, for the most part, were from the north wall. Portions of the gray intrusive body broke off though most of the avalanche material was from the rather rotten rock just above the intrusive body. Neither the odor of free sulphur nor hydrogen sulphide has been noticed for several days.

Fourteen earthquakes were registered by the Observatory seismographs, though none were perceptible at Volcano House. At the beginning of the week there was a slight northeast tilt. During the latter part of the week the direction of tilting changed to southwest with the result that the net tilt for the week was very slight to the south.

EXPERIMENTAL SEISMOGRAPH

Mr. H. O. Wood reports tests of five horizontal torsion pendulum seismographs and one vertical torsion instrument of the new type designed by Dr. Anderson at the Mount Wilson Observatory laboratory in Pasadena, California. (Report of Seismology Committee, Carnegie Institution, Bulletin Seismological Society, America, Sept, 1924.)

The seismometer consists of nothing more than a vertical "bow-string" bearing a tiny mirror. This is the pendulum, oscillating about the torsion axis of the string, and writing photographically with high magnification. Magnets damp the horizontal swing and a drop of oil in a sleeve damps against vibration.

Two initial instruments had free periods of 0.8 second and static magnification of 1200 times the displacement of the earth. Another was given a magnification of 2500. Damping used in these short period instruments was about one fifth of the amount required for the critical, or aperiodic, condition. The short period pendulums registered local earthquakes well also the first phases of distant quakes. The first phases were registered of aftershocks of the Tokyo earthquakes. Many regional California shocks show pre-phases even earlier than the normal first phase, owing to the extremely high magnifications employed and the adaptability by resonance of a critically damped pendulum of period as short as the earthquake vibration itself.

An improved short period torsion seismograph was made with convenient adjustments for levelling, damping and measuring periods, using a meter-focus concave mirror, a static magnification of over 4000, and a bright light source prevented from fogging in quiet times by a slotted disc. This brighter recording point of light prevented underexposure during earthquakes.

Also a long period torsion seismometer was operated and found satisfactory for distant earthquakes. The period was from 5 to 15 seconds, damping ranged from underdamping to overdamping, and magnification was 300. The instrument showed little disturbance from tilting or temperature. A major teleseism recorded in June 1924 showed clearly the long-period surface waves which had travelled a major arc of the earth's circumferance, and others that had traversed both the minor arc from the source to the station, and the complete circumference of the earth in addition.

Most of the local California earthquakes registered originated at distances 25 to 200 miles from the station. They were numerous. Microseisms were best registered on the long period machines and were small. Engine vibrations and blasts were recorded. A good test of the rate of transmission of earth waves was furnished by the detonation of 182 tons of dynamite 67 miles from the station in hard rock. The timing was checked, good records were written by the machines, and these records are easy to interpret on both the long and short period instruments.

A torsion-suspension vertical component seismograph with period of one-half second was operated successfully with critical magnetic damping. A long period instrument of this type is unstable. It is interesting to observe in all this work of Anderson and Wood that synchronizing of pendulum with earth period, through different instruments for different types and parts of earthquake motion is the key to success. T. A. J.

A NEW TYPE OF SEISMOGRAPH

Dr. Paul Kirkpatrick of the University of Hawaii has devised a novel type of seismograph. Instead of employing a pendulum bob as a steady mass from which to record the movements of earthquakes, the common practice, Dr. Kirkpatrick proposes to use a falling body as a steady point. The course of a falling body is not affected by any change in earth motion during the period of its fall. A continuous liquid jet is used instead of a series of individual falling bodies. The record is made by projecting the shadow of the falling jet onto photographic paper. With such a seismometer it should be quite easy to determine the absolute motion of the ground. With the ordinary pendulum seismograph such a determination, with precision, is difficult. Some of the practical applications of the seismograph, such as determination of the seismicity of a place and aproximation location of the seat of earthquakes, and recording the tilting of the ground from which the probable time and location of earthquakes may be foretold, can be made as well, however, with a pendulum instrument. (Nature, April 11, 1925, p. 530). R. H. F.

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NO. 21 | RELEASED WITHOUT COPYRIGHT RESTRICTION | MAY 21, 1925

KILAUUEA REPORT NO. 697

WEED ENDING MAY 20, 1925

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

Seismically the past week was the most active one in over a month. Forty earthquakes were registered at the Observatory. Of this number, however, half were of the type that accompanies avalanches.. A shake at 2:02 a. m. May 17 was slightly felt at Volcano House and plainly felt at Hilea. Its indicated distance from the Observatory was 18 miles. At 10:26 p. m., may 19 there was another shake with the same indicated distance. A distant earthquake was recorded at 7:13 p. m. of the 18th.

Along with the increase in number of avalanche type of earthquake there was an observed increase in the number of avalanches. For the most part the avalanches were from the north wall though small ones fell from all sides of the pit.

There was a slight northerly tilt during the first five days of the week and a moderate southerly tilt during the last two days. The net result for the week was a very slight north-northwesterly tilt.

LASSEN PEAK

The Carnegie institution of Washington has recently published a great work on the volcano activity and hot springs of Lassen Peak. The first part deals with the explosive eruption of Lassen Peak from May 1914 to August 1917. Part two deals with the Hot Springs of Lassen National Park. It is published under the joint authorship of Dr. A. L. Day and Dr. E. T. Allen.

Lassen has been active in recent historical time, probably less than 200 years ago, as have some other peaks in the same volcanic region, viz., Mount St. Helens and Mount Hood.

The eruptions were more or less continuous from the start on May 30, 1914 until May 22, 1915 when the largest explosions of the series occurred. Thereafter there was a decline in activity that practically ceased by August 1917. The exlosion cloud on May 22 reached a height of 25,000 feet above the mountain top. In 1917 as 1914 and 1915 may seemed to be a critical month.

On May 19 and May 22, 1915 there were horizontal blasts, similar to the one from Mount Pelee that destroyed St. Pierre in 1902. Nearly every tree in the valley through which the blasts went were either destroyed by the blasts or by a mud flow started by water from snow melted by the first blast.

In May 1915 there was an upheaval of the crater floor to a height of some 300 feet above the original floor-level. This to a great many people will recall the spine in the crater of Mount Pelee though the authors state on page 72 that Lassen had no happenings like the Pelee spine.

The authors assume an earthquake preceding the first explosion which by openeing a crack admitted water to magma below. A magma at a proper temperature and containing water and other volatile ingredients in cooling and crystallizing may produce a tremendous pressure of water vapor. That such a mechanism may produce a high pressure, is easy to follow, but, in the opinion of the reviewer, whether the earthquakes introduced water into the system with a consequent increase of pressure and resulting explosions or whether the earthquakes were the result of a growing strain within the mountain that ruptured the mountain top and finally produced the explosions, is a mooted question.

Part two is a valuable contribution to our knowledge of the temperature and chemical composition of waters in hot springs. It throws considerable light on the formation of ore deposits. Both parts are profusely illustrated and defintely related They constitute one of the most complete accounts, descriptive and causative, of volcanic on record. R. H. F.

TROUGHS OFF CENTRAL AMERICA

Commander Heck reports (Bull. Seismological Society of America, Sept. 1924) two newly discovered deep troughs detected by sonic soundings. One from 18,000 to 21,000 feet deep lies roughly parallel to the Pacific coast of Guatemala about 90 miles off shore. It is more than 300 miles long with steep slopes on both the shoreward and oceanward sides. the latter over 6,000 feet high to an ocean bottom lying about 13,000 feet below sea level.

The second trough is a narrow one 40 miles from shore between Tehauntepec and Cape Corrientes along the Pacific coast of Mexico. It is 650 miles long and from 13,000 to 17 000 feet deep. with shallower depths on both sides. These deeps are of interest as lying opposite two volcanic districts on shore, the Guatemala-Salvador belt and the Mexican plateau. T. A. J.

UNCONFORMITY IN THE ASH DEPOSITS NEAR GLENWOOD

In a cut through yellow ash in the road near Glenwood, Hawaii a dark streak representing old soil may be seen a foot or two below the surface. In this old soil layer old tree ferns may be found. This shows an appreciable time interval between the laying down of the layer containing the soil and the one on top. R. H. F.

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NO. 22 RELEASED WITHOUT COPYRIGHT RESTRICTION MAY 28, 1925

KILAUEA REPORT NO. 698

WEEK ENDING, MAY 27, 1925
Issued by the Observatory, U. S. Geological Survey;
R. H. Finch, Temporarily in charge

The strongest earthquake that has been felt at Volcano House since the fore part of April occurred at 9:01 A. M. May 26. It was accompanied by a roar and dismantled one of the seismographs at the Observatory. At 8:47 p. m. of the same day there was a very small shake with the same apparent distance to origin, about 2 miles. Altogether 23 earthquakes were registered during the week. Of this number six were of the avalanche type of earthquakes.

Tilting was a little stronger than for several weeks and was moderate to the southwest.

The increase in the avalanching noted last week continued into the present week. For the most part the avalanches were small though several sent up dust clouds well above the rim of pit.

CALIFORNIA EARTH MOVEMENT

Dr. Arthur L. Day of the Geophysical Laboratory reports for the several organizations working on California earth movements in "Science," March 27, 1925. The object is to focus scientific measurements on the inside of mountain ranges and sea-bottom so as to localize, not only the sources of earthquakes, but the centers of mountain building and creep of surface ground. To this end the Carnegie institution, the California universities, the U. S. Geological Survey, the Navy, and the U. S. Coast and Geodetic Survey are cooperating. The Advisory Committee on Seismology is aided by both the Geophysical Laboratory of Washington and the shops and laboratories of the Mount Wilson Observatory at Pasadena.

The Committee was appointed in 1921. Lawson had concluded from variation-of-latitude observations that the earth's crust near San Francisco had been drifting north a foot a year for 20 years. Lambert showed that probable errors were of the same order of magnitude as the assumptions indicating creep, so that Lawson's conclusion was not final. There are lateral displacements of 20 feet in places along the great fault that moved during the earthquake of 1906. A new base line for triangulation of the whole region was adopted recently in the Sierra Nevadas, and work for several years including 1925, supplemented by levelling, shows that a prior base line nearer San Francisco has itself moved southward some five feet. Another region to the south and some distance from the fault slip has moved north 24 feet.

Messrs. Noble and Kew have located new active faults in southern California. The Hydrographic Office of the Navy with sonic sounding apparatus, assisted by the Coast Survey, is developing new maps of the sea bottom off California. For determining local earthquakes, tremors, and tiltings J. A. Anderson and H. O. Wood have made new instruments in Pasadena, these are being tested, improved and manufactured, and seismographs on a new principle are actually working at magnifications of from 1200 to 4000. Other devices are being experimented with to solve the problem of uniform time service at separated stations. A number of California and Arizona stations have been selected for work on local motion. Eventually the Coast Survey hopes to standardize and improve registration of distant large earthquakes, at such stations as Hawaii, Alaska, Arizona, Washington, and Porto Rico. Dr. Day mentions in his report the interesting possibility of instrumental measurement continuously of deep-seated rock pressures underground, through some such instrument as a metal bulb containing a fluid connected by a tube with the surface, the bulb being cemented in a deep subterranean chamber.

If tilt and creep and changes of level can be precisely measured, Dr. Day thinks that in any given place known to be moving, the site of the next sudden release may be reasonably determined in advance. Prediction of the time of rupture is much more difficult. This whole California enterprise is of the utmost interest to seismologic science, and it is to be hoped that Hawaii may with her volcano facilities be able to add an item of cooperation. T. A. J.

THE SEISMOGRAPH IN OIL FIELDS

The difference in the records of the same or a similar seismograph in different locations in response to a constant disturbance is often very striking. With the magnification, period, and sensitivity of the instruments the same such differences must be due to differences in the soil or rocky layers underground.

Differences in underground characteristics at St. Mary's School in Hilo and at Hilea, Kau, both on the Island of Hawaii, were recently shown during the installation of very similar instruments with about the same magnification at the two places. The record from the Hilo instrument leads one to surmise that it is installed over a lava tube or over loose and broken pahoehoe slabs.

A recent application of the seismograph's ability to through light on underground structure is in locating places that are geologically favorable for the retention of oil. R. H. F.

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NO. 23 RELEASED WITHOUT COPYRIGHT RESTRICTION JUNE 4, 1925

KILAUEA REPORT NO. 699

WEEK ENDING JUNE 3, 1925

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

Kilauea volcano continues to be in a quiet state, save for avalanches from the walls of Halemaumau, the great pit in the floor of Kilauea.

The depth of the pit has remained unchanged since the slight filling by lava last July. The area of the hole, however, has been slowly increasing by avalanches from the rim. There have been avalanches from all the walls. The maximum recession of the rim amounts to 10-15 feet or more. The greatest movement in the cracks back of the rim has been at the south where the recession of the rim is the least.

The steam that escapes from the floor of the pit seems to be nearly pure now as only rarely can the odor of hydrogen sulphide or other gases be detected.

May 1925 has come and gone without any very unusual signs from the volcano and it will soon be a year since the last small explosion.

Only six earthquakes were recorded during the week. This is the smallest number recorded here in a like period since the latter part of November 1924. None of the earthquakes were strong enough to be felt at Volcano House and two of them were of the avalanche type. Small avalanches occur daily at the pit. Tilting was very slight to the northwest.

EARTHQUAKES AT KATMAI

A review of an article by Dr. Tams on the earthquakes that accompanied the Katmai eruption in Alaska in June 1912 appeared in No. 5 of the VOLCANO LETTER. A rather complete discussion of "Earth Movements Accompanying the Katmai Eruption" is given by Dr. C. N. Fenner in the February-March and April-May numbers of the Journal of Geology. Much has been published about the eruption and the resulting "Valley of Ten Thousand Smokes." Some of the facts about the eruption used by Dr. Fenner were obtained by G. C. Martin on a trip for the National Geographic Society, to the Katmai region in 1913, just after the eruption. The rest of the information was obtained on trips by Dr. Fenner in 1919 and 1923, several years after the outbreak.

Field observations near Katmai indicated a lack of violent earthquakes. A deep seated tectonic earthquake (earthquakes resulting from growth of the earth's crust, according to one definition) that was recorded on seismographs all over the world accompanied one of the larger explosions. Many of the earthquakes were felt over 500 miles away. The noise of one explosion was heard at Juneau, 745 miles from Katmai.

Most of the earth movements noted are in a valley between Mount Katmai and Mount Trident with some movement on the mountains themselves. Dr. Fenner is of the opinion that the fracturing of the valley followed by numerous fumaroles, making it a valley of "Ten Thousand Smokes," was due to the intrusion of a sill of hot lava.

Dr. Fenner has handled the information at his disposal in a masterly manner but the exact sequence of earthquakes and explosions must remain unknown. All the discussions of the Katmai eruption point to the need of continuous observations of such events.

Some stress is laid on the distinction between tectonic and volcanic earthquakes. Any definition of tectonic earthquakes will likely include many volcanic shakes as there is no sharp division between the two. "Tectonic" earthquakes in a volcanic region or its immediate vicinity frequently appear to have a much shallower origin than others in a region more remote from a volcano. In volcanic regions hot and somewhat plastic rock must be nearer the surface than in non-volcanic regions. R. H. F.

PUBLICATIONS OF THE NATIONAL RESEARCH COUNCIL OF JAPAN

No student of any science can afford to be without the publications of the National Research Council of Japan. Of these publications those that are of especial interest to students of volcanology and seismology are, Japanese Journal of Astronomy and Geophysics and Japanese Journal of Geology and Geography. These publications made their appearance in 1922. In addition to original articles such as Relations Between Frequency of Earthquakes and Atmospheric Pressure, and the Japanese Earthquake of Sept. 1, 1923, several of the numbers contain abstracts of articles published in other journals such as Seismological Notes of the Imperial Earthquakes Investigation Committee and in journals written in Japanese. R. H. F.

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NO. 24 RELEASED WITHOUT COPYRIGHT RESTRICTION June 11, 1925

KILAUEA REPORT No. 700

WEEK ENDING JUNE 10, 1925

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

Seismically, and otherwise, the volcano continues to be quiet. Only eight local earthquakes were recorded during the past week. None of the earthquakes were perceptible at Volcano House. The number of local earthquakes is getting to be nearly comparable to the number commonly recorded when molten lava is visible.

Two distant earthquakes were recorded as follows: June 4, 1:47 AM., slight; June 9, 3:21 AM, slight. The latter had an indicated distance to origin of 4750 miles, equal to the distance to the Philippines or Formosa.

Avalanches have been slightly more numerous and dust clouds that rose well above the rim of pit were common. But very few disturbances have been recorded on the seismographs to correlate with the avalanches. Most of the avalanches fell from the north wall.

THE DISTRIBUTION OF VOLCANOES

The some 430 active volcanoes in the world are widely scattered. The form of activity that a volcano may take varies greatly, from the quiet extrusion of fumes to an explosion like that of Krakatoa in 1883 that sent up dust clouds to a height of 17 miles.

In general, active volcanic regions are also regions of high seismicity. Not all regions subject to frequent earthquakes, however, have active volcanoes as for instance the middle Mississippi Valley, eastern South Carolina and the southern Appalachians in the United States. Volcanic regions cover a limited portion of the earth's surface, but no place is entirely immune from earthquakes.

In volcanic regions one can not say definitely that a volcano is the cause of all the earthquakes nor that the activity of the volcano is due to earthquakes. It would appear that both can frequently be referred to a common origin. If this is true then the terms "tectonic" and "volcanic" as applied to earthquakes refer more to different grades than to different causes.

Volcanoes usually are located in well defined zones. Sometimes the zone is comparatively short as in the Hawaiian Archipelago; and sometimes very long as the border of the Pacific Ocean.

The Pacific border chain of active or recently active volcanoes is in recent geological formation and crustal movements are still taking place. This is more or less common to all volcanic regions. For the most part ocean deeps are close to the shore so that the difference in elevation between volcano peaks and adjacent deeps is startling. Hawaii furnishes an example of proximity of elevation and deep more striking even than that of the west coast of South America. From the summit of Mauna Kea to a deep about 50 miles to the northeast there is a continuous land slope of about 37,000 feet.

In South America, Central America and Mexico the volcano chain is quite complete. In the United States the Pacific belt finds but few active volcanoes though several, in addition to Lassen's Peak, have been active in recent historic time and others in recent geologic time. Canada furnishes a near approach to a gap in the chain before Alaska with its several volcanoes is reached. The chain is continued by the Aleutian Islands to Kamchatka and Japan. In going south from the Philippines the chain fans out to include a large part of the southwestern Pacific Ocean.

Undoubtedly several of the island volcanoes started in as submarine eruptions on the ocean floor and built up the island and mountain. Scattered reports indicate that submarine volcanoes are still at work endeavoring to form new islands.

The Atlantic Ocean, while not so well supplied with volcanoes as the Pacific, has several in Iceland, the Azores, Canaries, and Cape Verde islands. In the Lesser Antilles group of the West Indies and in the Mediterranean Sea there are several volcanoes. The Mediterranean belt is almost continuous eastward for some distance into Asia.

Volcanoes are found in all oceans. The Artic ocean has its Jan Mayen volcanic island while in the Antartic are the volcanoes Erebus and Terror on Ross Island. One of the most active of volcanoes is on the Island of Reunion in the Indian Ocean about 400 miles southeast of Madagascar. It has been in eruption about every five years for a great many years and has been reported to show a continuous lake of molten lava similar to the one for which Kilauea is famous.

At times one of the most continuous volcanic spectacles is to be found at Matavanu volcano on the island of Savaii, one of the Samoan group. Starting in August 1905 Matavanu sent forth a lava flow that poured into the ocean continuously for about five years. R. H. F.

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NO. 25 RELEASED WITHOUT COPYRIGHT RESTRICTION JUNE 18, 1925

KILAUEA REPORT NO. 701

WEEK ENDING JULY 17, 1925

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

The seismic lull that started during the latter part of May still continues. During the week ending during the forenoon of June 17 nine local earthquakes were recorded at the Observatory. None was perceptible at Volcano House and only one was large enough to enable one to determine the approximate distance away. This one occurred at 10:09 P. M., June 10 with an indicated distance of 20 miles. Four of the others probably occurred at about the same distance from the Observatory. Seven of the nine shakes occurred on June 10 and 11.

The direction of the tilt was to the northeast. As during the preceding week the amount of tilt was very slight.

There were numerous avalanches during the week though for the most part they were less spectacular than during the preceding week.

Tremendous dust clouds were raised in the Kau Desert by the brisk wind on June 15. The desert showed a marked wall of dust that was fully 500-600 feet above the ground.

AN OFT-REPEATED MISSTATEMENT

How often we hear the assertion that the crater of Haleakala is "the largest crater in the world!" There are, however, two mistakes in this proposition. In the first place, the depression at the summit of Haleakala is smaller than are various craters in other parts of the world. And in the second place, this depression is not a crater at all.

Publications of the tourist agencies give the area of Haleakala "crater" as 19 square miles, its extreme length as nearly 7½, its extreme width as less than 2½ miles, and its perimeter as 20 miles. Anakchiak Crater, discovered in 1922, on the Alaska Peninsula is six miles in diameter but little more is known about it. If it is of circular outline, its area would be 28 squire miles and its perimeter 18 miles. This crater exceeds Haleakala in area though it does not equal in perimeter the long, irregular rim of the Haleakala rift.

In Tanganyika Territory (formerly German East Africa) there is a plateau called the "Highland of the Great Craters." This region has not been thoroughly explored but enough is known to justify the name. The best known crater is "Ngorongoro," which is about 12 miles across and has an area of 110 square miles. The surrounding walls are in general 2,000 feet high but two parasitic volcanic cones rise about 2,000 feet above the rim. There are only three or four possible routes of descent into the crater and the floor forms a natural game preserve with some 50,000 head of wildebeest and 25,000 head of other game. A single small volcanic cone rises from the crater floor.

A crater, according to Webster's New International Dictionary, is "the basinlike or funnel-shaped opening which marks the vent of a volcano." Undoubtedly the main, central vent of Haleakala was formerly in the region occupied by the present magnificent depression, the sight of which well repays those who climb to its rim. But the present form of this depression seems to have been caused not by volcanic action but by collapse within the mountain. The fracture at the surface took the form of a stretched letter "Z," the middle bar of which runs east-west while the others run south from the east end of the middle bar and north from the west end. The gash or rift made in this way has widened out a great deal by avalanching of the walls, much as Halemaumau has widened out in the last year. The subterranean continuation of the fracture has served as a channel for the ascent of small amounts of volcanic matter which have built cinder cones within the rift basin. True craters are of circular or oval groundplan and not of the irregular shape found on Haleakala. True craters are due to the processes that go on in and around volcanic vents ,whereas the Haleakala depression is due to processes independent of volcanism.

H. S. PALMER.

EARTHQUAKES AT KILAUEA DURING TIMES OF EXPLOSION AND TIMES OF QUIET

To show the difference in the number of earthquakes by months when the volcano is explosive and when it is quiet, the quiet lava activity of the year 1920 is compared with 1924 in the following table. In 1924 up to the 20th of February there was a large lake of molten lava. The extraordinary large number of earthquakes during April, May and June 1924 accompanied the subsidence of Halemaumau and the explosive eruption. The number of earthquakes to date in 1925 is comparable to the last six months in 1924.

	Number of Earthquakes 1920	1924
January	7	21
February	10	36
March	20	78
April	5	358
May	11	3961
June	13	801
July	9	110
August	15	90
September	8	116
October	35	106
November	36	51
December	40	169

R. H. F.

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NO. 26 RELEASED WITHOUT COPYRIGHT RESTRICTION JUNE 25, 1925

KILAUEA REPORT NO. 702

WEEK ENDING JUNE 24, 1925

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

The general situation volcanically of Halemaumau pit at the end of the year following the great collapse of May-June 1924 is extremely peaceful. During the spring earthquakes and avalanches have declined in numbers except for a minor revival in the latter part of May. In June earthquakes and avalanches showed another revival at the solstice, which was remarkable in that the greatest slide seen here for many months came at noon on June 20th.

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

The week has recorded 18 earthquake movements of local origin, of which 6 were of the avalanche type, and 5 indicated distance of source greater than the 2 miles between Halemaumau and the Observatory. None was felt. Tilt was slight SSW.

THE ENGULFMENT-COMBUSTION THEORY

The nearly complete oxidation of the hydrogen, sulphur and carbon gases of Hawaiian lava lakes, and the availability of abundant oxygen in earth and air as a heat-producing agent of combustion, have led us for many years to seek a logical combustion hypothesis of volcanism (Jaggar, Amer. Jour. Sci. Sept. 1917). Day, Shepherd and Allen have analyzed the gases and proved their extraordinary irregularity in composition and their oxidized condition when they reach the surface (Bull. Geol. Soc. Amer. 1913, 573: Bull. Hawaii. Volc. Obsy. July 1919, May 1920, May 1921, Aug. 1922). Jaggar and Finch have demonstrated that the explosive eruption of Kilauea was an incident of a low temperature engulfment process. The volume of rusty rocks engulfed was 253 times the volume of ejected matter; this should be known as the ejection-engulfment ratio 1/253. Every short cycle of slow lava rising ends with rapid collapse and engulfment. (Amer. Jour. Sci. Nov. 1924, Bull. Haw. Volc. Obsy. May Dec. 1924).

At the meeting in Washington, April 30, 1925, of the American Geophysical Union, Shepherd and Jaggar presented an engulfment-combustion hypothesis based on a conception of subterranean normal magma containing combustible gases in solution and iron mostly ferrous; while engulfment down vertical chasms was conceived as a normal process for introducing to the magma oxidized rock matter containing ferric oxide. This holds an excess of oxygen from the rusting of old lava exposed to the air and acids.

In the presence of hydrogen, for example, the ferric oxide would be reduced to ferrous and the hydrogen would be oxidized to water vapor with evoluttion of heat. Given a moderate amount of hydrogen in the new magma rising, and oft-repeated engulfment of rusty crater rock, enough heat would be supplied to keep lava volcanoes in activity without much fresh lava from great depths. By this hypothesis explosive steam eruptions become nothing more than accidents due to engulfment-plugging of craters over ground-water boilers below.

The two novel features confirmatory of this explanation are the ejection-engulfment ratio 1/253 measured for the first time at Kilauea in 1924, and the excessive amount of red oxide of iron there revealed in the wall-rock fragments. Seven billion cubic feet of this rip-rap were precipitated several thousand feet deep into the heart of the mountain. The new lava that reappeared in the pit July, 1924 had frothed its way up through the crevices of this oxidized breccia. It took up oxygen and was heated as it rose. Doubtless other oxygen was entrapped as air. The agglomerate is both a porous heat insulator and an oxygen supply for the burnable magmatic gases. If three percent of the breccia were ferric oxide reduced back to ferrous iron, enough heat would be supplied to raise seventy million cubic feet of the debris from air temperature 20°C. to the temperature of liquid lava 1200° C.

This theory accounts for the excess of water vapor in lava, for the oxidized condition of the other gases, for the rapid passage of gas up the lava column, for the channels and tunnels of the lava lake bottoms. The half-melted breccia is lifted or lowered as a whole by the gas-charged melt in its honey-comb, and this explains the "bench magma" with its puzzling crags, islands and floors. Convection through the crevices produces the varying currents of the lava lakes. The upper portion of the breccia is renewed by every crateral subsidence; this makes a concentration mechanism for the less volatile gases such as sulphur, and the sulphur acids in turn powerfully oxidize the crater rocks.

The world-wide history of volcanoes agrees with the hypothesis. Enormous engulfments went unmeasured at Krakatoa and Sumbawa. Downfaulting since Tertiary time is the rule around the Pacific. Downfaulting is the age-long process at volcanic craters everywhere. Subsided crater floors are dominant on the moon. Downfaulting is what may be expected above subterranean chasms that open laterally and engulf large masses of their wall rock. Collapsing of crater regions with or without explosion has volumetrically been the biggest volcanic process of post-Tertiary time. Engulfment on a gigantic scale appears to have occurred along the Cordilleran intrusive belts. Agglomerate necks, plugs, domes and dykes are common. Hydrogen throughout the solar system is the dominant volcanic gas and the current theory of the earth's interior shows an evolution that has produced oxides, including water, increasing from within outward, and metallic iron increasing inward.

T. A. J,

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NO. 27 | RELEASED WITHOUT COPYRIGHT RESTRICTION | July 2, 1925

KILAUEA REPORT NO. 703

WEEK ENDING JULY 1, 1925

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

Halemaumau the fire pit of Kilauea remains dormant, the conspicuous changes of the week being increases in the amount of vapor directly caused by heavy rainfalls, after a dry spell when the steam jets on the bottom were only slightly visible.

On June 25th in the forenoon there was fresh debris on the northeast talus, a little sliding was heard at the northwest, and the most vapor was at the west pocket of the bottom. The flat wall slope at the bottom of east side of pit had now lost all its staining with salts. On the 27th there was a little sliding west. The west and north taluses were wet with steam, the east and south ones emitted dry vapor, sulphur being most conspicuous ENE. June 29 in dry weather two sulphur patches SW and in the center showed increase of yellow and creamy crystals, without any vapor at the places in question. The next day after a rainy night the bottom was transformed to a field emitting hundreds of tails of vapor. There were some slides N and NE. Today there is less vapor and the sulphur patches are whitish.

Seventeen local earthquakes were registered, 5 of them of the avalanche type, and 2 were felt, namely at 5:56 a. m. June 25 with origin distance 14 miles, and at 10:42 p. m. June 26 with origin distance about 2 miles.

The beginning of the disastrous earthquake in Montana June 27th was registered here at 3:09 p. m. (6:30 p. m. Montana time.) The Santa Barbara disaster recorded its beginning here at 4:20 a. m. June 29th, (6:50 a. m. California time) the initial wave taking about 6 minutes to reach Hawaii.

Tilting of the ground during the week has been slight to the NNE, compounded of NE tilt during the first two days and thereafter very slight SW.

HAWAII FROM THE AIR

Through the courtesy of Major General E. M. Lewis, Commander of the Hawaiian Department, Messrs. J. B. Stone and R. H. Finch of the U. S. Geological Survey were permitted to make airplane trips over Puna District, Island of Hawaii, on June 27. The planes were piloted by First Lieutenants James D. Givens and Glenn C. Salisbury.

The primary object of the flights was to determine whether any lava reached the surface along the northeastern rift of Kilauea where underground movement was strongly suspected in 1924. No 1924 lava was found, though dead trees along some of the steaming cracks in the rift zone indicate an increase in that form of activity. A similar indicated increase of steaming had been previously noted at Aloi crater farther west.

While flying to and from the Parker Ranch landing field at Waimea good observations were obtained of the entire eastern half of Mauna Kea. It was noted that three stream channels extend well above the timber line nearly to the summit of this mountain. These stream channels will eventually control most of the drainage of the upper reaches of Mauna Kea. Observations of several cones point to the need of detailed investigation. One cone is partially surrounded by a black deposit whose nature could not be determined. It was also determined that the several points of interest on Mauna Kea can fairly easily be reached from existing trails.

Good views were obtained of the northeastern slope of Mauna Loa. Most of the lava flows from this slope come from a well defined rift zone. It was noted that this zone, as far as lava flows from it are concerned, stops and forms a definite shoulder on the mountain about 15 miles from the summit.

The views of Kilauea and its lines of cones, craters, and cracks extending to the northeast and southwest were of great interest.

More inspection can be accomplished in a two hour geological reconnaissance from the air, over the territory traversed, than in two weeks on foot. R. H. F.

SEVERE MONTANA AND CALIFORNIA EARTHQUAKES

The copper region of Montana and the volcanic district of the Yellowstone were shaken destructively by earthquakes beginning about 6:40 p. m. June 27 and continuing the next day. Three Forks reported 41 shocks in 30 hours. $500,000 damage was estimated in Gallatin County and the town Manhattan. Two railways were blocked by slides. Three persons were reported injured, none killed. There were ground cracks and canyon landslips at Livingston, the hotel wall was cracked at Great Falls, avalanches occurred near Lombard, and serious shocks were reported from Billings, Butte, Missoula, Helena, White Sulphur and Anaconda, as well as the Yellowstone Park.

Just thirty-six hours later at 6:44 a. m. June 29, Santa Barbara was bumped upward and then wrenched in all directions by a sudden shock accompanied by noise that seemed like a subterranean explosion. The business district was wrecked, Arlington Hotel was a complete loss, State Street was buckled and cracked, two fires started but were extinguished, water mains and reservoir burst and made a flood, 13 people were killed and 30 injured, damage was estimated at $15,000,000, the lighthouse collapsed, and electric light, power and gas were cut off. Shocks continued. Weather was calm and sultry. Four shocks in the early morning and forenoon of the 30th occurred, one severe. T. A. J.

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NO. 28 RELEASED WITHOUT COPYRIGHT RESTRICTION July 9, 1925

KILAUEA REPORT NO. 704

WEEK ENDING JULY 8, 1925

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

Changes in Halemaumau are small. There were small rock slides SW July 3, very little W and NW July 4, hardly any July 5 during time of observation, some N and NW July 7 and fresh debris shown NE. and July 8 there had been a strong avalanche leaving a scar, debris and dust from the NE wall, probably coinciding with the earthquake of 6:45 a. m. There are white stains on the pit wall, a vapor column shows at night and during humid weather, and there is always hot steam on the bottom.

The week registered 12 local earth movements. Perceptible earthquakes occurred July 4 at 7:55 p. m.; distance 22 miles, felt in Hilo; July 6 1:47 p. m. distance 11 miles, EW component dismantled instrument; July 8 6:45 a. m. distance about 11 miles. A distant earthquake at 3:51 a. m. July 7 did not appear to coincide with the disaster reported from Nagoya for that morning, for by Japan time the shock registered here would have been late at night (about 11:30 p. m.). Tilt for the week was very slight to SW.

EARTHQUAKE-PROOF BUILDINGS

More than three hundred books on earthquake-proof construction are on file with the Building Committee of the Seismological Society of America (B. Willis, Bull. Seis. Soc. Amer. Dec. 1924, 256). Good workmanship and materials are of first importance, and are rare. Structures should resist a lateral stress equal 30 pounds per square foot. They should have unity and a natural period of vibration different from that of a strong earthquake. Earthquake periods are from 1 to 2 seconds. The best buildings are rigid and low with a half-second period or less. When the earth and structure synchronize the strain is terrific. Houses of brick or reinforced concrete up to eight stories may be stiffened to swing as natural pendulums with a period of a half second or less. Sky-scrapers have a period of two seconds or more; this was the natural swing of the ground in the Tokyo earthquake. If the vibration is shorter than that of the earthquake, the strain is on the basement; if longer the great stress is two-thirds of the height above ground.

Lack of unity causes the frame to knock the partitions and walls down, or the whole house to knock the chimney down, or the faced lower walls to knock the upper unfaced walls down. If the rectangular cells of a steel frame are distorted to become rhomboids, it stands to reason that a hollow tile partition will "stand about as much chance as a Sevres teacup under a steam hammer." If frames are flexible, then the contents of the frame must be made movable. The stress to be met is a horizontal jerk. If frames are rigid on a unit basement slab, and the walls as strong as the unrights and the horizontal beams, and all tied together, then your house floats on the moving ground like a ship. The ideal earthquake-proof house should stand still, while the ground jerks back and forth under it, like a ship cradled on two sets of rollers.. Stiffness may be greatly increased by diagonal sheathing of wood, metal lath, or steel struts in ferro-concrete panelling.

A well built house is a man's best insurance. The "fallen building" clause should be permanently removed from all insurance policies. There is no wisdom in taking earthquake insurance just after an earthquake, but it should be carried all the time on the principle of life insurance. Our towns are mortal. Let us make them immortal.

There were sixteen large steel-frame buildings in Tokyo of which ten were severely damaged. The undamaged ones used ferro-concrete wall construction which stiffened and braced them, and they suffered no damage whatsoever (Hadley, Bull. Seis. Soc. Amer. March, 1924, 6). In the others everything vertical that was supported by the frames was damaged.

Reinforced concrete performed splendidly. In the city 78 percent of 592 ferro-concrete structures were undamaged, and only 1.3 percent entirely collapsed. In the outside district 75 percent were undamaged and 7 percent collapsed. The remainder in both cases were more or less damaged.

Brick buildings with heavy exterior and division walls well tied together escaped without damage in some cases. The damage was much greater on soft soil than hard. Of 49 brick buildings on hard soil 6 percent entirely collapsed, about 50 percent were ruined, 32 percent were slightly damaged and 12 percent were uninjured. Of 436 on soft soil 10 percent entirely collapsed, 44 percent were ruined, 27 percent were slightly damaged and 19 percent escaped.

T. A. J.

NOTE ON VOLCANIC ORIGIN OF EARTHQUAKES

H. H. Turner (Report Brit. A. A. S. 1913, 65) studied correlation of volcanic eruptions and earthquakes for the period 1790-1900 with reference to times of increasing and decreasing volcanicity and seismicity and found 39 percent of correspondence between the two. He wrote "earthquakes and eruptions are affected by the same cause." This was a quantitative numerical calculation made after the method of an astronomer. Milne has published a world map of elliptical areas enclosing the regions of major earthquakes: the ellipses all enclose volcanic districts.

Volcanism includes underground intrusive action as well as surface craters; and this action may extend 100 miles down. In view of this it is extraordinary how persistent is the tradition among geologists to the effect that "volcanic earthquakes" are trivial, superficial, and limited in extent. Volcanologists generally tend to concur in the views of Oldham, Joly, Heilprin, Branca and others to the effect that great earthquakes may be occasioned by magmatic shifts beneath the earth crust, and even the great fault movements may be effects rather than causes.

T. A. J.

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NO. 29 RELEASED WITHOUT COPYRIGHT RESTRICTION JULY 16, 1925

KILAUEA REPORT NO. 705

WEEK ENDING JULY 15, 1925

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

There has been a change during the week in the direction of increased numbers of local earthquakes, avalanches on the west wall of the greater crater of Kilauea, some earthquakes felt that appear to center about Mauna Loa, and a little avalanching in Halemaumau pit. This appears to imply augmented seismic motion in the whole volcanic system, and the northerly tilt at the Observatory, if significant, would imply upward pressure in the underground lava.

July 10 avalanches at the pit made dust clouds at 8 and 11 a. m., and at 2:15 p. m. At 2:30 p. m. a small slide fell from the west niche. A yellow patch was observed east of the dyke in the north wall. July 13 at 4 p. m., a small slide occurred on the northeast wall, there was a little working of the northern walls the next day, and July 15 at 8:05 a. m. there was a considerable northeast avalanche which stripped part of the intrusive sill and left fresh debris and red dust on the northern side of the bottom.

At 8 a. m., and in the afternoon of July 14, slides fell from the high part of the Uwekahuna wall west of Kilauea, and July 15, at 7:20 a. m. and 9:00 a. m., fresh scars were made at the south end of that cliff by avalanches, both at the same place, as though the southwestern rift system were working. Nothing seismic was noticed simultaneously.

In Halemaumau a crack across the floor suggested swelling, but it was not certainly new. There was some blue fume and sulphur smell from this place July 15.

Twenty-seven earthquakes of local origin were registered, of which 3 were of the avalanche type. The earthquake of 6:45 a. m. July 8 was felt all over Hawaii. Two recorded quakes of the evening of July 9 were felt at Pahala. At 4:25 p. m. of the 12th an earthquake was felt here vertically moving accompanied by rumble. A shock registered 3:23 a. m. July 14 indicated an origin 27 miles away and was felt at Pahala, strongly suggesting movement under Mauna Loa.

THE WAR AGAINST CATASTROPHE

The publication of a thoughtful quarterly for the study of calamities ("Materiaux pour l'etude des calamite's," Geographical Society of Geneva under the International Red Cross, $1.25 per year, No. 1 Promenade du Pin, Geneva, Switzerland) was begun with the April-June number of 1924, written in French and English mostly, and has now finished its first year.

The topics considered are earthquakes, eruptions, landslides, floods, tornadoes, droughts, famines, conflagrations, locusts, epidemics and tidal waves. The motive for the journal is the compilation of a world disaster map by the Red Cross, to assist in the mobilization of relief forces, and the publication is designed to draw together world organizations in reports on frequency, alleviation, preparation, education, defense, mapping, legislation and research.

Each number contains original memoirs, correspondence and reviews. Leading articles to date have dealt with landslides in Italy by Amalgia, the locust problem by Vayssiere, earthquakes and volcanoes by de Launay and Brun, tropical cyclones by Visher, earthquake-proof construction by van de Putte, the Kalahari irrigation project for Africa by Schwarz, tidal waves by Vallaux.

On the practical side of the war against volcanic eruptions Brun recommends geophysical studies at observatories of volcanic gases, magnetism, earth movements, sounds, ground temperatures, and full administrative powers in the matter of forewarnings. Precautions should be enforced and the populace trained in what to expect, in routes of retreat by land and sea, in requisitioning of shipping, in avoidance of beaches on account of probable tidal waves, and in organization of picked men as leaders. Houses with high pitched roofs to throw off the ashes are best in regions of explosive eruption even to distances ten miles or more away from the craters.

De Launay believes strongly in a "pyrosphere" or region of intrusive magma inside the crust of the earth intimately akin to both earthquake and volcanic phenomena. He points out that rise of temperature with depth varies enormously in different places in a proportion even as high as 1 to 10 for the same depth. The most ancient and solid lands are cooler than the younger and thinner parts of the crust. Near Lake Superior it is necessary to dig 124 meters to get a rise of temperature of 1° Cent.; in Tuscany the rate is 10 meters to a degree. The rate in Canada and New England is 124 m.: Bohemia, of Carboniferous age, 60 m.; the Paris basin of flat Teritary strata, 30.; Colorado, a region of extinct Teritary volcanism, 16 m.; and active volcanic centers of the present day, 10 meters or less. What is the temperature under the floor of the deep oceans?

It appears to the reviewer that this magazine of the Geneva Society is a most valuable educator and every Red Cross member should subscribe to it. In science there are two approaches to the earth-mapping problem for earthquake research where everybody may help; one is the distribution broadcast of simple seismoscopes for recording very small shocks so that everyone may become interested. The second is the taking of exact temperatures in hundreds of shallow holes in millions of places in the rock, wherever engineers and quarrymen drill, the world over. The Red Cross is an international organization capable of collecting such data. Both of these are parts of a propaganda for educating the public, and getting returns from the public. It is through such public interest that thousands of rain gauges and thermometers assist our Weather Bureau. It is through the compilation of such data that we may map the local shakiness and heat of the earth.

T.A. J.

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NO. 30 | RELEASED WITHOUT COPYRIGHT RESTRICTION | JULY 23, 1925

KILAUEA REPORT NO. 706

WEEK ENDING JULY 22, 1925

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

The increase in numbers of local earthquakes instrumentally registered continues, the numbers for each of the three weeks of July to date being 12, 27 and 34.

Of the 34 shocks of the past week at least ten were of the type characteristic of avalanches at Halemaumau, and the dust of numerous avalanches has been seen. Some of these avalanches, especially two near midnight July 18-19, were big and carried away the northeast rim of the pit where a new trig station flag had been erected the day before. These falls of wall-rock left the bottom covered with much red dust. A remarkable slide observed the afternoon of July 17 started at a brick-red patch in the middle of the northeastern wall and made a rose-colored cauliflower cloud and a purplish red streak on the wall.

Three local earthquakes perceptible here were at 11:57 p. m. July 16; 8:52 a. m. July 18, and this one was accompanied by rumbling noise; and 8:46 p. m. July 19. Tilting of the ground for the week was very slight to the west.

There has not been much of interest at Halemaumau pit. Small dusty slides were seen by anyone remaining a half-hour or more. At 6:15 p. m. July 16 a northeastern slide was heard at the observatory and the dust-cloud seen. One was seen on the 17th from the southeast wall, which is unusual. Sulphur stain on the bottom was increasing the 18th but the avalanches covered the stain with dust. That afternoon a remarkable fumy cloud was seen over Mauna Loa about 5:45 p. m.

A sharp earthquake producing panic about San Francisco bay (R. F. grade 7) is reported for 11:31 a. m. California time July 19. It was not registered on the Kilauea seismograph.

THE SEA-BOTTOM

The earthquake of October, 1873 west of Greece produced a cliff on the sea-floor where the depth was 2000 feet instead of 1400 feet, the former sounding. A violent earthquake near Crete in 1878 broke the submarine cable in two places and made the bottom so irregular as to make necessary the laying of the new cable in another place. The cable from Zante to Crete was broken by an earthquake in 1886 and at the break soundings revealed an increased depth of 1300 feet. There are cliffs on the Mediterranean bottom 3000 to 5000 feet high. (Scott's Geology, p. 47).

With new precipices forming from time to time several hundred feet high in the depths of the sea, it is certain that the bedrock is accessible, and in many places on the floor of the deep oceans the mud may be thin. Fragments of the bedrock have not been collected.

Seventy-two percent of the bedrock of the earth's surface is thus unexplored. If we add some twenty percent of unexplored territory in the Antarctic, the Asiatic mountains and deserts, about the Arctic circle and the South American and African jungles, it is evident that we know little as yet about the globe and its rocks.

The topography and geology of the sea-floor is the biggest item of ignorance. If it is worth spending millions to study the sea-bottom until at least we know what the rock is. The echo-measurement machine for sounding the oceans is now engaging the attention of the nations. With it hundreds of accurate soundings can be made where one was made with the sounding wire. Soundings can be made while the ships are travelling. An electric buzzer or an explosive detonation makes the sound under water, electrical devices determine with great accuracy the time of discharge and the time of the arrival of the echo, and the difference of these times gives the distance of the bottom. The U. S. Naval Research Laboratory through Dr. H. C. Hayes is working out a new instrumental equipment that will both register and record the depth automatically. The U. S. Coast and Geodetic Survey through Commander N. H. Heck has developed a method of accurate loacting of a survey ship by sound ranging to the shore for distances of fifty to a hundred miles. (Jour. Franklin Inst. March 1924).

This type of sounding will quickly produce topographic maps of the hills and deeps on the sea-bottom, but what about the rock specimens? Dredging and tubular sounding irons have secured mud specimens for a few feet of depth into ooze bottoms. Thirty nautical miles east of Hilo, Hawaii, the ocean depth is 18,000 feet. Such depths may be followed for thousands of miles beyond. What is the bedrock? The two possibilities of invention for collecting specimens of the deep sea rock are blasting and boring. They would require long cables and devices operated electrically through them. A mine set off on the bottom followed up by a drag-net might be the simplest solution.

Boring with a rotary diamond drill from an enclosed motor on the sea-bottom set to drive say thirty feet of rods automatically and bite off the core, would be the most elegant device. The frame would have to be heavy and self-adjusting on the bottom. The ship supplying current and holding the cable would have to hold itself fairly stationary or else detach a float. The motor would have to operate at the great pressures of the bottom water. When is the exploration of the unknown seven tenths of the earth to begin? T. A. J.

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NO. 31 RELEASED WITHOUT COPYRIGHT RESTRICTION JULY 30, 1925

KILAUEA REPORT NO. 707

WEEK ENDING JULY 29, 1925

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

Halemaumau continues quiet so far as exhibiting live lava is concerned, but seismically it is uneasy, sulphur gases testify to lava below, and exceedingly hot vapor rises in places through the bottom gravel.

Near the road terminus July 24 a new hair line crack crossing the hardened mud of the road and for a short distance on each side along the steam cracks following the southeast margin of Kilauea crater was observed. This showed motion in the floor of the greater crater along cracks parallel to the pit rim but 2000 feet back.

Heavy dust clouds were observed in the Kau desert this day and the next. The northeast trade wind is thereby greatly rearranging the ash and sand of 1924.

There were numerous avalanches July 25, one at the pinnacles east of the south station at 10 a. m. July 27 and at 10:15 a. m. one northeast. During the night preceding July 29 after heavy rain there was a fall of rock from the northeast wall leaving a straight-sided upright band of fresh dry rock in the wall and a new dump of debris at the base. On the opposite side of the pit falling rock was heard at the rift caverns at 9 a. m. July 29.

The seismic frequency diminished from 34 movements the previous week to 27 this week. Fourteen of these were like avalanche jarrings. There were perceptible earthquakes at 8:57 p. m. July 23 and at 2:42 a. m. July 27, the latter indicating origin distance 19 miles. The seismograms showed what appeared to be harmonic tremor the forenoon of July 25 and the morning of July 29: this is a type of motion ordinarily characteristic of active lava at Halemaumau. Tilt for the week was slight SSW, varying from moderate NE to moderate SW.

The summit crater of Mauna Loa was visited July 24 and found to be fuming in two principal places as usual. No remarkable change there was observed.

SURVEY OF THE MOON

The nearest of the heavenly bodies is still incompletely surveyed by modern telescopes. The 100-inch reflector on Mount Wilson reveals thousands of topographic objects on the moon's face hitherto unrecorded (Saunder, Mem. Roy. Astron. Soc. LX, 1-81, 1911-15), and makes possible photographic mapping stereoscopically that will reveal the relief even of the bright lines, hitherto believed to be flat.

A complete survey should contemplate securing two sets of excellent photographs with the big telescope for the two extreme positions of latitude libration, each set covering every hour of the lunar month of approximately 28 days. Once an hour would give a sufficient number of shadow changes on the lunar ridges to measure small items of relief. Roughly this would amount to 672 photographs for extreme north libration, and 672 for south libration, furnishing 672 stereoscopic pairs, or 1344 photographs in all. Comparatively few extra pictures would cover the stereoscopic possibilities of the diurnal and longitude librations.

It would take years to complete this atlas, but in the meantime the photographs taken could be worked up into contour maps as separate atlas sheets, using adjustment or "restitution" cameras, as in aerial topographic mapping, for converting the pictures of the inclined portions of the lunar surface to a suitable uniform projection, and referring the contours to an arbitrary baselevel spheroid. Such an atlas would exhibit everything measurable in the moon on a large scale in terms of measured dimensions. Then and only then could we compare scientifically the craters and other topographic features of the earth with the volcanic relief of the moon, making due allowance for the difference of gravity on the two spheroids, so as to arrive at quantitative conclusions. This result is of first importance for geology.

T. A. J.

NEW SAN FRANCISCO EARTHQUAKE

The earthquake shocks of January and February in the eastern United States and Canada gave promise of a seismical year in North America. Numerous subsequent shocks in the eastern states, and in Montana and southern California, partially fulfilled the promise. It continues to be verified. If press report is correct, the latest demonstration is from the northern Coast Range of California. A strong earthquake occurred at 11:31 a. m. by California time, on Sunday forenoon July 19.

The brief telegram announces that what damage there is is not reported (doubtless owing to the usual suppression of earthquake news). The shock was so sharply felt in San Francisco, Oakland and San Jose as to cause church congregations to run into the street. General panic of this type denotes an earthquake of Grade VII of the Rossi-Forel scale, wherein I is very feeble and X very disastrous.

San Jose is 250 miles from the reported center, hence the shock was more widespread than the local but disastrous Santa Barbara quake of June 29. The center of the new shock is said to be 200 miles northwest of San Francisco. This would be either in the ocean floor at the north end of the great rift of 1906, or on land near Cape Mendocino. Along these mountains are boiling springs, steam used for power, quicksilver mines, and very hot ground testifying to subterranean volcanic energy. T.A.J.

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NO. 32 RELEASED WITHOUT COPYRIGHT RESTRICTION August 6, 1925

KILAUEA REPORT NO. 708

WEEK ENDING AUGUST 5, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Nothing has occurred of new activity at Halemaumau. Even avalanching is reduced to a minimum. There is some new red debris on the northeast talus. There have been very high winds, dry days and wet days but none of these has produced avalanching.

August 1 and 2 there were destructive sea waves due to high northeast winds, and microseisms became large. For the week there were 24 local earthquake movements, none felt. An earthquake felt on Oahu 9:18 p. m. July 29 was not recorded here. A shock at 8:11 a. m. July 30 indicated origin distance 13 miles and most of the local disturbances appeared to originate farther away than Halemaumau. Tilt was moderate to the NNW. Seasonal northerly tilt is usual in late summer and autumn.

UTILIZING VOLCANIC STEAM

The Larderello electric plant using natural steam (World Power Conference, July 1924, Wembley, address by Prince Ginori Conti; also in "Chimie et Industrie" 1923) is in a region of Liassic, Eocene and Miocene limestones, slates and serpentines. Eight districts of steam blow-holes occur, natural water is scarce, the elevation is 600 to 1600 feet, and the active area covers 100 square miles of hilly country in Tuscany near Volterra and Florence. Borax works have been using the vapors for chemical processes since 1818. The emanations contain besides mineral salts from 94 to 96 percent by weight of steam, and the gases remaining contain percentages by volume of carbon dioxide 92, hydrogen sulphide 2, methane 1.78, hydrogen 2.45, and small amounts of oxygen, nitrogen, argon and helium. Borings yield steam at temperatures varying from 100 to 190 degrees C., and ordinarily pressures of 1 or 2 atmospheres in excess of that of the air.

Ginori Conti applied a jet of this steam to a rotary motor in 1903. He next used a small reciprocating engine connected to a dynamo. Then bore-holes of 12 to 20 inches diameter were drilled and higher temperatures were obtained and a variety of pressures. The temperature was found constant for a given output of steam, but the steam was superheated for an unknown cause and could not be treated as saturated and its pressure measured by its temperature In 1905 a strong well gave 4000 kg. of steam per hour at slightly above atmospheric pressure when fully opened. A 15 h. p. engine was started in 1905 and has been working steadily for 15 years. In 1915 a 250kw. unit with turbo-alternator was started, using aluminum wires and circuit-breakers on account of the corrosion induced by the fumes on copper. This turbine received an effective pressure of 0.5 atm. at 3000 rev. generating a three phase current at 4000 volts and 50 periods frequency. Power was conveyed as far as Volterra In 1916 three units of 2500kw each were installed . The turbines have jet condensers. The natural steam at 120° C. is led through 22 evaporators in which pure water is heated to 110° C. in aluminum tubes, this water being the condensate of natural steam from huge cooling towers. By drilling new wells over 120,000 kg. of steam per hour from wells was supplied. The effective pressure at the turbines is only a quarter atmosphere or about 4 pounds per square inch.

The wells are driven by both percussion and rotary drills. Iron casings are used diminishing the diameter two or three stages to each well. The depths vary from 200 to 600 feet. Steam increases as a well deepens. A headpiece over the well diverts the steam laterally while the working rods pass through an opening at the top. It takes two to six months to complete a well. Sometimes in wet ground little steam comes until a piston is put down and raised suddenly; this starts a geyser of mud and stones followed by steam, which then takes control. The steam output is measured by fitting conical gauge openings on the well, below which a mercury manometer reads the pressure appropriate to the opening: the volume is then calculated by the Saint Vainant formula. By using different openings a diagram is drawn giving the outputs at different pressures.

Since 1923 the evaporators have been abandoned, the natural steam is cleared of its gases by physical condensation and revaporizing, and so is led directly to the turbines. Three such depurators furnished 60,000 kg. of steam per hour with only 0.5 per cent of gas. Some new wells are furnishing 35,000 and 60,000 kg. each per hour. Experiments are successfully progressing with a turbine exhausting into the air, thus doing away with the condenser plant. The net result of the Larderello experiments is that the consumption of natural steam at 2 atm. effective pressure is 40 kg. per kilowatt hour. The plant is now connected with two high tension lines at 38,000 volts for current distribution in Tuscany, running in parallel with several large hydraulic plants.

In view of the great quantities of rocks red with ferric oxide in the Larderello region, and the presence in the dry gases of oxygen along with 6 per cent of hydrogen and its combustible compounds, it appears to the reviewer that the superheat may well be due to slow oxidation of gas with reduction of mineral oxides. T. A. J.

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NO. 33 RELEASED WITHOUT COPYRIGHT RESTRICTION AUGUST 13, 1925

KILAUEA REPORT NO. 709

WEEK ENDING AUGUST 12, 1925

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

Halemaumau, the fire-pit of Kilauea volcano, has reached another extra quiet spell as shown by few avalanches and few earthquakes or tremors for the week. There were 11 local seismic movements of which five appeared to be of the avalanche type. Most of the others were very small and from origins apparently, as determined from their preliminary tremors, more distant than Halemaumau. The pit itself shows sulphur increasing about eastern and southern edges of the bottom, and during an inspection of two hours the forenoon of August 9 small avalanches averaged every fifteen minutes from different parts of the walls.

On that morning there had been a big slide making a dust cloud seen at a distance. This had fallen from the middle of the large gabbroid sill in the northeast wall. Falls at that place had created a new notch in the wall and a new talus conoid below.

Tilting of the ground for the week at the Observatory was moderate to the SSE.

There is nothing to imply "extinction" in present conditions. Extra quiet spells preceded a fortnight by extra quaky ones have come every two months since the beginning of 1925. There have been no big inward tilts to indicate subsidence of the internal lava since it was present in the pit in July 1924.

VOIDS IN LAVA FLOWS

In a typical shelly pahoehoe lava flow quite an appreciable percentage of the total bulk of the flow is represented by voids. A water stream channel developed through such lava has great bottom irregularities as well as numerous voids in its banks.

The large volume of the bottom irregularities and voids in the sides of the channels is often strikingly shown by the behavior of freshets in small streams. The road between Mountain View and Glenwood, Island of Hawaii, crosses the same stream several times within a little over a half mile. Sometimes after a heavy shower in the upper reaches of the stream there is a lapse of nearly an hour between the time of the stream becoming bank full at the upper bridge and the beginning of the flood at a lower bridge about a half mile away. The water is flooding underground before it appears overground. Seepage is probably only a minor factor in controlling such retardations in flood stages. R. H. F.

ENGULFMENT AT CRATER LAKE, OREGON

In view of the remarkable evidence of engulfment as the dominant process at the explosive eruption of Kilauea in May, 1924 (Bull. Hawn. Volc. Obsy. Dec. 1924) wherein the ejected matter was less than one percent of the matter engulfed, Diller's conclusions concerning the origin of the vast crater at Crater Lake National Park, Oregon are interesting. (Jour. Geol. April-May 1923, 226).

The great depression containing the lake is completely encircled by a rim cliff 2000 feet high, the lake is 2000 feet deep, and the outfacing slopes are gentle. The whole constitutes Mount Mazama built up of lavas and ejecta, andesite first, folowed by dacite and dacite pumice. The latest dacite flows outside the crater are not covered by material blown out and flows just inside the rim of the crater as it stands came from a notch produced by the collapse that engulfed the central portion of the volcano.

As the Crater Lake basin with the water removed is five miles in diameter and four thousand feet deep, and this is only one of many volcanoes in the northwestern United States, it would appear that engulfment may be a big process is post-Tertiary volcanism. T. A. J.

ILLINOIS-WISCONSIN EARTHQUAKE OF 1909

The supposition that the central United States is safe against earthquakes was rudely shaken May 26, 1909. Michigan and the great lakes are places seismically quiet according to de Montessus, but at 8:38 a. m. five hundred thousand square miles were shaken from Missouri to Michigan and from Minnesota to Indiana. Buildings were lightly damaged, chimneys fell, furniture was overthrown, dishes were broken, there was much panic. There were three centers and the duration varied from four seconds to a minute. There were rumbling and swishing noises.

Sidewalks were seen to heave and a bridge to sway. People had difficulty in keeping their feet. Glass was shattered. Instruments and machines were put out of commission. Gas pipes were disjointed in Chicago. Fires were started in Aurora and Chicago. Grain bins broke and lost their contents. Italian laborers fell on their knees and prayed. Chicago feared a tidal wave from the lake. Telephone girls left the switch-boards. The top floors of the high office buildings swayed much more than the bottom. (Udden, Pop. Sci. Mon. Aug. 1910). T. A. J.

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NO. 34 RELEASED WITHOUT COPYRIGHT RESTRICTION August 20, 1925

KILAUEA REPORT NO. 710

WEEK ENDING AUGUST 19, 1925

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

T. A. Jaggar, Official in charge

Halemaumau remains passive. On August 13 the niche over the northwest talus appeared to be without its former overhang that had made it a kind of a cavern, and the talus below showed fresh debris, showing that the overhang had been falling away. On the 16th and 17th the pit was very quiet, the former being rainy with steam showing in the bottom, the latter dry with hardly any steam. From the northeast side of the pit, the upper rift tunnel in the southwest wall appeared more filled with debris in its bottom part than formerly.

August 18 there were fresh white sulphates at a steaming patch in the middle of the bottom and a sulphur smell was perceptible at the southeast edge of the pit. There has been very little of this odor lately, and the hydrogen sulphide odor, which a year ago was strong even miles away to leeward, is no longer noticed.

August 19 at 2:30 p. m. some light sliding at the northwest wall of the pit was noticed twice during a quarter hour of observation. There had been some recent fresh stripping up and down the west wall. There was fresh white stain on the northeast and southwest walls due to drying after recent rains.

At the Observatory 10 earthquakes of local origin were registered during the week, but for five days from the 10th to the 14th there were not any. One appeared to be an avalanche tremor and all the others were small and unfelt. The net tilt of the ground for the week was zero.

A moderate distant earthquake was recorded at 1:46 a. m. August 19, the seismogram indicating an origin distant about 3000 miles—equal to the distance from Hawaii of Kamtchatka or northern Mexico.

NEW ZEALAND VOLCANO OBSERVATORY

Thanks to the excellent work of Hon. G. M. Thomson and Dr. J. Allan Thomson, it is reported that the Minister for the Interior has approved the proposal of a committee of the New Zealand Institute for establishment in the North Island of a volcano observatory.

As a beginning a suitable man is to be appointed for two years as volcano observer, stationed in the Taupo district, equipped with a motor car, and prepared to make as continuous observations as possible, having in view the selection of a site for a permanent observatory. The publication of regular reports from the New Zealand volcanoes will be welcome to volcanologists. T. A. J.

BATHYSEISMS

Dr. R. D. Oldham, who from 1879 to 1903 studied earthquakes as a member of the Geological Survey of India, in lectures at the Royal Institution January-February, 1923 (Nature, March 31, 1924, 432) reaches the conclusion that great earthquakes may result from rapidly produced strain. They are commonly thought to result from gradual accumulation of strain, which acts from below in opposite directions on some part of the solidified outer shell of rock, so that the shell gives way by faulting or "elastic rebound," and the rupturing motion on the fault-fissure is the earthquake nucleus or center. In such a case the maximum quaking should be at the rupture, the rupture should be parallel to the line of strain, and the strain should be demonstrably slow.

Oldham points out that the maximum quaking is often not at any one rupture or at any visible rupture at all; in the great Indian earthquake of 1897 and the California earthquake of 1906 there were several centers of intense shallow shaking over hundreds of miles, with isoseismal lines close together, and outside of these there are widely separated isoseismal lines for the lesser intensities of shaking. The Charleston earthquake showed no definite faults at all. The fault displacements in the Cutch earthquake of 1819 and in the California earthquake of 1906 reached twenty to thirty-five feet up-and-down or horizontally, but away from the fault plane die out within six miles.

The argument is that the multiple centers are themselves the result of a big movement more profound called a bathyseism; that their close set isoseismals are the results of their own shallow movements; that complicated scattered movements simultaneously over a wide area with outlying centers are incomprehensible results of slow growing strain, but are easily understood if the development of deep strain over a wide area is rapid. L. Pilgrim in 1913 concluded that the origin of the California earthquake lay at a depth of 100 miles, and H. H. Turner concludes on analytical evidence from seismograms that many teleseisms originate from 50 to 300 miles below the surface of the earth. As at these depths the material is weak and plastic, the original motion is not conceived to be fracture, but a volume-density change due to some process of deep-seated volcanism.

The Tokyo and Santa Barbara earthquakes agree with the conception of deep strain. Tokyo showed two distinct displacements; widespread slight shore uplift of one to seven feet due to a deep cause, and a dropped fault-block, locally down six hundred feet in the bay. Santa Barbara lay between measured bench marks that in fifty years have moved respectively 24 feet north and 10 feet south; no north-south fault has been reported on the surface, but the bench-mark creep appears to indicate growing strain, remote from the 1906 movement. Oldham's ideas are in good agreement with many earthquakes where the shock is evenly felt over wide areas. T. A. J.

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NO. 35 RELEASED WITHOUT COPYRIGHT RESTRICTION AUGUST 27, 1925

KILAUEA REPORT NO. 711

WEEK ENDING AUGUST 26, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge

Halemaumau has never been quieter. On August 21 the pit was dry and still. On August 22 the only observable change was that a sulphur spot on the bottom appeared brighter yellow. On August 25 after rain the walls were deep red and vapor rose even above the rim.

The seismographs during the week registered 15 earthquakes. One at 11:32 a. m. August 19 was felt in Hilo and Kohala and the seismogram indicated origin 41 miles away. With the same indicated distance came a smaller quake the same day at 3:49 p. m. The other shocks of the week were small and four of them were of the avalanche type accompanying slides in Halemaumau.

Tilting was very slight to the north. At 4:05 a. m. August 21 a meteor was observed at Kilauea, Kohala and Kona.

INCREASED EARTHQUAKE INSURANCE

A New Haven insurance firm states that many firms in the eastern United States are taking out earthquake insurance. This is confirmed by the Spectator, an insurance journal of New York, the Underwriter's Report of San Francisco, and the National Underwriter. The Edison Electric Illuminating Co. of Boston has insured for $45,000,000; the Equitable Building of New York is insured against earthquake for $2,000,000 on a basis of 25 percent coinsurance, and against tornado for $4,000,000 on 50 percent coinsurance. This means that if the total amount of such insurance at time of disaster on the property is less respectively than 25 or 50 percent of cash value by any or all companies insuring, the underwriters of these particular policies shall be liable for those proportions of the actual loss which two million dollars and four million dollars respectively bear to the said 25 percent and 50 percent of total value.

Large buildings in Providence and Philadelphia have been insured up to 90 percent of their value. The New Haven firm above mentioned offers a rate of 40c per $1000 for one year, or $1 per thousand for 3 years on dwellings and fireproof buildings in the East. Revised California and Montana earthquake insurance rates range from 21c to 40c a year on $1000 according to the class of risk and coinsurance percentage, the latter being mandatory with a minimum of 70 percent.

From the Santa Barbara earthquake the estimated total loss given by the insurance journals is under seven million dollars, and the insurance losses under two millions. The amount of insurance written by Los Angeles offices within four days after the Santa Barbara catastrophe was thirty millions, placed all over southern California on all classes of buildings, and all records for earthquake insurance were broken in San Francisco the second week in July when the Assocated Oil Co. purchased thirty-seven million dollars protection for its containers, pipe lines and tanks and their content. The underwriters are described as fairly swamped with earthquake business, which is very complicated in its requirements and necessarily imperfectly understood and badly scheduled. Some companies are declining to write earthquake or raising their rates, maintaining that for such a catastrophe hazard a large reserve should be built up. Usually all companies demand that fire insurance be purchased in at least equal amount with earthquake protection.

The Los Angeles Board of Education has applied for $20,000,000 earthquake insurance on sixty brick school buildings. The San Francisco board of supervisors has passed a resolution calling for a study of Santa Barbara and revision of building regulations. Buildings insured against earthquake are the Woolworth in New York $5,000,000, Kearns in Salt Lake City $360,000, dwellings, offices, warehouses and factories in New Orleans, Boston, Baltimore, Portland, Seattle and cities in New Jersey and in Canada. Many of the smaller buildings have been insured in New York and Brooklyn. The Schuster stores in Milwaukee have been insured for $5,630,000. The companies write a regular earthquake policy covering both seismic danger and the fire that may follow earthquake. They are unhesitatingly accepting more earthquake insurance in Santa Barbara than ever before. T. A. J.

RAPIDITY OF EARTHQUAKE VIBRATIONS

It has long been noted that the period of vibrations of earthquake waves increases somewhat with increase of distance. For some very distant earthquakes the period of the waves in the principal portion of the record on seismographs may be as high as 70 seconds, or less than one vibration per minute. With very local schocks—distance to origin two or three miles—the period is very rapid. Often vibrations at the rate of 200 per minute are recorded. When the distance increases to 10-20 miles the common period of earthquake waves is 0.5 second or 120 vibrations per minute. Periods of 0.6 to 0.8 second or more are commonly observed with earthquakes when the indicated distance to origin is from 30-50 miles. An experienced observer in a suitable building by merely experiencing a perceptible shake can often get some idea of its distance to origin. The long period waves of distant earthquakes do no damage to buildings and are not perceptible to human beings. They can only be detected by seismographs. R.H.F.

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NO. 36 RELEASED WITHOUT COPYRIGHT RESTRICTION September 3, 1925

KILAUEA REPORT NO. 712

WEEK ENDING SEPTEMBER 2, 1925

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

The only remarkable change of the week has been a very notable development of spasmodic tremors increasing about September 1, as registered on the seismographs. The pit of Halemaumau has shown no phenomena accordant with the tremors.

August 27 steam was heavy on the taluses after much rain. Blue fume mingled with the steam along the east edge of the floor. August 29 there was fresh debris on the northern slopes. An upward directed cavernous hole was developing above the northwest talus in the wall. Otherwise the pit has been very stable, except for little falls of single stones from the walls.

There were 27 local earthquakes and 36 spasmodic tremors, none of them felt here. A shock at 9:03 p. m. August 28 had an indicated distance to source of 43 miles and was plainly felt in Kealakekua. One at 2:42 p. m. August 29 had distance indicated as 25 miles. Tilting for the week was slight to the northeast and this is the time of year when tilt usually changes radically from southwesterly to northeasterly.

WHAT HOT SPRINGS INDICATE

In a recent symposium on hot springs (Jour. Geol. 1924) physicists and geologists mostly of the Geological Survey and the Geophysical Laboratory described warm springs of Virginia, boiling springs of the west, and scorching fumaroles of Alaska. These are "outpourings of heat energy at the earth's surface," regarded as continuous series. Chemical reaction and radio-activity prove inadequate to explain the high temperatures. Forced flow from a depth of greater pressure may explain part of the slight heating of such warm springs as those in the southern states and Haiti. Heat effects might also be produced by a forced flow of steam from the water excluded from cystallizing lava or magma underground.

From study of rate of increase of temperature downward the Yellowstone boiling waters are calculated to rise from depths of from 3400 to 8000 feet, the water being rain-water that reaches unusual depths. Iceland, Lassen Park, and the Sonoma county boiling waters of California are believed to be more than half rain-water. Geologists differ as to how much magmatic water is mixed with surface water.

Sosman summarizes the discussion by saying that the thirteen authors agree that the source of hot-spring heat is in hot magma under the crust of the earth. These authors represent the southeastern United States, Haiti, Arkansas, California, Greece, Italy, Iceland, Nevada, Utah, Idaho, Katmai in Alaska, and the Yellowstone as places of hot-spring investigation.

The question is left open as to how the volcanic heat is localized and applied. There is no obvious direct connection between volcanic lavas and hot springs, but the heat underground at shallow depths is greater in regions of recent lavas or active intrusives. The increase of temperature downward in flowing wells ranging in depth from 50 to 1600 feet varies from 3 to forty-eight feet per degree Fahrenheit; in mines and non-flowing wells from 20 to 60 feet per degree. The average for flowing wells is about 30 feet, and in mines and still wells about 40 feet per degree. Two hundred and eleven places in the western United States are included.

There is evidently much hot ground in the regions of ore deposits, recent lavas and hot springs, including under "lavas" recent intrusive igneous rocks. Heat of acid formation and of rock oxidation is found by Day and Allen to yield only two percent of the temperature of boiling springs. There seems to the reviewer to be room in the discussion for oxidation of hydrogen and reduction of rock oxides as a prevalent deep intrusive heating process in the outer crust of the earth wherever engulfment and assimilation may be in progress. And oxidized hydrogen is water. T. A. J.

WEST INDIAN EARTHQUAKES

Centers of the many destructive earthquakes recorded in the West Indies are grouped along two east-west lines north and south of very deep ocean troughs south of Cuba and north of Porto Rico. (Taber, Bull. Seis. Soc. Amer. Dec. 1922.) These reach depths of 3500 and 4600 fathoms. The earthquake belts coincide with faults at the edges of the troughs. Haiti suffers most. Sometimes successive earthquakes are on the same fault. There are exceptions to the oft-cited rule that the steepest slopes are the most seismic. High relief does not agree with places of most earthquakes. Permanent changes of shore elevation at time of quakes are rare. Such changes have however occurred gradually within fifty years.

Continued deepening of the troughs accompanies the quaking. Neither tension nor compression agrees particularly with the observed facts. Loading with sediments is not considerable. Big sea-waves have been abundant, usually with withdrawal of water preceding rise, indicating sudden downward displacement of ocean bottom. Disastrous quakes rarely repeat at the same places, hence those places along the belts "near which severe earthquakes have not originated during historic time are to be regarded as most dangerous." As the towns are built on water-logged alluvial soil, and the Antillean masonry is bad construction, the selection of sites and architecture (excepting the modern Kingston) is dangerous both for waves and earthquakes. T. A. J.

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NO. 37 **RELEASED WITHOUT COPYRIGHT RESTRICTION** September 10, 1925

KILAUEA REPORT NO. 713

WEEK ENDING SEPTEMBER 9, 1925

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

There has been no change in Halemaumau pit. Very slight falls of rock from the walls have been heard every time the pit has been visited, and on one occasion there appeared to be more sulphurous steam of bluish color at the south talus than usual. A little fresh debris is discernible on the southern taluses.

Forty-four earthquakes and tremors of local origin were registered. Quakes plainly felt in Pahala happened at 8:24 p. m. and 10:40 p. m. September 2. An earthquake felt here at 3:34 p. m. September 5 had origin distance indicated as 39 miles. A slight record of distant earthquake was registered at 6:21 a. m. September 5. Tilt was slight to the west.

RADIOACTIVITY, GEOLOGY AND VOLCANOES

Professor Joly of Dublin accounts for the systematic recurrence of great geologic revolutions accompanied by mountain-building, volcanism and extinction of floras and faunas, by a series of cycles thirty million years long each, occasioned by storage and release of radioactive heat. (Halley Lecture, Oxford University Press, 1925, "The influence of radioactivity on the surface history of the earth," J. Joly. See Nature, May 5, 1923, June 7, 1924 and May 30, 1925). This conception accords well with the volcanologist's experience of short term tides and cycles, and with the evident condition of the earth today volcanically as degenerate compared with Tertiary time.

There is first a lowering of the continents under shallow seas and deep sediments. Then the sediments rise crushed and wrinkled and are worn into mountains. There is outbreak of floods of lava, generally along western coasts. The land attains its former elevation and a long time of comparative quiet ensues with life prospering. Figuring the age of the sedimentary rocks we know from the radioactive degeneration of thorium lead, Joly makes the four or five world revolutions of geology thirty million years apart.

The continents float upon yielding basalt below. The crust is 24 miles deep and the basalt 200 miles. The cooled non-liquid basalt heats itself to liquidity in 25 million years. It becomes lighter on heating, so that the continents sink slightly while the supporting liquid expands and ruptures them. The ubiquitous radioactive elements do the heating. Volumes of lava pour out. The volume increase of the lava substratum is over six percent, enough to increase the surface area of the globe 650,000 square miles.

Tidal effects appear in this sea of lava underground. The continental crust lags behind as the earth rotates and the eastward pressure of the substratum crushes and crumples the deeper portions of the continental blocks filled with sediments, especially on their western sides. These crushed troughs are to become the mountains. The continents drifting relatively west leave the lava on the east under the sea-bottom close to the surface, quicker circulation in the liquid lava causes it to cool and crystallize losing its heat to the oceans, so that the hot eruptive period draws to a close.

With the cooling comes greater density to the basalt and the continents rise by floating higher through a period of some five million years, and volcanic activity wanes. The sea-bottom lava shrinks and lowers. This is the sort of time we are living through now. The early Tertiary age was the last time of revolution. The crushed sediments of the former shallow land-locked seas are heaved higher than the rest of the continents because their roots go lower in the floating, just as a deeper ice-berg lifts a higher peak. The weather and streams erode them into mountain ranges.

It is true that all mountain ranges do not trend north and south like the Cordilleras. But in the cases of the Himalaya and the Pyrenees, for example, the rupturing Eurasian continental blocks had merely to execute slight turning movements to distort the mountain axes. The inter-revolutionary periods are full of small revolutions through graded cycles leading to the big ones. Summarizing, radioactivity furnishes the heat that periodically takes effect by liquefying the outer part of the earth, and the rest of the energy is furnished by the rotation of the earth when the crust becomes mobilized. The globe is enormous and heavy, the crust is trivial and light, and the surface velocity is 1000 miles an hour. T. A. J.

MAXIMUM HEIGHT OF EXPLOSION CLOUDS FROM KILAUEA IN MAY 1924

Owing to the closeness of the Observatory to the seat of the explosions good estimates of the maximum heights of the clouds could not be made. The cloud columns would lean in various directions so that their true distances from the Observatory were not known and one could not measure the angle to their summits and accurately compute their heights. The estimates of the height of one of the tallest clouds noted at the Observatory accordingly varied between 15,000 and 30,000 feet above sea level. The tops of the clouds of the three most violent explosions of the series could not be seen from the Observatory because of general cloudiness.

Good views of several explosion clouds were obtained from Waimea. Waimea is about 50 miles from Kilauea and 2700 feet above sea level. The clouds were observed just to the right of a line to the summit of Mauna Kea from Waimea and appeared to be about 2000 feet higher than the summit. As the summit of Mauna Kea is about 20 miles from Waimea and 13,825 feet above sea level, it would seem that the cloud heights may have been 33,000 feet above sea level. Allowing for possible errors in estimates and some spreading out of the cloud tops, it would appear that the maximum height reached by the explosion clouds was about 30,000 feet. R. H. F.

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NO. 38 RELEASED WITHOUT COPYRIGHT RESTRICTION September 17, 1925

KILAUEA REPORT NO. 714

WEEK ENDING SEPTEMBER 16, 1925

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

Nothing new happened at Halemaumau pit until the evening of September 11 when about 11 p. m. the roar of an avalanche of rock was heard in the still night air, the noise proceeding from the pit and quite audible at the Observatory and Volcano House two miles away in an air line. Somewhat later the same night there was another avalanche.

From 10:30 to 11:30 the next forenoon the northeast wall was seen to be working, two slides occurred in a half-hour, and at 1:45 p. m. came a larger slide that sent up a considerable dust cloud from the same place. The weather at this time and for most of the week was hot and sultry, the maximum temperature reaching 82° F. September 14. On that day there were slight slides, but a loose slab that appeared ready to fall at northeast edge of the pit was still in place. A dust cloud rose at 12:50 p. m. September 15. The pit thereafter was tranquil and very dry, the only notable steam patch being at the west pocket. The many avalanches of the year have produced vertical striations on the walls.

Sixteen seismic movements were registered, of which eight were of the avalanche type notably on September 12. Tilting was moderate SSW. None of the earthquakes was perceptible.

EARTHQUAKES IN THE UNITED STATES 1915-23

During the nine full years, 1915-1923, that the U. S. Weather Bureau collected and published in the Monthly Weather Review the earthquake statistics for the mainland of the United States, 955 separate earthquakes distinct enough to be perceptible were reported. This makes the yearly average over 100. Forty-two states and the District of Columbia reported earthquakes. The average number of states reporting one or more earthquakes each year was 19. If the records for 1924 and the first two months of 1925 were included all states excepting Delaware, Florida, and Louisiana would have earthquake reports. An earthquake on October 16, 1916 was undoubtedly perceptible in Florida also, as it was reported from a place in Georgia almost on the Georgia-Florida line.

The number of earthquakes felt in each state is shown in the following table:

State	No. of shakes 1915-23 incl.	State	No. of shakes 1915-23 incl.
Alabama	8	Nebraska	1
Arizona	20	Nevada	36
Arkansas	12	New Hampshire	2
California	594	New Jersey	2
Colorado	19	New Mexico	4
District of Columbia	1	New York	10
Georgia	2	N. Carolina	5
Idaho	15	N. Dakota	1
Illinois	29	Oklahoma	1
Indiana	7	Oregon	17
Iowa	2	Pennsylvania	2
Kansas	3	S. Carolina	17
Kentucky	16	S. Dakota	6
Maine	7	Tennessee	28
Maryland	1	Texas	2
Massachusetts	3	Utah	36
Michigan	4	Vermont	1
Minnesota	2	Virginia	6
Montana	5	Washington	37
Mississippi	4	W. Virginia	1
Missouri	20	Wisconsin	3
		Wyoming	13

As several of the earthquakes were felt in more than one state they were counted more than once so that the sum of the numbers in the above table exceeds the actual number of separate earthquakes. Over half of the earthquakes were reported from California but this is not surprising when one considers the great extent of the state and the fact that it is the most active region, seismically, in the United States.

The most active regions seismically in the eastern United States are along the middle part of the Mississippi River—southern Illinois, western Kentucky and Tennessee, northeastern Arkansas, and southeastern Missouri—and the southern Appalachians. Some of the earthquakes experienced in these regions caused minor damage; though the areas affected were nearly as great as the area affected by the San Francisco earthquake of 1906. This indicates that the actual breaks that cause the earthquakes are, as a rule, at a greater depth below the earth's surface in the eastern part of the United States than in the western part.

During the first part of the nine-year period under discussion several earthquakes were experienced yearly at or near Charleston, South Carolina but during the latter part of the period the frequency of earthquakes at that place seems to have diminished.

The strongest earthquake during the nine-year period occurred in Nevada on October 2, 1915. It was the strongest earthquake that has occurred in the United States since the San Francisco earthquake and was recorded on seismographs all over the world. Cracks 22 miles long were opened in the earth's surface, but little damage was done, however, as the break occurred in a sparsely settled country.

R. H. F.

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NO 39 RELEASED WITHOUT COPYRIGHT RESTRICTION September 24, 1925

KILAUEA REPORT NO. 715

WEEK ENDING SEPTEMBER 23, 1925

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

T. A. Jaggar, Official in charge

Nothing has happened as yet to indicate any equinox effect at Halemaumau pit. There has been some stripping of the north wall by avalanches. On the 19th there was a new notch adjacent to and west of the north sill; the debris below was red. On the 23rd there was new dry debris on this same north talus but it was white, and had come from the horn of the sill itself, which consists of a whitish rock.

Not much has been seen of these avalanches. About 1 a. m. of September 22 the roar of an avalanche was heard. That the walls are still unstable was proved on September 22, when some men throwing bowlders over the northwest rim succeeded in starting a slide sufficiently great to make a small dust cloud above the pit. The pit most of the time is quiet. Bluish vapor has been noticed at the base of the wall itself SSW. After rain increased steam returned to the bottom.

Nine earthquakes of local origin were registered on the seismographs. One of these was felt in Hilo at 9.53 a. m. September 17; the seismogram indicated distance to origin from the Observatory at Kilauea of 12 miles. Only one of the registered seisms appeared to be of the avalanche type. Tilt was moderate to the ESE.

COSTA RICAN VOLCANIC DISASTERS

There were many earthquakes, eruptions and floods in the mountainous and volcanic lands of Costa Rica from the seventeenth century on, but reliable records only begin about 1840. From that time some ten to twenty earthquakes per year were sufficiently destructive to be recorded. From 1888, when there was a severe shock in central and western Costa Rica, the Alajuela disaster, a seismologic station was established in the capital San Jose', and from thirty to eighty local earthquakes per year were registered, many very short, only from four to sixteen seconds duration.

Cartago, the second city, and near the continental divide, has suffered terribly from earthquakes in 1822, 1841 and 1910. April 10, 1821, a shock damaged the parochial church, and a year later, May 7, 1822, the whole of central Costa Rica was devastated by a major earthquake, aggravated by the rainy season that deluged the refugees in their straw, plank or skin huts. In 1827 a church at Nicoya on the Pacific coast was ruined. September 27, 1841, Cartago was destroyed anew by a violent quake. The population numbered 17,000, and a third of them were trapped in the ruins and many lost their lives. The center of the city containing 600 large and beautiful buildings including many churches was a total wreck, and 4205 houses were more or less demolished. Shocks continued for twenty-one months, keeping the inhabitants in light shacks exposed to the weather. This was the worst Costa Rican seismic disaster in the 19th century. The year 1851 produced a serious earthquake at San Jose', which is a few miles west of Cartago in the same mountainous central region.

The terrific Cartago earthquake of 1910, on May 4th, demonstrated the obscure but intimate relationships between volcanoes and these shocks. Cartago is at the foot of Irazu volcano and San Jose' near the base of Poas, another active cone with a geyser-like lake of boiling water in its crater. In 1910 Poas became explosive on January 25th and threw much ash over the country and pumice bombs on the borders of its crater. In southern Costa Rica there had occurred a strong shock January 10th. On April 13th there were two midnight shocks of great intensity near San Jose', damaging several towns, and felt from Nicaragua to Panama; the aftershocks were numerous and kept many persons in camp outside of their houses. On May 4th at 6:50 p. m. a tremendous jolt from the east came after an afternoon of many shocks and made of Cartago a heap of rubble, destroying the Carnegie Peace Court, the churches, dwellings, public buildings, and shops. There were killed 272 persons and hundreds were wounded.

Irazu volcano in 1910 showed cracks about its crater, but no activity until 1917 when it broke into explosive eruption damaging the agricultural lands with ash. March 4, 1924, violent earthquakes shook the western half of Costa Rica, again two shocks an hour apart, seriously injuring San Jose', several other towns, the roadways by landslip debris, the western railway and a large country district.

It is worthy of note that in 1891 Cartago was smashed by another type of disaster, a sudden torrential river flood caused by a cloudburst. This started a landslide that dammed a stream, which finally burst the barrier. (Materiaux pour l'e'tude des calamites, April-June 1925, Tristan, p. 62; Viquez, p. 91 See also Jaggar and Spofford, Jour. Assoc. Eng'g Socs., February 1911, Boston).

T. A. J.

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NO. 40 | RELEASED WITHOUT COPYRIGHT RESTRICTION | September 30, 1925

KILAUEA REPORT NO. 716

WEEK ENDING SEPTEMBER 30, 1925

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

R. H. Finch, temporarily in charge

This week marks the end of 14 months during which the volcano has been quiet. Several avalanches, some of which were loud enough to be heard at Volcano House and sent up dust clouds, occurred during the week.

On September 30 there were several bright red patches on the walls of Halemaumau showing that light rains may produce redness in restricted areas. Heavy rains cause a general reddening of the walls.

Ten earthquakes were registered on the Observatory seismographs. None was perceptible at Volcano House. Excepting three that were of the avalanche type the majority appeared to have had origins at distances considerable in excess of two miles from the Observatory. Tilting was slight to the west.

PRESENT CONSTITUTION OF THE EARTH

Sir Horace Lamb, president of the British Association for the advancement of Science, made a notable address on this subject at the recent Southampton meeting. (Science, Sept. 11, 1925 and Nature, Aug. 29, 1925). "The primary aim of science is to explore the facts of nature, to ascertain their mutual relations, and to arrange them into a consistent and intelligible scheme."

Irregularities in the intensity of gravity have been found to exist over wide areas, proving that in mountainous regions the observed value of gravity, i. e. the weight of the earth crust, is abnormally low, whilst on oceanic islands and about the sea it is abnormally large. The accepted explanation is that the stratum of rock above an imaginary level surface sixty miles down is approximately uniform, in the sense that equal areas of the surface in question bear equal weights. The mountain elevations are held up by the inferior density of the underlying matter, whilst the oceanic hollows are made up for by increased density beneath. The matter in the interior of the earth, below the stratum of "isostatic balance," is in a state of pressure uniform in all directions. The material of the stratum itself is strong enogh to withstand the shearing forces due to the weight of continents and the lack of lateral support at the oceanic depressions.

A rough picture of the material of the inside of the earth makes the central core of about the density of iron, surrounded by an envelope of rock. This satisfies the requirements of gravity distribution, the ascertained velocities of seismic waves from big earthquakes at different depths and the permissible elasticity of the globe.

Lord Kelvin's attempt to limit the age of the earth by loss of heat was upset by the discovery of generation of heat in the processes of radioactive change of elements everywhere present in the rocks. A stratum some ten miles in thickness would provide all the heat wanted for the present known increase of temperature downward. The time elapsed since the consolidation of the earth, estimated by a comparison of the amount of uranium and of the lead associated with it by radioactive degeneration, must be between a thousand million and ten thousand million years.

As to rigidity, the earth itself has a tide occasioned by the deforming action of the sun and moon. The horizontal force of these bodies must slightly deflect the apparent vertical of a pendulum. If the earth were perfectly unyielding, the pendulum would have a calculable displacement. If its observed displacement were less than the calculation, it would mean that the earth itself yielded to that extent. Michelson used two canals E.-W. and N.-S. as pendulums, each 500 feet long, and measured optically their microscopic tides, with a range of movement of the order of a hundredth of a millimeter. The observations magnified exhibit all the features of a tide-gauge record, but the observed tides were only seven tenths as great as those calculated for the canals on an assumed rigid earth. Both E.-W. and N.-S. were alike. The three tenths unaccounted for were taken up by the tides passing through the solid rock. This would amount to a rise and fall of about a rigid, like steel, but not perfectly rigid. The elasticity of foot each half-day. The material of the earth is highly the earth as shown by the wave velocities of compressional and distortional waves from earthquakes, and the ratio of the two, appears to be much like that of ordinary metals and glass. The compressional travel 4½ miles per second and the distortional or transverse waves 2½ miles per second in the outer rocks; thirteen hundred miles down and beyond they travel much faster, 8 and 4 miles per second respectively.

There is an interesting discrepancy between the thermal and tidal arguments about the earth's interior. The thermal argument suggests a plastic condition for the interior. The perfect elasticity shown by the tidal arguments and the earthquake waves indicates great resistance to shearing or flow. Some substances are plastic only to long continued stress. Dr. Lamb suggests that the interior matter of the globe may be plastic under the steady application of centrifugal force, but rigid under such short period forces as the tides or the earthquake waves. T.A.J.

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NO. 41 RELEASED WITHOUT COPYRIGHT RESTRICTION October 8, 1925

KILAUEA REPORT NO. 717

WEEK ENDING OCTOBER 7, 1925

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

R. H. Finch, temporarily in charge

After the spell of moderate avalanching noted during the middle and last of September Halemaumau is again rather quiet. Small rock falls, however, can nearly always be heard. On calm days the wierd multiple echoes produced by such falls make it seem as though many landslides were in motion.

Several of the steaming vents on the floor of Halemaumau pit and on the avalanche slopes appear dry as though the visible vapor escaping were live steam. The rapid ascensional rate of some of the steam columns that appear above the rim of pit on damp days also indicates a rather high temperature. The borders of other vents appearing wet leads one to believe that the vapor escaping from them is not excessively hot.

Nineteen local earthquakes, all too small to be perceptible at Volcano House, were registered on the Observatory seismographs. Four of the tremors were of the avalanche type.

Faint records of two distant earthquakes were written at 5:30 p. m. October 3, and 5:58 p. m. October 4.

There was considerable fluctutation in tilt during the week with the net result being slight to the southeast.

Mr. J. B. Stone, geologist of the Bishop Museum, who spent a week on the summit of Mauna Loa with the topographers of the U. S. Geological Survey, now mapping that mountain, reports the usual amount of fume in Mokuaweoweo the summit crater. The odor of sulphur dioxide is quite perceptible at the several fuming vents.

TILTING OF THE GROUND AT HAWAIIAN VOLCANO OBSERVATORY

By tilt is meant a change in the angle of inclination between a portion of the earth's surface and the horizontal. If an entire mountain edifice domes upward symmetrically with a maximum uplift at its central area and decreasing amounts with increase of distance from the center, then at the central area there will be a vertical uplift. Any other surface within the area affected by the swelling will have its angle of inclination with the horizontal changed. There would be a tilt away from the center. Similarly if the mountain subsided there would be a tilt toward the center.

Tilt may be measured by noting the changes in the position of rest of a pendulum. A horizontal pendulum, such as is commonly used for seismographs, may be made more sensitive to tilt than an ordinary pendulum like those in clocks.

Tilt records are affected by temperature changes, probably both by temperature changes in the ground and in the instrument itself. There is a diurnal tilt that closely follows the dirunal temperature change and a seasonal tilt that closely follows the seasonal temperature change. The cylcic seasonal tilt at Kilauea, though large, is small compared with the accumulated tilt for several years.

An attempt was made to find some correlation between tilt and rainfall but no striking results were found. This is surprising as Kilauea is situated at the edge of the rain belt with heavy rains to the northeast and very light rains to the southwest.

Sometimes the area to the northeast of Kilauea will receive in one day a rainfall load of nearly 1,000,000 tons per square mile while the area to the southwest may have but little or no rain.

A very rapid tilt means a rapid bending of the rocky layers that compose the Kilauea mountain edifice. A large and rapid bending of rocky layers is apt to cause breaks with the resultant earthquakes. There seems to be a positive connection between tilt and earthquakes.

At Kilauea there is a connection between tilt and volcanic activity. From 1913 to 1919-1920 there was a gradual rise of the mean lava level of 600 feet. During the same time there was a gradual swelling of the mountain top as shown by the northeast tilt on the Observatory seismographs. This tilt was checked by level lines run in from sea level. They showed that at the Observatory, 2 miles or more from the place of suspected maximum increase of elevation, there had been an increase in elevation of over a foot between 1912 and 1921. At some places nearer Halemaumau the increase in elevation was greater.

From 1919-1920 until the disappearance of lava in 1924 there was a gradual sinking of the lava column. During the same time there was slight accumulation of southwest tilt showing that the mountain was sinking. Coincidental with the rapid sinking of the lava column in the spring of 1924 there was a rapid southwest tilt. The accumulation of southwesterly tilt during the three years ending with 1924 amounted to about one minute and 32 seconds of arc. In September 1925 A. L Burdick, Hilo engineer, kindly ran a level line between the Observatory and two points near Halemaumau. The levelling showed that one point had sunk nine feet and the other five feet with respect to the Observatory. The Observatory itself undoubtedly sank several inches.

This is but an outline of a more complete discussion to be published elsewhere. R.H.F.

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No. 42 RELEASED WITHOUT COPYRIGHT RESTRICTION October 15, 1925

KILEAUEA REPORT NO. 718

WEEK ENDING OCTOBER 14, 1925

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

Eleven earthquakes were registered during the week. None was perceptible at the Observatory. A month has elapsed since a perceptible earthquake has occurred at Volcano House.

Avalanches have been rather infrequent during the past week, though small rock falls were occasionally noticed. After the heavy rain of October 13 the walls of Halemaumau were colored a brilliant red excepting for some thick dense layers and instrusive bodies which remained gray.

Tilting was slight to the south-southwest.

Microseismic motion that increased on October 12 indicates the possible presence of a storm at sea near Hawaii. Microseisms became more noticeable on the 13th and continue on the 14th. The only other effects of such a storm noted were southwest winds, thunderstorms, and heavy rainfall.

THIRTY YEARS OF EARTHQUAKES

A summary study of all earthquakes felt in Italy for thirty years following 1891, compiled at the government office, shows that the time of day between 2 and 4 a. m. has the most shocks, while the fewest are from 6 to 8 p. m. There are somewhat more earthquakes in summer than in winter, about 20 per cent more. (Cavasino, Boll. Soc. Sism. Ital. XXV, 49, 1925).

There is great difference between night and day, about twice as many earthquakes being reported at night. This is commonly attributed to fallacy, dependent on more being felt in the quiet hours. To test this, Cavasino listed only strong earthquakes of Grade V of the Mercalli scale or stronger, as these would surely be generally felt either night or day. This special list showed that 1194 shocks of this magnitude came at night as compared with 890 in daytime during the thirty years, making 34 per cent more at night.

He asks, what is the reason? And why is the maximum in the summer and from 2 to 4 in the morning? Cavasino suggests barometric pressure of the atmosphere as a possible control. A millimeter of pressure change on a square kilometer of the earth equals 13.6 million kilograms, sufficient to tilt the adjacent land 0.29 seconds.

Such change gradually applied could have little systematic effect on tectonic earthquakes dependent on accumulating pressure or tension. But for volcanic magma underground the effect might be regular in releasing gas tension. Low barometric pressure would favor such expansion of magma and the pressure of the confined paste on its chamber walls would produce earthquake by repeated rhythmical stresses. The barometer is lowest and the atmosphere presses least at four a. m. for the day and in the summer among the seasons, thus agreeing with the theory. But there is a disagreement; there is a daytime minimum of atmospheric pressure at 4 p. m. without any corresponding earthquake maximum.

An investigation of rainfall by districts in relation to earthquake frequency discovered no correspondences.

The districts of Italy, listed in the order of intensity or violence of their earthquakes, and then in the order of frequency of all earthquakes, showed about the same order of quakiness by both methods. Those places having the most shocks have also the strongest. Sardinia is remarkable in being without earthquakes. In the order of increasing numbers of shocks next came Basilica, Liguria, Lombardy and Piedmont, places of weak seismicity. Next are Lazio, Emilia, Puglia, and Venice, moderate shakiness. Lastly and strongly seismic are in order of increase Campagna, Abruzzo, the March, Tuscany, Calabria, Umbria and Sicily.

In all Italy in thirty years the number of shocks was 13,531 or 451 earthquakes per year felt. Many of these were aftershocks due to the adjustment of local disruptions produced with big earthquakes. Eliminating the aftershocks from the list there are still high frequencies for the years of big earthquakes; such are 1905 (the Calabrian disaster), 1909 (Messina), and 1915 (Avezzano). Apparently some deep-seated process affected all Italy in those years.

Apart from aftershocks, there is an earthquake every two days in Italy, and a disastrous one about every two weeks destroying either property or life. And Italians have done much for practical seismology; may they carry on the work until every dweller in the land feels that his house is safe.

T.A.J.

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NO. 43 **RELEASED WITHOUT COPYRIGHT RESTRICTION** October 22, 1925

KILAUEA REPORT NO. 719

WEEK ENDING OCTOBER 21, 1925
Issued by the Observatory, U. S. Geological Survey:
T. A. Jaggar, Official in charge.

There are no changes to report in Halemaumau pit. Small slides occur from time to time. The floor vapor continues to rise at several places, increasing after rainfall. On October 15 with southwest wind the vapor condensed about 400 feet below rim and made dense clouds at rim level at 2 p. m. when the weather was foggy. On October 17 small rock falls were heard, and dust from such a fall was seen about 2 p. m. October 21.

For the week seven local seisms were registered, of which four were of the avalanche type and none was perceptible. Tilting of the ground was moderate to the NNE. Microseisms were stronger than common during the forepart of the week.

THE DALY GLACIER ON MAUNA KEA

Evidences of ancient glaciers on the top of Mauna Kea in the form chiefly of stony moraines and ice-scratched ledges and bowlders have been observed since 1909. At that time they were described by R. A. Daly (Am. Jour. Sci. 1910, 279; Science Conspectus, 1911, 120; Proc. Am. Acad. Arts. and Sci. 1915, 158). The writer October 13, 15 and 19 explored the scenes of the Daly glacier and in addition to the other evidences of glacial action discovered large outwash plains from the glacial drainage on the SSW flank of Mauna Kea at elevations about 6600 feet. By the Daly glacier is meant the ice cap that covered the summit flat south of the summit cones. The summit flat ends with a distinct shoulder that edges the plateau, where the slope below increases to thirty degrees or more. The shoulder is at about the 10,500-foot level. Apparently the glacier overhung this shoulder and its drainage swept down 4000 feet to the plain below.

As other moraines are described on the northern parts of the summit area, the ice cap must have been seven or eight miles across. The Daly glacier was over three miles long, now represented by mutton-back ledges elongated to the SSW, scored heavily in grooves and polishings, the rock a smooth trachydolerite whitened by the weather and more or less covered by erratic bowlders. The bowlders are sub-angular, rounded and scratched. The mounds of morainic material make big whitish piles heaped along the mountain shoulder. The ledges are curiously broken up and plucked, as though by the freezing and thawing of snow ice of modern days. There are drainage gorges amid the moraines. The whitish glaciated area is in marked contrast to the red aa lava spurs and red cinder cones which bound it. As to the relation in age between these volcanic eruptions and the glacier, the upper part of the latter appeared to leave debris that was younger than the summit cones of the mountain, but some lower lava cones appeared partially to bury the glacial deposits. This is a matter that requires geologic mapping.

The plain of gravel, rounded bowlders and alluvium below is ten miles long in a WNW direction from Kalaieha, the sheep station, and at a slightly lower level is another series of flood plains about four miles long. The width of the upper plain is four or five miles. It is wonderfully flat, covered with winding stream channels of only a few feet depression, revealing in their banks an upper two or three feet of yellow or buff alluvium, over coarse gravel and stones below. The plain is covered with bunchy grass and scattered mamane trees. The streams appear to converge upward at a big diagonal gorge that led down from the glacier, and west of this are other gorges trenching the pyramid-like face of the mountain below the moraines. Some of the plain areas are bordered by terraces that suggest lake shores, consisting of old aa flows reshaped and partially buried by flood or lake action. The plains are so flat as to remind one of playas. The stones of the flood plain are identical with those of the glacier, and with nothing else.

The big wash plain where it butts against the steep face of the mountain makes a sharper angle in profile than the upper shoulder makes with the summit plateau. This summit plateau is far from flat and is interrupted by immense cones that appear 800 to 1000 feet high or more. These cones threw out bombs of viscous lava in almond shapes and of all sizes, they have cup craters, and aa lava flows emerge from them. The summit lake is at about the head of the Daly glacier. Towards the sheep station there appears to be a zone of cones suggesting the trend of a rift line. T.A.J.

ACTIVITY OF SANTORIN

H. S. Washington of the Geophysical Laboratory of the Carnegie Institution sends word from Greece that the well known volcano Santorin, near the island Thera of the Grecian Archipelago, is again in eruption. The new cone is back of an older one called Mikra Kaimeni, formed in 1573, and within the central group of island cones that recent eruptions have formed, this all being in the middle of a circular oceanic lagoon surrounded by an annular older island. With Professor Ktenas of Athens Dr. Washington is watching the eruption; on September 14 a high Strombolian cloud of steam was rising accompanied by continuous loud roaring and many blocks were ejected without much lava flow being visible.

On September 18 a definite cone had formed which these observers call Fouque' Kaimeni after the distinguished French savant who has monographed Santorin. They approached the cone September 17, but showers of red hot lava blocks prevented them from getting very near. The spectacle was magnificent. T.A.J.

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NO 44. RELEASED WITHOUT COPYRIGHT RESTRICTION October 29, 1925

KILAUEA REPORT NO. 720

WEEK ENDING OCTOBER 28, 1925

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

The large inner pit of Kilauea crater, Halemaumau, left 3500 by 3000 feet in plan and 1300 feet deep by the activities of 1924, remains inactive with reference to lava activity, but very hot in parts of its bottom and in its convectional emission of gas or vapor. There is little odor. The evidence of heat was striking on the late afternoon of October 26, after a thunder storm with torrential rain, when the vapor jets from all over the Kilauea floor were drawn inward toward a huge cumulus over the pit which billowed up to an immense height. Steam spouts or whirls have been common with the cessation of the trade-wind. With light south wind the gas from the pit nucleates the vapor jets north of it.

Slides have been small. For 15 minutes the morning of October 24 no single pebble fell. There are notable dry hot streaks in otherwise wet talus south and northwest where steam rises. The north and northeast walls have peeled the most showing fresh breaks and cavernous recesses.

The seismographs have registered 10 tremors of which six were pronouncedly of avalanche type and none was perceptible. Tilting was moderate SSE.

A WORLD CAMPAIGN OF EARTHQUAKE SAFETY

"If the seismologic control of the world were put in the hands of some superman with scientific knowledge and authoritative powers it is possible to imagine the way in which he would organize his forces and carry out his task. First of all he would not rest content with the scientific resources in his possession, but would provide for continuous investigation in order to re-examine constantly the knowledge already acquired and to add new information. He woud fit up well-equipped and competently manned centres for investigation. These institutions he would place in strategic positions throughout the world in such a way as to bring the widest variety of earth movements under constant scrutiny. He would further see to it that the staffs of these research centres were in constant communication so that duplication of effort would be avoided and the results secured in one place put quickly at the disposal of workers in all the other institutions. In this way he would organize geonomic research as a world activity, constantly recruiting his groups of investigators and producing steadily new knowledge about the nature and variety of tilts, level changes, tremors, quakings and wave movements, and especially the safe living of mankind with the cataclysms which afflict it."

With only a few words changed (hygienic to seismologic, etc.)' the above is the first paragraph of "International Public Health" by Dr. Vincent, President of the Rockefeller Foundation, in Caldwell and Slosson's "Science remaking the World." What is being done in public health may be done in LOCAL seismology, but this means the creation of just such an organization as the Rockefeller Institute of Medical Research to unite the world in defense against the earthquake "epidemics." All the succeeding measures advocated by Dr. Vincent apply equally to earth study: an administrative world preparedness and construction organization, a centralization of seismic statistics, a positive campaign of house to house education and of training experts. Avoidance of earthquake disaster does not mean stopping the earthquake, but as Mr. John R. Freeman has well said, "seventy-five per cent of the great losses of life and property in the earthquakes of the past could have been prevented by better building, and all within present economic means" (Earthquake Insurance, Manufacturers Mutual Fire Insurance Co., Providence).

It is one of the tasks of the Hawaiian Volcano Research Association to encourage LOCAL study of earth process about the Pacific Ocean. Taking the final paragraph reviewing the success of public health propaganda in Dr. Vincent's article, seismologic science is seen to be backward in comparison; "In the last half-century the scientific resources of modern medicine have been enormously enriched. The causes of a great number of devastating diseases have been discovered; the methods of controlling them have been worked out; medical education has been put upon a higher level; a beginning has been made in the training of expert sanitarians and an entire hygienic personnel. Organization of health administration has been greatly increased in efficiency. The death rates in all the leading countries of the world have fallen in a most gratifying fashion. Beginnings have been made in the education of the public, etc."

To paraphrase this, the scientific resources of modern LOCAL seismology have not been experimentally enriched; the causes of LOCAL earth movements have not been discovered; the methods of LOCAL earthquake-proof placing and construction have not been worked out; seismologic education is not in the school geographies, and except for a few men such as the late honored Professor J. B. Woodworth of Harvard there are few professors of the subject in the universities, and those not reaching the LOCAL, experimental and engineering sides of the subject; no beginning has been made in the training of expert seismic engineers and architects and a seismician personnel. Organization of LOCAL seismologic administration and statistics is still backward. The seismic death and destruction rate in all the earthquake countries of the world is increasing alarmingly without sufficient insurance control of congestion and conflagration, and hardly any beginning has been made in the education of the public.

In view of the colossal destructions of life and capital of the last quarter century this comparison is pregnant with possibilities for reform. The insurance companies are the logical agents to bring about the reform, for the situation affects every department of their business. T.A.J.

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NO. 45 RELEASED WITHOUT COPYRIGHT RESTRICTION November 5, 1925

KILAUEA REPORT NO. 721

WEEK ENDING NOVEMBER 4, 1925

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

On Saturday, October 31 there were rocks in motion falling from the north and west walls of the Kilauea pit Halemaumau. The north corner showed fresh red debris and dust on the slopes. The recently developed talus cone against the northeast intrusive sill lies below a niche in the wall that has scaled off so as to be bounded on the east by the rift dyke of 1919. On November 3 there were occasional slippings of wall rock SW, NW, and NE. These slides were very small. The steam rising at the west pocket of the bottom is livelier than elsewhere.

Thirteen seisms were registered, mostly little shocks, four were avalanche tremors. A local earthquake at 4:52 p. m. October 28 had indicated origin 8 miles southeast of the Observatory and was of the perceptible class. Tilt was moderate NNE.

TELLING THE AGE OF OLD LAVA FLOWS

It is impossible in Hawaii to guess at the relative ages of lava flows by the vegetation or any such landmark, because the different rainfalls in short distances produce strong differences in apparent weathering and plant growth.

Nature (Oct. 3, 1925, 515) cites M. R. Chevallier who worked on the lava flows of Etna and showed it to be possible "to determine the magnetic declination at the time the lava solidified by observing the direction in which it is now magnetized" (Annales de Physique, July-August 1925). The magnetic declination or compass variation from the true north slowly changes through the centuries at any one place, so that a given year has a characteristic declination.

Chevallier took the average direction of polarity of several pieces of lava from a flow just as they lay, and therefrom obtained a satisfactory agreement with the declination of the year 1911 for the 1911 flow; and with the declination of 1669 for the 1669 flow. This appears to mean that a majority of the crystals of magnetite oriented themselves to the earth's magnetism before the flow congealed. When the declination values so obtained from specimens of earlier lava flows of known dates were plotted, the curve obtained continued the known declination curve of the Etna region symmetrically backward, passing zero declination about 1630, through 18 degrees east about 1440, and through zero again toward westerly variation about 1240. The time intervals from zero to zero are nearly equal and the extremes of declination east and west are the same. These results appear worthy of laboratory experiment on slags containing magnetic minerals. T.A.J.

BUILDING FOR EARTHQUAKE SAFETY

The natural period of vibration of the Claus Spreckels building in San Francisco is 2.3 seconds, about twice that of the ground in a destructive earthquakes. In 1906 the walls were most damaged about the 13th floor, two thirds of the height up. The buildings in Santa Barbara on the other hand had short vibration periods less than that of the ground, and their frames and walls suffered most in the lower stories (Dewell, Building against earthquake shock, The Commonwealth, Sept. 1, 1925, published by the Commonwealth Club of San Francisco).

Block construction is inherently unsatisfactory against earthquake. Dewell lists earthquake-proof construction in order of excellence: first, structural steel frame and reinforced concrete walls; second, ferro-concrete buildings of small height; third, structural steel and brick walls; fourth, reinforced concrete frame and brick walls; fifth and weakest terra cotta buildings without structural frame. All these are fire-proof.

On solid elastic ground the wooden house properly founded and braced suffers only broken chimneys and cracked plaster. But it can be greatly improved. We pile one story on another without continuous members. We could make wooden buildings immune to earthquake if we used the "balloon" framing, with vertical studding continuous, with diagonal bracing continuous cut and nailed into the studs, with floor-joist ends spiked into the studs; and with heavy metal lath instead of chicken-wire in the plaster, this metal reinforcement properly tied at the joints, in plaster thickened using good Portland cement; such construction might increase the cost ten per cent and be opposed by the craftsmen, but it would give the owner of a residence a feeling of real security.

Since 1906 San Francisco has been "letting down the bars." Wind pressure resistance has been reduced from 30 pounds to 15 pounds, and this is earthquake resistance also. Office buildings that resisted the 1906 shock were designed for a floor load of 75 pounds per square foot. Today they are designed for 40 pounds. "Recently the ordinance has again been revised to allow an increase in the permissible unit stresses for structural steel of 12½ per cent, saving one eighth the steel formerly required." Buildings are very much weaker, reinforced concrete is of poor quality, schools are of hodge-podge construction, low cost apartment houses and hotels are being built with light ferro-concrete frame and timber interiors, and another earthquake of the severity of that of 1906 will throw down stores, schools, churches, offices, hotels and apartments. Mr. Dewell concludes that the Californiia public needs to be warned. The warning should be taken to heart away beyond California. T.A.J.

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NO. 46 RELEASED WITHOUT COPYRIGHT RESTRICTION November 12, 1925

KILAUEA REPORT NO. 722

WEEK ENDING NOVEMBER 11, 1925

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

There is nothing new to report of volcanic or other activity in the Hawaiian volcanoes. They are dormant. Halemaumau pit sent up dust clouds due to avalanches at 9:20 and 10:26 a. m. November 5th from the north side. Fresh red and gray debris was left on the northern slopes.

Twelve local earthquakes were registered, two of them avalanche tremors, and one at 10:44 p. m. November 5 indicated an origin distant 13 miles probably to the NW. This was felt at Volcano House and in Hilo. The long waves of a strong distant earthquake were registered at 3:35 a. m. November 10. Tilt for the week was slight to SE.

A BUSINESS APPRAISAL OF EARTHQUAKE DANGERS

The following paragraphs are from "Earthquake Insurance," a forty-one page pamphlet issued by the Manufacturers Mutual Fire Insurance Co. and five associated companies with headquarters at Providence, Rhode Island, offering "a new service of earthquake coverage for the peace of mind of those already insured in this company who realize that a destructive earthquake can happen in New England or the Mid-west, with as little warning as at Charleston, S. C.,, in 1886."

"Seldom or never has destructive violence extended farther than over spots in a narrow tract, rarely so extensive as 10 miles wide by 50 miles long."

"There is an immunity from tornado and windstorm and lightning loss in the Pacific coast localities, that will go far toward offsetting additional earthquake hazard."

"It is hoped to develop recommendations for obtaining maximum resistance to earthquake shocks, somewhat as heretofore our engineers have developed many aids to fire-resisting construction."

"After a period of activity the internal stress becomes relieved, and there is a long period of quiet."

"The cause of earthquakes is now well established as being a slight slip of a great mass of bedrock, of many cubic miles in quantity."

"Earthquake damage comes nearly always from the elastic oscillation extending out several miles on either side of the deeply buried rift."

"Greatest damage is nearly always found near the border line, between original hard ground and soft marshy ground or 'made land'."

"Earthquakes of greater or lesser intensity somewhere in the world are occurring almost daily." This is an understatement; the average is of the order of 2000 shocks per year on recorded ground, and more than 80 per cent of the world's surface is uninhabited and unknown.

"It was not until about 25 years ago that the modern science of earthquakes, or seismology, was fairly started."

T.A.J.

AMERICAN EARTHQUAKES IN 1924

An earthquake sheet published by the Safe-Cabinet Co. of Marietta, Ohio, makes a serious statement of the congestion-earthquake-tornado-fire menace, which is reliable:

"Two of the greatest fires in history have occurred in the last twenty years as a direct result of earthquakes, those of San Francisco and Tokyo."

"Modern civilization is responsible for the grouping of great numbers of people in one community. It is also responsible for the vast number of fires grouped into these communities for cooking, heating and industrial purposes." It might have added transportation, for every motor-car is burning gasoline.

"The following table, compiled by F. A. Tondorf S. J., chief seismologist of Georgetown University, covers the earthquake record of the U. S. for 1924.

Winchester, Va.,	Jan. 1	Salinas, Cal.,	May 26
Greenville, S. C.,	Jan. 1	Walla Walla, Wash.,	May 27
Florence, Alabama,	Jan 1	Santa Rosa, Cal.,	July 6
Orderville, Utah,	Jan. 1	Brawley, Cal., (2),	July 17
Los Angeles, Cal.,	Jan 2	Eureka, California,	July 17
Salinas, California,	Jan 4	Brawley, California,	July 18
Stanfield, Oregon,	Jan. 5	Yellowstone, Wyo.,	July 20
Walla Walla, Wash.,	Jan 6	Yorba Linda, Cal.,	Aug. 26
Milton, Oregon,	Jan. 6	Santa Rosa, Cal.,	Sept. 1
Eureka, California,	Jan. 9	Eureka, California,	Sept. 7
Yellowstone, Wy.,	Jan. 11	Summerville, S. C.,	Sept. 26
Santa Clara, Cal.,	Feb. 9	St. Johnsbury, Vt.,	Sept. 30
Seattle, Washington,	Feb. 10	Calexico, California,	Oct. 2
Calexico, Cal.,	Feb. 13	Calexico, California,	Oct. 3
Summerville, S. C.,	Feb. 14	Julian, California,	Oct. 7
Cairo, Illinois,	March 2	Columbia, S. C.,	Oct. 20
San Francisco, Cal.,	Mar. 3	Landover, S. C.,	Oct. 30
Spreckels, Cal.,	March 9	Los Gatos, Cal.,	Nov. 12
Spreckels, Cal.,	April 2	Salinas, Caliornia,	Nov. 13
Paducah, Kentucky,	April 2	Geneva, Idaho,	Nov. 24
Clarksville, Tenn.,	April 3	Montpelier, Idaho,	No. 25
Monterey, Cal.,	April 3	So. Pass City, Wy.,	Nov. 25
Yosemite, Cal.,	April 4	Roanoke, Va.,	Dec. 25
Kalispell, Montana,	April 9	Salinas, Caliornia,	Dec. 27
Hayward, Cal.,	April 11	Hayward, Cal.,	Dec. 28
San Jose, Cal.,	April 22	Salinas, California,	Dec. 29
Seattle, Wash.,	April 25	Santa Barbara, Cal.,	Dec. 30
Calexico, Cal.,	May 23	Rapid City, S. D.,	Dec. 30

T.A.J.

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NO. 47 RELEASED WITHOUT COPYRIGHT RESTRICTION November 19, 1925

KILAUEA REPORT NO 723
WEEK ENDING NOVEMBER 18, 1925

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

Volcanic activity remains dormant in Hawaii, but other parts of the world appear to be having large earthquakes. Three such distant earthquakes were recorded on Observatory seismographs. The one beginning at 1:34 a. m. November 16 had an indicated distance of 3200 miles, equivalent to that of Kamtchatka or Mexico.

The only changes in Halemaumau pit have been peelings of the wall at the north, at the west end of the gray sill in red ancient lavas, dumping red and gray debris on the slope below. This has cut away the shelf that formerly was topped by a high talus over the west horn of the sill. There was odor of hydrogen sulphide at the northeast rim November 17.

Eight local seisms were registered, none perceptible. One on the 13th at 5:30 a. m. appeared to originate 16 miles away by seismogram measurements. Tilting of the ground was slight to the NNE.

INTERIOR OF MAKAOPUHI CRATER

On November 16, 1925, a party from the Observatory, (Stone and Finch) visited the pit crater of Makaopuhi eight miles southeast of Kilauea. The descent into the lower pit was made with little difficulty. It is apparent that at some former time the western wall of the crater closed around what is now the eastern "mezzanine floor." The collapse which formed the present western pit exposed a section through the older floor. At the surface are four pahoehoe flows with an aggregate thickness of perhaps 20 feet underlain by a massive lava fill at least 100 feet thick. Beneath the fill is a layer of red cindery material marking the old floor. The upper part of this fill has developed a very regular, vertical, prismatic jointing; the lower portion also has prismatic jointing but dipping west as if it were normal to the former crater wall High up on the massive rock of the exposed lava fill is a patch of bright blue-green, which has given the name "Makaopuhi" ("eel's eye") to the pit. More of the green coating was found on the enormous talus blocks in the bottom of the pit and has been determined to be the basic copper sulphate, brochantite.

The flow of 1922, which issued from a straight northeast trending fissure in the western wall, covered the bottom of the pit with a jagged layer of mostly aa. Steam issues from a number of cracks and there are sulphur patches on the talus against the western walls. Several small dikes were seen low down in the southwest wall. Approximately the lower quarter of the 900-foot wall is concealed by talus, but in the remaining section no ash beds were visible. J. B. Stone.

MONOGRAPH ON TOKYO EARTHQUAKE

The Imperial Earthquake Investigation Committee of Japan has issued three volumes of its reports in Japanese on the earthquake of September 1, 1923. (Sinsai Yobo Tyosakwai Hokoku, 100A, 100B, 100E, Tokyo 1925. Professor A. Imamura, Secretary of the Committee, Imperial University, Tokyo, has already issued in English a preliminary note in Seismological Notes No. 6.)

Imamura contributes the leading article on seismology of the earthquake followed by a second statistical and mathematical discussion by Saemontaro Nakamura of the Meteorological office. These are followed by special studies of phenomena observed in different prefectures, damage to wooden buildings compared in different places by Matuzawa, aftershocks in Tokyo and Oshima by Yasuda and Seizi Nakamura, relative intensities in different places by Nasu, personal experience near Kamakura by Abe, and list of casualties

The second volume deals with geology, physical geography, land changes in elevation and triangulation, and tidal waves. Kato and Yamasaki are the leading geological authors. Seizi Nakamura presents a survey of Oshima volcano. Imamura discusses the coast line changes of the Boshu peninsula and the mud flow of the Nebukawa. The maps and charts are intensely interesting showing the changed profiles, the places where cables were broken, the numerous epicenters, the progressive changes in railway levels in all directions from Tokyo and Yokohama, the depression area in the middle of Sagami bay and the raised areas opposite the peninsulas. Faulting appears to have been complex, and of the tilted block type so characteristic of the old volcanic mountains of the Connecticut valley.

The third volume deals with an exhaustive engineering, physical and economic research on the conflagration. This ought to be translated piecemeal by insurance bureaus and engineering societies until it is well known in the American business world. Photographs are reproduced showing the terrifying heaps of tens of thousands of corpses in the Honjo yard. The succession of maps showing the fire nuclei anl the successive stages of merging conflagration, and other maps showing scores of tornadoes that developed, are most instructive. Professor Seizi Nakamura of the Physics department of the Imperial University organized students into a fire investigation corps immediately after the disaster, and his chartings form the bulkiest parts of this exhaustive work. Some of the diagrams in these volumes have English titles, a practice to be commended if such invaluable monographs are not to be issued in the English series. We hope however that the whole of it is to appear in English; it is needed by economists, geologists, actuaries and engineers. T.A.J.

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NO. 48 RELEASED WITHOUT COPYRIGHT RESTRICTION November 26, 1925

KILAUEA REPORT NO. 724

WEEK ENDING NOVEMBER 25, 1925

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

At Halemaumau, the lava pit of Kilauea, nothing new has developed. During a period of two hours on the forenoon of the 21st three slight slides from the walls in different places were heard The next dav dust was seen occasionally. On the 24th in the forenoon nothing but slight trickle of gravel was noticed, but in the afternoon a dust cloud rose from the pit. Today the 25th after noon the weather was damp and clouds hung low, there was abundant vapor in and about the pit, one slide and two or three light falls of stones were seen in a quarter-hour from the northern walls, and dense steam at the south talus was hot and unusually blue with sulphur gas.

Eleven seisms were recorded for the week, six of which were of the avalanche type. All were too small to be perceptible. Tilting of the ground was slight to the SSW.

ISOSTASY

This Greek word means *the balanced stand* between the land and sea-bottom parts of the earth crust A condition of such balance is proved by gravity measurements. The continents are light and the sea-bottom rocks are heavy. Sandberg has added the notion that the loss of heat and importation of heat at different crustal blocks may effectively change gravity relations, so that an area of mountain erosion may go down beneath the sea, and one of basin accumulation of sediment under the ocean may emerge and become eroded. ("Isostasie, and the causal unity of mountain-building and volcanism," in German, by C. G. S. Sandberg, Gebr. Borntraeger, Berlin, 1924.)

The fact that such revolutions of sea and land have happened has been one of the stumbling-blocks to theory. The surface of the earth was at one time molten. It was not uniform, so that some blocks solidified first. As solid rock is heavier than its molten gassy magma it tends to sink. In the primitive paste stresses were set up between the thicker blocks that sank lowest and the later ones. There was thus a primitive topography, the lowest and thickest blocks being the ocean basins. Then came water condensation and erosion, the high lands being worn down and lightened over the paste below, the depressions being filled and weighted. The lowest and thickest blocks were thus made still thicker, and the highest and thinnest still thinner. Gravitative isostasy keeps a floating balance, and the weighted blocks sink lower and the eroded blocks rise. But geological history shows that periodically basins full of thick sediments have swollen, wrinkled, thickened and lightened, so as to rise into mountain ranges.

Here comes in thermal isostasy. The balance between heat acquired at the bottom of the crust blocks, and heat lost at the surface determines that in the erosion area the bottom of the crust is cooling. In the sea-bottom, blanketing with muds, the bottom of the crust is heating. Under the erosion area, the bottom of the crust is thickening. Under the other, its bottom is melting. Also the heated mantle of water-charged sediment expands through both rock and steam distension, increases in bulk and decreases in density. This expansion folds the strata and along with the isostatic adjustment set in motion, it lifts the area of sedimentation above the sea. The erosion area near base-level is wearing more and more slowly anyway, and the material worn off makes less and less addition to the basin. The strongly developing thermal activity is all that is needed to upset the balance. The thickened and heavier crust under what was the eroded area sinks, and the melted off and lightened crust under the basin rises. All of this imagines a definite crust and a definite pasty substratum, without attempting to define the viscosity. By "bottom of the crust" is meant the contact side of a crust block with the hot paste beneath.

Sandberg believes that active volcanism and folding of strata are both products of this heating up of sediments in basins, with the water of sedimentation furnishing physical and chemical reactions quantitatively sufficient, according to the depth of burial. He conducts experiments in the distension and folding of a sheet of asphalt, subjected to hydrostatic pressure and release. We follow him so far as volcanism applies to mountain-folded regions, but we believe there is more primitive volcanism still active in the oceanic basins, connected with the substratum itself. Sandberg illustrates mechanism whereby big overturned folds may pile up, with igneous matter at their cores. He calls this "regenerated" or "vitalized" magma. He believes that both mountain-building and volcanism would wane or disappear or become only periodic in a world losing its air and water. This he thinks happened to the moon, and he thinks the great craters on the moon themselves prove that it once had air and water. T.A.J.

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NO. 49 RELEASED WITHOUT COPYRIGHT RESTRICTION December 3, 1925

KILAUEA REPORT NO. 725

WEEK ENDING DECEMBER 2, 1925

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

There has been nothing whatever of volcanic activity in the Hawaiian pits for the week, other than vapor and sulphur fume as usual. Halemaumau at Kilauea continues to sleep. The pits to the east such as Aloi, Alealea and Makaopuhi, and the field of 1923 lava west of the latter, give up steam and some sulphur. The 1920 fissures in Mauna Iki in the Kau Desert are hot enough to light wood. Fissures in and near Mokuaweoweo, the summit crater of Mauna Loa, are hot and sulphurous. Tremors local to the crater regions indicate that something below stirs. No great tilt of the ground inward since the lava was in Halemaumau in July, 1924, but rather at present a tilt outward or away from the center, indicate that the underground lava is either stagnant or rising. A poised slab of the rim of pit was found to have fallen November 28th.

For the week ending this morning 14 earthquake movements were registered, all small and imperceptible, with three of the avalanche type. Coincidental with a cool spell beginning the 26th there was marked NE tilt. The net tilt for the week was strong NNE. Seasonal tilt in this direction is expectable in the winter.

INTERNATIONAL VOLCANO REPORTS

The second and third volumes of the Bulletin of the Section of Volcanology of the International Geodetic and Geophysical Union, covering the last quarter of 1924 and the first two quarters of 1925, are published. (Prof. A. Malladra, Royal Vesuvian Observatory, Resina, Naples, Italy, 30 francs a year).

The office of publication of this quarterly has now been definitely established at the University of Naples. The second volume promised that a full account of volcanology at the Madrid meeting of the Union would appear in the next volume, but it did not appear. This was in October, 1924, and the report of the general meetings has appeared, published in Toulouse, 1925, with hardly any mention of volcanology.

The articles in the second and third Bulletins are very interesting. In the second, Matsuyama reports very briefly on gravity measurement with Eotvos balance across Sakurajima and Unzen in Japan. He finds changing density, apparently across country. At Unzen these changes are not radial to the volcano, but in parallel belts NE-SW. At Sakurajima the gravity changes corresponded somewhat to the subsided areas of the eruption of 1914. He makes the extraordinary statement that the area of subsidence there, proved by precise levelling, has recovered its former level.

In the third Bulletin H. Tanakadate reviews the activity of 18 Japanese volcanoes from 1914 to 1924. Of eight recognized volcanic belts in Japan all but two have had activity in the decade that ended with the Tokyo earthquake. In the five belts of volcanoes that converge on central Japan, ten volcanoes erupted, Tarumai, Komagatake, Kattadake, Asama, Yakedake, Hakone (tremor spasm), Oshima, Bayonnaise Rock, Smith Rock, and Minami-Iwozima. In the numbers of volcanic events tabulated the maxima were in 1914, 1919 and 1923. Apart from earthquake there were 17 and 15 events in 1919 and 1923. The activities extend all the way from the Kurile Islands to the Loo Choo group.

Another paper in this volume is by A. Lacroix on the island Reunion near Madagascar. The active lava crater is at the southeastern end of the island, a U-shaped amphitheatre sloping to the sea, with numerous inner craters always different as seen by a succession of travellers. The activities are very frequent, and mostly quiet lava flows. There have been one or two explosive eruptions, very exceptional, just as at Kilauea. The flows are both aa and pahoehoe, aa being called "gratons" or scratchers. To show how frequent are the lava flows, fourteen different years exhibiting some activity are cited for the twentieth century. Most of the flows are from fissures and the top crater is a pit from 700 to a thousand feet wide and variously filled up or evacuated. All the "cow-dung" splashes of lava, bombs, Pele's hair and glassy types of basalt with iridescence are like Hawaii. T.A.J.

SUBMARINE LANDSCAPE OFF HAWAII

Hawaii is very wonderfully situated for scientific experiments with the sea-bottom. Could one look east from Hilo and drain away the ocean, a vast flattish territory would be seen 18,000 feet below and only thirty nautical miles away, with perhaps some big volcanic domes here and there like Hualalai. In the foreground would be a ragged mountain slope with remnant beach lines. The observer would be far up an enormous mountain range, bigger than the Himalaya, and he would have nose-bleed and nausea, for he would be up towards the top of the sea of breatheable air. The atmosphere would have filled up the space of the lost ocean. We could no longer live in Hilo, unless we developed the wonderful lung capacity of some of the tribes of the Andes.

We want to sound by echoes and discover those lost volcanoes. We want to bore into that great plain and get cores of the rock. Is there oil, iron, copper, sulphur, manganese, radium or selenium in vast quantities there? No man knows. No one has ever prospected the ledges of the deep sea, 72 per cent of the earth's face. If we lay a delicate magnetic instrument on the bottom, electrically connected with Hilo by cable, and thoroughly sealed, is the magnetism extraordinary? If we swing a gravity pendulum in a closed case on the bottom, is the rock enormously heavy? Pendulum work many years ago suggested that the matter under the Hamakua shore is twice as heavy as the stuff under Mauna Kea. Does it not get heavier as we go out under the sea? If with our cable attachments we operate a very delicate seismograph in a vacuum on that bottom land, so that the slightest tremblings or tilts of that wonderful country are written as autographs in the Hilo laboratory, day and night all the year around: will not this be exploration to make the north pole look tame?

Why go to remote lands when the greatest discoveries in the history of science and invention are within the reach of engineering experiment, a sampan sail of thirty knots from Hawaii? (Address Hilo Rotary Club November 11). T.A.J.

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NO. 50 RELEASED WITHOUT COPYRIGHT RESTRICTION December 10, 1925

KILAUEA REPORT NO. 726
WEEK ENDING DECEMBER 9, 1925

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

The past week has exhibited a marked revival of felt local earthquakes, such as has not been registered here for some months, but as yet nothing has occurred of volcanic activity on either Kilauea or Mauna Loa. There was considerable avalanching in Halemaumau before the earthquake spell began.

In a quarter-hour from 9:45 to 10 a. m. December 3 four slides fell from the western and northern walls of Halemaumau. The wind was light SSE. The walls were wet and steaming in several places though there had been no rain. The slides were small but started suddenly from high up the walls and made trails of rocks and dust, especially about the southwest rift outcrop. The walls were much more in motion than at any time recently. There were trickle cascades of sand in motion on the west wall. Soon after noon the next day big clouds of dust rose from the pit and the seismogram at 2:31 p. m. showed a long earthquake movement coinciding with an extra big avalanche.

On the 5th there was a large scar in the west wall, cascades of black sand were continuous four fifths of the way up the wall, and there was fresh red debris below and dust clear across the bottom obliterating the sulphur stains.

Two strongly felt shocks occurred about 9:30 a. m. and 12:45 p. m. each dismantling both of the seismographic instruments. The first set off a small slide at the pit, but in the afternoon the pit was very still and sleepy. On the 7th at 2 p. m. there were again sand cascades on the west wall and slides occurred several times during the day. An earthquake at 10:16 p. m. December 8 was prolonged but gentle and a lighter shock occurred at 11:48 p. m.; both of these were felt at Hilo. The indicated distance was 9 miles SE of the Observatory.

Eighteen earthquakes were recorded during the week of which one was of the avalanche type and four were perceptible. The two of December 6 appeared to have origins very near, only two miles away. A strong NNW tilt accompanied the quakes of that day and the tilting of the week was moderate NW. A dog showed alarm and pheasants squawked during the first earthquake of the evening of December 8.

TIDAL WAVES

The disastrous sea-waves that go by this name are of various origins, and they do their damage on shelving shores. The most common are occasioned by big earthquakes on the bottom of the ocean. Some are occasioned by volcanic disturbances of the sea-floor. Others are due to typhoon storms with greatly depressed barometer such as occur in the Bay of Bengal. (Materiaux pour l'etude des Calamites, No. 4, Geneva, Jan.-March, 1925, Les Raz de Maree, by C. Vallaux, p. 333).

The waves are distributed rather markedly about the Pacific and the Mediterranean belts, including the tropical East Indies and the Caribbean. The Atlantic coasts are remarkably free from tidal waves, excepting the Cape of Good Hope and Ascension Island. An active zone of submarine eruptions between Africa and South America does not, however, make tidal waves on those coasts.

Peru and Chile have suffered much from tidal waves. These are accompanied usually by earthquakes that are felt. The people pay little attention to this, but look for the "negative wave," that is, the retirement of the sea as a first sign. But frequently the first movement is a positive wave or rising water, usually smaller than the succeeding negative one. On the 28th October, 1746, a terrible earthquake that destroyed Lima in the interior, also made a terrific wave on the coast, as did the Lisbon earthquake of 1755. The Lima wave finished the destruction of Callao already begun by the earthquake. The sea retired slowly and returned with a roar. It swept everything before it. There were twenty three ships in port most crushed and sunk, but the largest were carried beyond the walls of the city, four vessels, and left in the fields. The sea swung back and forth several times. Of 4900 inhabitants, only 200 escaped. Great quantities of sand and pebbles was swept over the ruins from the wash of landslips made in the harbor islands by the earthquakes and subsequently transported by the waves.

Darwin described the tidal wave at Valdivia in 1835, again following a severe earthquake, as producing a quiet rapid rise and rapid fall. During aftershocks there were curious and complicated currents in the harbor. At the port of Concepcion, which city was damaged by the earthquake, great flocks of sea-birds were seen flying inland. Thirty minutes after the earthquake the sea retired so far as to strand ships in 7 fathoms of water. All the reefs came into view. Then the return wave poured in thirty feet above high tide. Two others followed, some minutes apart, and progressively bigger. Then for several days there were small oscillations. There were said to be eruptions out to sea.

At Arica in 1868 there was an earthquake about 5 a. m. August 13th and twenty minutes afterwards there came inward a wave two or three meters high. Then the sea went out for a mile and the inhabitants fled to the heights. An enormous wave returned more than 17 meters above high tide line and carried two ships a mile into the interior of the country. Several oscillations a quarter of an hour apart followed. This wave did damage even on the New Zealand coast across the ocean.

The two most murderous waves of this sort were the Krakatoa wave of 1883 near the Strait of Sunda on the Java shore, and the Kamaishi wave on the east coast of Japan in 1896. They drowned respectively 30,000 and 32,000 people. The Krakatoa waves appeared to be due directly to the gigantic engulfment of the island that went with the volcanic eruption, an affair of three huge explosions in two days. The waves bombarded the adjacent coasts of the strait, the largest 22 meters above tide, and a succession of them kept going about a half-hour apart. They flattened out in a very short distance, for they were not large at Batavia, just a short distance away.

The Kamaishi wave was a positive inundation of from 6 to 15 meters, the earthquake occurring far out to sea. It was not felt. The fishermen at sea in their boats knew nothing of the tragedy until they returned to their homes to find the flat shore devastated. T.A.J.

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NO. 51 RELEASED WITHOUT COPYRIGHT RESTRICTION December 17, 1925

KILAUEA REPORT NO. 727

WEEK ENDING DECEMBER 16, 1925

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

T. A. Jaggar, Official in charge.

The spasm of seismic intensity registered last week has this week died away. No activity has yet appeared in Kilauea or Mauna Loa.

Visits to the pit in dry weather have discovered much wetness of the walls with steam. Steam crack belts in and outside the pit notably accord with the southwest rift direction. Small stones fall most of the time from the north wall. Avalanche dust arose December 13 at noon. There is some sulphur odor and sulphur spots are reappearing on the bottom through the avalanche dust of a week ago. Steam is increasing at the southwest wall.

Twelve very feeble earthquakes were registered, lessening in amplitude and frequency. Microseismic motion increased about the 15th. Most of the quakes were mere tremors.

PREDICTION OF TIDAL WAVES

In the discussion quoted last week from Vallaux, (Materiaux p. calamite's No. 4), some interesting data are given about the Fosse de l'Hirondelle, a supposed submerged volcanic crater northwest of Saint Miguel in the Azores. This and other submarine volcanoes are believed to be the source of some dangerous tidal waves known as tide rips which occur on the coasts of Cornwall and Brittany. At places where the depths shallow rapidly near shore, a succession of sudden, brief, big waves develop without any relation to the weather or earthquakes. These change by interference into big swells that break on the shore, sweep everything and frequently drown people, and retire equally quickly. A family of five were drowned in this way near Land's End in 1870.

Vallaux remarks that there is no hope of predicting tidal waves successfully or of learning anything from experiment. In view of the very successful experiments on harbor reactions in Japan and of valuable forecasts from seismograms in Hawaii seven or eight hours in advance, we do not feel so pessimistic about it. (Prediction of tidal waves, by R. H. Finch, Monthly Weather Review, Washington, March, 1924, p. 147). Even with regard to long range forecasting of submarine earthquakes, there are seasonal effects which Perret has pointed out, (Science, August 28, 1908, p. 277). Vallaux thinks typhoon tidal waves are entirely hopeless, yet Father Algue' in the Philippines has repeatedly demonstrated that typhoons are entirely predictable, their courses are charted in great detail, and the waves that result are quite calculable by experience. T.A.J.

METAMORPHISM DUE TO MAGMA

Sandberg has introduced the word "magmamorphosis" into geology (Geodynamische Probleme, II, Tektonik und Metamorphose, Borntraeger, Berlin, 1924), meaning all kinds of heat and pressure recrystallization, in sedimentary rocks which have subsided and been buried to depths where the contained water was heated by magma or underground lava. This theory is in line with Sandberg's conception of a volcanic substratum everywhere under the earth's crust. (See Volcano Letter No. 48).

The remarkable accordance of the direction of strike of gneisses and schists with the margins of granite bodies, the interpretation of hornblende schists and serpentines as altered sediments rather than eruptives, the analysis of "regional metamorphism," heat metamorphism and "dynamo metamorphism," the obvious chemical relations of "contact metamorphism"—these being the different forms of recrystallization of deeply buried sedimentary rocks—all these phenomena are a part of the genesis of folded mountains, and the fundamental cause is the "activating" of magma.

All folded mountains must contain magmatic cores if we go deep enough. Magmamorphosis is the interaction of such magma with the sediments. This produces effects in both minerals and structure. The operation of magmamorphosis is strictly limited to geosynclines—that is, to troughs which have deepened while receiving erosion products from adjacent land until the sedimentary mantle itself reached the bottom region of the earth's crust. Here thermal isostasy asserts itself by rock expansion, water expansion and intrusion of substratum matter. The magmamorphism introduces an episode which itself conditions the production of mountain folds. Beyond the range of gas and hydrothermal action there may still be enormous compressions and folds due to the gliding of masses of sediments, from higher to lower positions on the flank of the swelling geosyncline. T.A.J.

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NO. 52 RELEASED WITHOUT COPYRIGHT RESTRICTION December 24, 1925

KILAUEA REPORT NO. 728

WEEK ENDING DECEMBER 23, 1925

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

R. H. Finch, temporarily in charge.

The walls of Halemaumau are again very red. The red is more extensive than has been observed for a long time and even several of the talus slopes are very brightly colored. Steam from the numerous vents in the pit has been abundant. Rock falls, especially from the northwest wall, are frequent.

Six earthquakes were recorded during the week. The one at 3:37 p m. December 19 was felt locally and at Olaa. Its indicated distance to origin, 9 miles, is the same as that of the shakes of December 8. Tilting was moderate to the southeast.

Coincidental with the beginning of the Kona wind there was a marked increase in the amplitude of the microseisms as registered by all the seismographs on the island.

THE SOUTHWEST RIFT OF MAUNA LOA

An Observatory party recently returned from spending several days on the southwest slope of Mauna Loa with E. G. Wingate, topographer of the U S. Geological Survey, who is now engaged in mapping that portion of the mountain. The Wingate camp is in a lava tube at an elevation of 9940 feet on an ancient Hawaiian trail. The trail roughly follows the 9900 foot contour and shows evidence of having been extensively used in former times.

Mauna Loa is certainly a mountain of contrasts. Starting up from sea level on the Kona or western side of the mountain one first encounters a hot arid belt. With further increase in elevation one traverses in succession a belt of moderate rainfall with a heavy vegetal growth, one of heavy rainfall with a tropical jungle, then moderate rainfall with open forests and one reaches the timber line which is limited by both cold and moisture at about 8,000 feet. The mountain is quite arid beyond the 8,000 foot level though there seems to be a slight increase of precipitation beyond the 10,000 foot contour over that of the 8,000 to 10,000 foot belt. An ohia tree (metrosideros polymorpha) over one foot in diameter was noted at an elevation of 8200 feet and smaller ones of the same variety can be found several hundred feet higher.

Leading southwest from Mokuaweoweo, the central crater of Mauna Loa, is a great belt of fissures from which have poured numerous lava flows both recently and long ago. This rift belt has a slight southerly curving tendency which is especially noticeable about 20 miles from Mokuaweoweo. Its total length is about 35 miles and in many place it is over two miles wide. The counterpart of this rift on the northeast slope of Mauna Loa seems to terminate about 15 miles from Mokuaweoweo.

Activity, marked by vari-colored cinder cones, lava spattered cracks, and long arms of aa (clinkery) or pahoehoe (smooth) lava flows, has taken place from numerous vents along nearly the entire length of the rift. While many of the lava flows reached the sea the majority issued from vents between the 3,000 and 13,000 foot contours.

The sequence of events in the 1919 flow from Mauna Loa is rather typical of the lava flows from the southwest rift. Acompanied by earthquakes the southwest rift zone became active and the ground began to crack open. On September 26 lava broke out at an elevation of about 11,000 feet. This outbreak, which lasted but a few hours was accompanied by fiery fountains and produced a very frothy lava flow. The cracking appeared to progress down the mountain and on September 29, the main lava flow broke out 11 or 12 miles from the upper site at an elevation of 7,700 feet. A stream of molten lava reached the sea, 14 miles away, in about 24 hours and continued to pour into the ocean for 10 days. Thereafter the volume of the output diminished and activity was confined to shorter flows around the source region. The fire fountains occasionally were as much as 400 feet high and built up a cone 250 feet above the former ground level All activity appeared to cease during the first week in November.

The rift belt may be reached at several places from both the northwest and southeast side without encountering much aa lava. By leaving the timber line at a point above the Komakawai water hole in Kona and travelling almost due east one reach the site of the preliminary outbreaks without having to traverse over 1000 feet of aa lava. In recent years there have been several preliminary outbreaks all the way from the 11,000 foot elevation to the summit crater. Between the 11,000 and 12,000 feet elevations the rift is marked by brilliant sulphur deposits and hot steaming cracks, and is covered by fresh pahoehoe lava

The thin covering of new lava at the upper vents appears to rest on very old lava In fact all the lava flows on the southwest half or Mauna Loa may be put into two classes —recent (within the last 100 to 150 years, say) and old. There is no uniform gradation between the youngest and oldest lavas.

Exploration of the summit of the mountain and along the rift line as low as 12,000 feet (lower when the mountain is covered with snow) is greatly facilitated by the fact that many of the cracks contain snow, ice, and water. Some are so deep and narrow that a line is necessary to lower a container to the water pocket.

The sunset effects over clouds produced by both land and sea breeze and tarde wind currents is truly wonderful. It is similar and perhaps less majestic than the view from the proposed Mauna Loa road terminus on the rim of Mokuaweoweo.

R.H.F.

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NO. 53 RELEASED WITHOUT COPYRIGHT RESTRICTION December 31, 1925

KILAUEA REPORT NO. 729

WEEK ENDING DECEMBER 30, 1925
Issued by the Observatory, U. S. Geological Survey:
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No renewal of activity nor of seismic action heralding activity has appeared after the December solstice at the Halemaumau lava pit of Kilauea volcano. Everything remains placid at the end of the year. At 11 a. m on December 27th no rock falls were heard during a visit to the pit, and steam was abundant especially from the southwest half of the bottom region and walls. On the 29th a few small dust puffs rising from the cauldron during the day gave evidence of slides. Today, the 30th, dust in small amounts rises frequently, steam is conspicuous along the south rim of the pit and from the southwest half of the interior, and at the edge in the forenoon sulphurous odors were noticed, possibly hydrogen sulphide. On the northeastern wall above the great intrusive sill a coating of white sulphates has recently blossomed out on the face of the rock.

For the week ending December 30 nine local earthquake movements were registered on the Observatory seismographs, all too feeble to be perceptible. Tilting of the ground was slight towards the west.

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COMPOSITION OF HAWAIIAN LAVAS

In a recent copy of the Extension Letter of the University of Hawaii attention was called to the fact that contrary to common opinion most vegetables raised in Hawaii contain as much iron as vegetables raised on the mainland. When one considers that the lavas of Hawaii contain from 5 to 15 per cent of iron and that some soils show even a higher percentage, it is to be expected that Hawaiian vegetables should not be deficient in iron.

Not only are there appreciable percentages of iron in Hawaiian lavas but a great variety of other minerals is also found. The following table shows an analysis by oxides of lava dipped from a molten lava lake at Kilauea. Its composition is quite typical of most of the recent flows from Kilauea and Mauna Loa.

Silicon	49.74	per cent
Aluminium	12.36	"
Iron	11.72	"
Magnesium	8.83	"
Calcium	10.88	"
Sodium	2.45	"
Potassium	0.55	"
Titanium	2.49	"
Phosphorus	0.41	"
Manganese	0.14	"

In addition to the above a great variety of other substances are found in varying amounts. Among the more common of these substances are sulphur, copper, selenium, chlorine, nickel, chromium, strontium, barium, vanadium, and molybdenum.

Besides the commonly observed olivine, an iron-magnesium-silicate, which sometimes constitutes 60 per cent or more of some lavas, a great variety of other crystals are found. Among the other crystals augite, magnetite, hematite and feldspars are common.

Frothy pahoehoe lava may well be termed an iron-stained glass. Hawaiian lavas are classified as basaltic though some specimens have been found that approach the acid types of lava, and quartz is not uncommon on Oahu.

R.H.F.

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EARTHQUAKE INSURANCE RATES

It is interesting to observe that insurance specialists have called in engineers and geologists to secure revision of earthquake rates, increasing the charges in all cases except on wooden dwellings. National Underwriter, November 19, 1925, p 10). Immediately after the Santa Barbara and Montana earthquakes the schedule adopted was short and regardless of territory. Then the only consideration was nature of buildings, in three classes. Now there are six classes of building risks, and four specified districts.

The buildings in the order from least dangerous to more dangerous are (1) wooden dwellings, (2) first class stores, (3) limited size wooden houses, (4) second rate brick and concrete, (5) factory and frame constructions of masonry and some wood, (6) soft masonry, dams, reservoirs, bridges, etc.; each of these six classes being scheduled at greater length than is shown here.

The districts for the Pacific Board of Underwriters are (1) Alaska and Nevada, lowest rate, (2) Interior counties California, next higher, (3) coast counties and Montana, and (4) Imperial, Riverside and San Bernardino, highest rate for the six classes, namely 15 cents for Class 1 buildings, and $1.40 for Class 6, per thousand dollars of insurance. For district (1) the rates of these two classes are 7 cents and 65 cents. Contents of buildings and co-insurance and rents are also scheduled.

This rapid evolution of earthquake insurance shows how little is really known of the risk, what a gamble there is in the words "Alaska, Nevada, dams, bridges," and what a splendid field of research is here for the future of science and humanity.

T.A.J.