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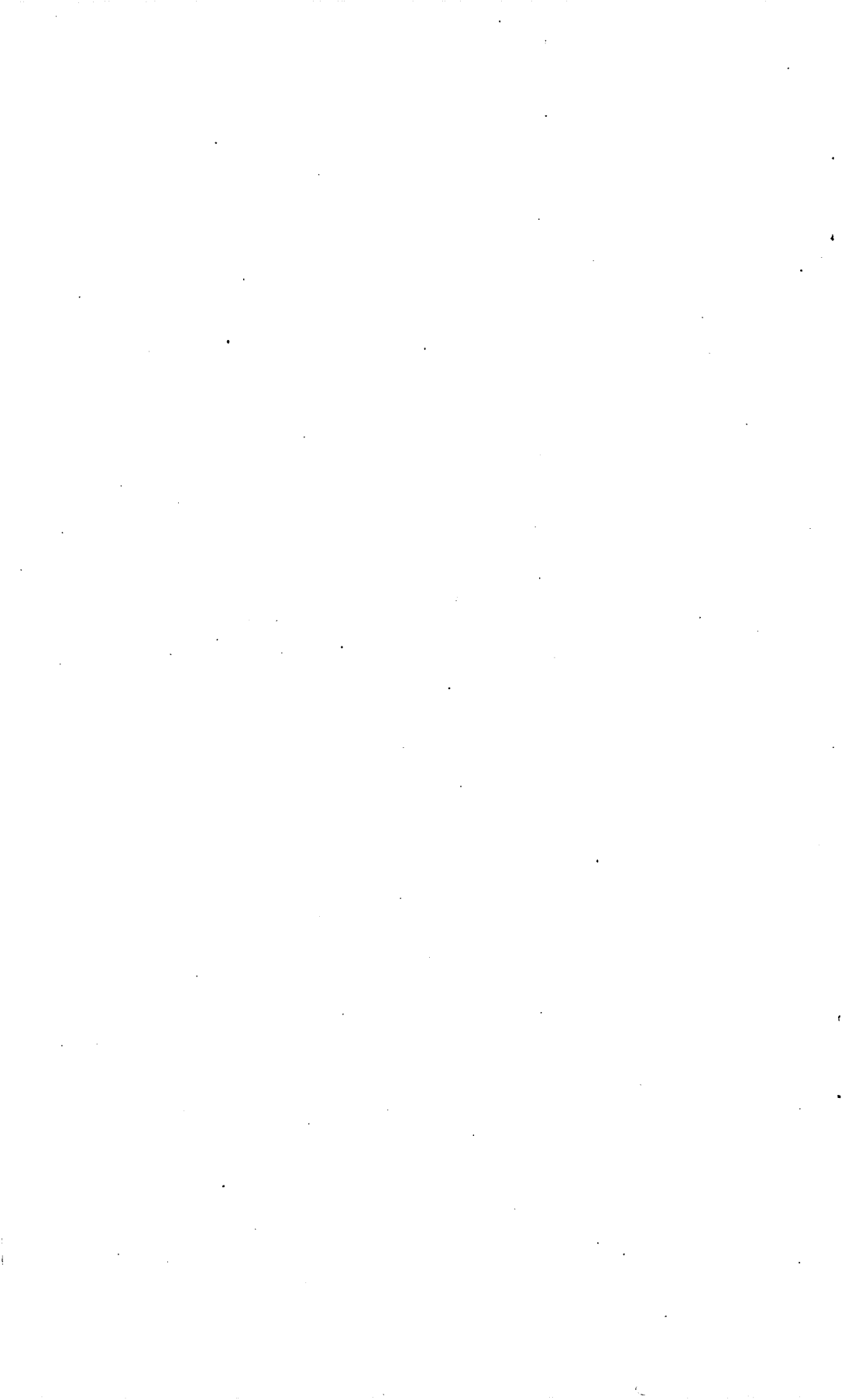
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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

EARTHQUAKES IN CALIFORNIA

IN

1894

BY

CHARLES D. PERRINE

OF THE LICK OBSERVATORY



WASHINGTON
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LETTER OF TRANSMITTAL

UNIVERSITY OF CALIFORNIA,
LICK OBSERVATORY,
Mount Hamilton, March 15, 1895.

SIR: I have the honor to transmit herewith Mr. C. D. Perrine's report of earthquakes observed at Mount Hamilton and in California generally during the year 1894, in order that it may be printed as a bulletin of the Survey, as heretofore.

Very respectfully

EDWARD S. HOLDEN.

Hon. C. D. WALCOTT,
Director U. S. Geological Survey,
Washington, D. C.

EARTHQUAKES IN CALIFORNIA IN 1894.

By CHARLES D. PERRINE.

INTRODUCTION.

The following report is a continuation of similar records,¹ and brings the list up to the end of the year 1894. It contains accounts of all the shocks observed or felt on Mount Hamilton and all those reported to the Lick Observatory by letter, as well as newspaper reports of earthquakes occurring in the State during that year. Many newspapers have been examined, and this bulletin is largely made up from their reports. Some may have escaped notice.

It has been the object especially to record earthquakes occurring in California, but a number of shocks are here recorded which do not properly belong in a record of California earthquakes, which have been included for fear they may have escaped other compilers. The records of the United States Weather Bureau and of the United States Light-House Board, together with the present list, will afford a fairly complete account of the California earthquakes of 1894.

INSTRUMENTS.

The instruments used for recording earthquakes on Mount Hamilton are described in Publications of the Lick Observatory, Vol. I, page 82. The largest and most complete instrument records the three components of the earth's motion, viz, north and south, east and west, and vertical, separately, on a smoked glass plate, which is started by the preliminary tremors of the earthquake and rotates in about three minutes, the edge of the plate being graduated into seconds at the same time by a clock, which also serves to record the time of occurrence of the shock. This instrument has been called the Ewing seismograph in the notes.

¹ List of recorded earthquakes in California, Lower California, Oregon, and Washington Territory (1769 to 1888), Sacramento, State Printing Office, 1887, 8vo. Earthquakes in California in 1888; American Journal of Science, Vol. XXXVII, May, 1889. Earthquakes in California in 1889; Bulletin of the U. S. Geological Survey, No. 68, 1890. Earthquakes in California in 1890 and 1891; Bulletin of the U. S. Geological Survey, No. 95, 1892. Earthquakes in California in 1892; Bulletin of the U. S. Geological Survey, No. 112, 1893.

Another simpler form consists of a heavy "duplex" pendulum adjusted to a long period of vibration, with a magnifying pointer or pen, which records on a smoked glass plate the two horizontal components of motion. The vertical component and the time are not recorded. The motion of the earth is magnified 4.0 times in the duplex seismometers.

The Observatory possesses other seismographs of various patterns, but they are not constantly in use.

SCALE OF MEASUREMENTS.

In the record made by the Ewing seismograph both horizontal components are magnified 3.3 times, and the vertical component is magnified 1.6 times. The measures of the vibrations as given in the notes are taken directly from the tracings, and therefore represent the magnified motions, unless otherwise noted.

If both the period (T) and the amplitude (a) of an earthquake wave are given, the maximum acceleration due to the impulse, which may be taken as a measure of the intensity or destructive effect of the shock, is given by the formula—

$$I = \frac{4\pi^2 a}{T^2},$$

in which the motion is assumed to be harmonic.

DIFFERENCES OF INTENSITY.

Estimates of the intensity of shocks are also given (in roman numerals inclosed in parentheses) according to the Rossi-Forel scale, which for convenience of reference is inserted below. Experience has suggested that for observations in California a few additions should be made to this scale, and these are printed here in italics. When these are in quotation marks also, they are expressions actually used in the newspapers, etc., in describing earthquake shocks whose intensity is otherwise known. The scale as amended is as accurate as anything of the kind can be.

I.

Microseismic shocks recorded by a single seismograph, or by seismographs of the same model, but not putting seismographs of different patterns in motion; reported by experienced observers only.

II.

Shock recorded by several seismographs of different patterns; reported by a small number of persons who are at rest: "*a very light shock.*"

III.

Shock reported by a number of persons who are at rest; duration or direction noted; "*a shock*;" "*a light shock.*"

IV.

Shock reported by persons in motion; shaking of movable objects, doors, and windows; cracking of ceilings; "*moderate*;" "*strong*;" "*sharp*;" (sometimes) "*light*."

V.

Shock felt generally by everyone; furniture shaken; some bells rung; *some clocks stopped*; *some sleepers waked*; "*smart*;" "*strong*;" "*heavy*;" "*severe*;" "*sharp*;" "*quite violent*."

VI.

General awakening of sleepers; general ringing of bells; swinging of chandeliers; stopping of clocks; visible swaying of trees; some persons run out of buildings; *window glass broken*; "*severe*;" "*very severe*;" "*violent*."

VII.

Overturning of loose objects; fall of plaster; striking of church bells; general fright, without damage to buildings; *nausea felt*; "*violent*;" "*very violent*."

VIII.

Fall of chimneys; cracks in the walls of buildings.

IX.

Partial or total destruction of some buildings.

X.

Great disasters; overturning of rocks; fissures in the surface of the earth; mountain slides.

The relation between the intensity (I) of a shock as determined by the formula already given and the numbers of the Rossi-Forel scale has been reduced from all available data up to 1888, and is given below in tabular form. It is, of course, a rough approximation only.

Rossi-Forel scale.	Intensity. millimeters per second.	Difference.
I	20
II	40	20
III	60	20
IV	80	20
V	110	30
VI	150	40
VII	300	150
VIII	500	200
IX	1,200	700

One of the objects of the earthquake observations on Mount Hamilton is to obtain data for correcting this table, so that the intensity of a shock, as defined mathematically by the formula—

$$I = \frac{V^2}{a}$$

(where V is the maximum velocity of the vibrating particle), can be approximately inferred from the ordinary descriptions of its effects.

STATIONS.

A number of duplex-pendulum seismographs, quite similar to the one used at the Lick Observatory, are placed at different points on the Pacific Coast, but they are not all in operation. The stations are:

Students' Observatory, Berkeley, in charge of Professor Leuschner.

Chabot Observatory, Oakland, in charge of Mr. Burckhalter.

Private observatory of Mr. Blinn, in East Oakland.

Observatory of the University of the Pacific, San Jose.

Observatory of Mills College, near Oakland, in charge of Professor Keep.

Residence of Mr. P. Perrine, 2138 Alameda avenue, Alameda.

Office of State Weather Bureau, Carson, Nev., in charge of Professor Friend.

Other seismographs are located as follows:

Private observatory of Professor Davidson, San Francisco.

Tacoma, Wash., Mr. F. G. Plummer.

CHRONOLOGIC RECORD, 1894.

January 14.—OLYMPIA, WASH.—Mr. Fred. G. Plummer reports a disturbance at 3.25 a. m. A tremor lasting three seconds was followed after an interval of four seconds by a shock from south-southwest, and a slight tremor later. His seismograph at Tacoma barely showed the shock.

VANCOUVER (BRITISH COLUMBIA).—The earth trembled in British Columbia to-day. While the quaking continued, hanging pictures swayed slightly and crockery rattled on the shelves.—San Francisco Chronicle.

January 17.—Reports were published that on January 17 Mount Jefferson, as seen from Salem, Oreg., poured forth smoke and steam from its summit at sunrise. Later explanations showed this to be due to atmospheric phenomena.

January 24.—RIVERSIDE.—Quite a heavy shock of earthquake was felt here this morning at 3.50. The shock lasted several seconds.—San Jose Mercury.

February 5.—KEELER, CAL.—A shock of earthquake was felt at 9.01 p. m.—Newspaper.

February 7.—SAN JOSE.—At 2.09 o'clock there was a slight earthquake shock in this city. There was perceptible but one short, sharp shock.—San Jose Mercury.

February 8.—LOS ANGELES.—News received during the day shows that the earthquake shock felt here at 5.45 this morning was also felt quite generally in this section. It was short and sharp, and there was only one shock.—San Francisco Examiner.

February 15.—HAWTHORNE, NEV.—9.01 p. m. (II.)—Report of Nevada State Weather Service, 1894.

March 3.—MOUNT HAMILTON.—One short shock of intensity III, R. F. 4^h 42^m 50^s 1 p. m.—E. S. Holden.

Rattled stoves, etc., slightly in second and third stories of brick dwelling. 4^h 43^m 1^s p. m.—Mr. and Mrs. W. W. Campbell.

Neither of the seismographs showed any record of this shock.

May 7.—MOUNT HAMILTON.—Two distinct shocks, two seconds apart, of equal intensity. 11^h 56^m 7^s p. m. for the last shock.—E. E. Barnard.

Four shocks in less than 2 seconds, of intensities III, II, II, III, R. F., respectively. 11^h 56^m 16^s ± 10^s p. m. In bed in the third story of the brick dwelling.—W. W. Campbell.

No record of this disturbance was found on either of the seismographs.

MOUNT. HAMILTON.—At 10^h 52^m p. m. a movement of the earth was detected by the meridian circle, which was so slight as not to be felt by the observer. The motion was a regular oscillation in an east and west direction, and lasted for fifteen to twenty seconds. At 11^h 56^m 45^s, approximately, one single sharp shock was felt.—R. H. Tucker.

July 13.—PINE RIDGE, CAL.—News comes by telephone from Pine Ridge lumber district, 60 miles northeast of this city, to the effect that a sharp shock of earthquake, lasting a few seconds, was felt there at 8.50 last night. The shock was accompanied by the greatest electric display ever witnessed by inhabitants there. The strange feature is that no clouds were noticed by the citizens.—San Francisco Call.

FRESNO, August 16.—Parties arriving from Pine Ridge, 50 miles east of here, state that a recent earthquake (July 13?) injured the dam across Stephenson Creek, by which water is turned into the Pine Ridge flume. The joints in the masonry were damaged sufficiently to allow the water to pass through, but it is believed that no permanent injury was done, as the openings can be plugged.—San Francisco Chronicle.

July 14.—FRESNO.—A remarkable phenomenon is reported from the Sierra Nevada Mountains east of Fresno. About sunset last evening a red cloud, apparently 50 miles in length, gradually settled over the range, and as soon as night came on persons in this city observed a wonderful display of electricity on the edges of the cloud.

To-day news from that region says that when the electrical display was at its height an earthquake, violent enough to rattle houses and shake trees, was felt. It continued several seconds. After it had subsided the cloud rapidly passed away and the atmosphere became clear.

So far as can be learned the earthquake was felt at no place else than immediately under the cloud. It was not felt on the plains, 20 miles distant.—San Francisco Chronicle.

July 18.—OGDEN, UTAH.—At 3.50 p. m. distinct earthquake shocks were felt. Dishes were shaken from the tables, the walls of some large blocks were cracked, and a general shaking up occurred. Many people were frightened into leaving their houses.—San Francisco Chronicle.

July 29.—SAN BERNARDINO.—A shock of earthquake occurred at about 9.15 p. m. The movement was of several seconds' duration, and seemed to be from the northwest to the southeast. The disturbance was very noticeable, causing doors and windows to rattle, chandeliers to swing, and buildings to vibrate. As far as can be ascertained no one was injured and no property destroyed.

The First Methodist Episcopal church was occupied at the time the earthquake occurred. The building is large and built of brick, and the disturbance caused a panic that was soon quelled by those who had presence of mind, though a number sought safety in the open air. The pastor continued his discourse as soon as quiet was restored.

Instances of parties leaving buildings hurriedly are reported.

In the yard at the depot cars standing on the track were put in motion and the men had to set the brakes.

Some report seeing a large meteor in the heavens at the same time the shock occurred.

The clock in the old court-house tower stopped at 9.21 p. m. as a result of the shock.—Newspaper report.

LOS ANGELES.—At 9.12 p. m. the city was shaken by a shock of earthquake, which was one of the most severe felt in this part of the country for many years. The undulations appeared to be from south to north, and there were three distinct tremors. The first was a light one, but the second made the windows rattle and disturbed loose articles lying about on mantels and shelves. With the third tremor the wave passed.

As far as could be learned no damage was done, aside from the breaking of a few panes of glass. The shocks naturally created consternation in some of the large lodging houses and hotels, and caused the inmates to start out in more or less confusion. The tower of the city hall swayed very perceptibly, and the electric-light masts continued to vibrate for fifteen or twenty minutes after the disturbance.

In the restaurants and drug stores along Spring and Main streets the chandeliers swung like clock pendulums and the glassware and crockery rattled at a lively rate. In some places the guests rushed out, leaving their meals uneaten, but soon recovered from the scare and returned.

At the post-office, in the Federal Building, which is one of the most solidly constructed edifices in the city, the shock was very severe, and caused a panic among the clerks. The only damage done, however, was the breaking of several bottles of ink, which were jarred off the shelves.

Up at the grim prison on the hill there was the biggest kind of a scare. The steel floors and partitions, the great steel doors and staircases rattled and creaked and strained.

PASADENA.—A severe shock of earthquake was felt here at 9.17 p. m., lasting ten seconds. The motion was from northwest to southeast, and the shock was accompanied by a loud rumbling. It was felt all over the city, brick buildings being shaken until the bricks creaked. There was much excitement in the churches and meetings, and at the Salvation Army meeting quite a panic ensued; one woman was slightly hurt, and fainted when the crowd was making its exit. No damage was done in the city so far as known. At Echo Mountain the new hotel was shaken.

SANTA MONICA.—Two distinct shocks of earthquake were felt here about 9.11 p. m., the last shock being the heaviest ever felt here. The plate-glass windows in the Hotel Jackson were distinctly seen to wave in and out. No damage has been reported.

SANTA ANA.—At 9.15 o'clock this evening this city was visited by the heaviest earthquake ever experienced here. Buildings shook and glassware and crockery rattled. There were three shocks, the vibra-

tion being from south to north. The electric-light masts continued to vibrate for some minutes after the shock.

MOJAVE.—A heavy shock of earthquake at 9.12 o'clock this evening shook this town badly. Goods were knocked off the counters of stores and general excitement prevailed. The vibration was from north to south.

ONTARIO, CAL.—The severest earthquake shock ever felt here occurred at 9.12 p. m. No damage reported.—*Los Angeles Times*.

August 3.—**MOUNT HAMILTON.**—Professor Holden reports a single shock of intensity III to IV on the Rossi-Forel scale as awakening him at 11^h 50^m p. m. \pm one-half minute. He was expecting an alarm clock to go off, and presumably was easily awakened. The duplex seismograph gave a record of this shock, the displacement of the earth being 0.25^{mm} in an east and west direction.

August 22.—**LEWERS RANCH, NEVADA.**—4.28 a. m. (II).—Report of Nevada State Weather Service, 1894.

September 30.—**MOUNT HAMILTON.**—The record of a single vibration was found on the plate of the duplex seismograph on the morning of October 1. The seismographs were examined on the evening of September 30 and again on the morning of October 1, when the record was noticed, so that the shock must have occurred in this interval, although it was not felt by anyone here and did not start the Ewing instrument. The displacement of the earth was about 0.25^{mm}.

EUREKA.—Two heavy earthquake shocks occurred here this morning, the first at 9.36 o'clock, lasting nearly half a minute. The vibrations were from north to south. The second was at 9.59 o'clock, the vibrations being northeast to southeast. It lasted five seconds. No damage was done.

SISSON.—A slight earthquake shock was felt in this vicinity this morning. The vibrations were from north to south.—*San Francisco Chronicle*.

October.—**NEW HEBRIDES ISLANDS.**—The New Hebrides group passed through a series of heavy earthquakes and volcanic disturbances in October and November, which threatened the existence of several of the largest and best islands, including Ambrim. A layer of ashes from 2 to 6 inches thick covers the once fertile fields.

At Epi, on November 2, there was a severe earthquake in the early morning, which opened an entirely new volcanic crater on the west side of Ambrim, about 14 miles distant, and all the next day the whole island trembled. Since then it has opened in five or six different places. Even the island of Epi, which was much less affected, had to the 7th of November felt sixty-three distinct shocks, and for weeks had been covered by clouds of ashes and smoke. Traders and planters living on Ambrim Island fled precipitately to Port Sandwich (Malicollo), the nearest port, in many cases abandoning all their possessions.

On the 13th of November an earthquake shock rocked Ambrim from

east to west, causing the land on which stood a small native village to slip, with the humble homes of the inhabitants, into the sea. It is impossible to accurately determine the extent of the fatalities, but the lowest estimate of the loss of life is 50. Fatalities are reported from other islands of the group also. Owing to the lateness of the disaster details were not available when the *Warrimoo* left the southern seas, although natives from all the volcanic islands were flocking to the centers of civilization for safety.

The special correspondent of the Sydney Morning Herald, writing from Epi early in November, said: "Ambrim Island is still in violent eruption. The outbreak commenced on the 16th of October at an old crater in the center of the island. The lava stream extends from the crater to near Dip Point, at the western end. The center of the island is one mass of lava.

"Frequent earthquakes were felt as far as Malekula, many of them being severe. Some of the officers have ascended the crater, which is 1 mile in diameter and 1,000 feet deep. Dense smoke continues to issue from this crater. The lava streams are moving slowly toward the sea and cooling. All the western end of the island is covered with a deposit of fine ashes. As far as at present can be ascertained the loss of life has been 60 killed by the great landslip of the 13th and by falling stones."

Following is the report made by the commander of H. M. S. *Dart*:

"While we were lying at Dip Point, Ambrim Island, an eruption on that island took place. On weighing anchor at 6 a. m. (October 16) and proceeding to the eastward to resume our surveying work a remarkably heavy mass of cloud was seen rising over the center of the island, and on clearing the point dense columns of smoke were seen descending from just the other side of the low coast range.

"It presently became evident that a lava stream, marked by a dense column of smoke, was making its way through the hills to the sea. The ship was stopped some 300 yards offshore, where it was seen that the stream would emerge, and at 8 a. m. tongues of flame were seen among the trees, and presently the head of the stream appeared, a red-hot, molten mass, with lumps of slag tossing about on the surface.

"When it reached the water a most magnificent sight ensued. A dense pillar of steam rose rapidly in a perpendicular direction to a height which was afterwards found to be 4,500 feet. A few seconds later violent submarine explosions of steam took place, the water rising in huge bubbles some 100 feet high and then bursting in all directions in radiating tongues of water mixed with black masses, presumably of lava. A considerable swell was set outward, and as the area of explosions appeared to be extending rapidly the ship was moved to a safer distance.

"Canoes full of natives were leaving the island in all directions, some of which were taken in tow to Dip Point, where they were clear of

immediate danger. The ship then proceeded around to the south side of the island, when it was seen that the old crater of Mount Maryun, in the center of the island, was in violent eruption, and that dense masses of smoke were rising over all the western end of the island.

"On returning, while rounding Dip Point, a sudden outburst, accompanied by continuous violent explosions, took place. About 2 miles to the southward of Mission Station the cliffs were seen to be falling inland and, when anchoring, flames appeared over the crest of the gap behind the mission.

"The natives were assembled in terrified groups on the beach, and I accordingly sent boats in, offering to take off all that wished. The group was in a state of terror and the noise of the eruption was indescribable. Dust and debris from the burning brush fell continuously. We embarked over 80 men, women, and children, for the most part belonging to Dr. Lamb's mission, and proceeded with them to Rannon, near the northeast point of the island; a place of comparative safety. Throughout the next day earthquake shocks were so severe as to cause resident trader Mr. Rossi, a Frenchman, to remove to Port Sandwich with all his natives and belongings. The natives brought from Dip Point were comfortably housed in the schoolhouse belonging to Dr. Lamb.

"The next morning we proceeded to the northeast point of the island as far as Dip Point, which was found to be in inky darkness; objects being scarcely visible over a quarter of a mile. We communicated with the shore and found the natives reassured, as the actual fires in the vicinity had ceased. At 6 p. m. we proceeded to Port Sandwich, not clearing the shower of dust till more than halfway across.

"Several shocks were experienced on the way, and that night thirty-one shocks were distinctly felt in seven hours forty minutes on board the ship, one at 2.30 a. m. being particularly severe.

"A great portion of the cliff at Dip Point has fallen into the sea, and all along the shore to the eastward continuous clouds of dust are arising and landslides have occurred. We anchored at Rannon afterwards and reembarked all the natives and landed them at Dip Point, the present danger being removed. Dust was now falling heavier than ever, but of lighter color and finer description. Everything on shore was covered with the deposit, the landscape being of one uniform dull slate color and the ship a gray mass. We landed and proceeded over the hill for about 2 miles until the stream of lava was reached. Although cooled down, it was still proceeding at some 4 or 5 feet an hour in the direction of Banlag, on the south coast. Owing, however, to the thickness of the atmosphere it was impossible to get any views of what was happening. We then returned to Port Sandwich."—Extract from San Francisco Examiner.

October 23.—SAN DIEGO.—This city and neighboring towns were visited this afternoon by a series of earthquakes of more than ordinary

severity. The first shock occurred at 3.03 p. m. and was followed at intervals of a quarter of a minute by two others, the last being one of the strongest experienced hereabouts since the advent of Americans. People in brick houses swarmed into the streets, hearing the grinding of brick and mortar and seeing in some cases the walls crack. A loud noise was heard in all parts of the city immediately preceding the shock. Considerable consternation was caused in the public schools, the children in some of the rooms being hastily dismissed.

The second shock was observed by few people, being very light and coming when all were talking of the first; but the third was so pronounced as to bring the people into the streets without delay. Telephone messages from Coronado, Upper Otay Dam, Campo, National City, and other places show that the earthquake was felt about equally at all surrounding points. Loose rocks were shaken from the hillsides and rattled down the canyons, and a heavy booming noise accompanied the tremors.

The weather observer reported another slight shock at about 4.25 o'clock, not so strong as the first ones, but quite perceptible. It was not felt on the ground. The waves were from east to west in all instances. So far as known no serious damage was done.

RIVERSIDE.—Two distinct shocks of earthquake occurred to-day at 3 p. m. The first was light, followed in a few seconds by quite a sharp shake. No damage was done.

SAN BERNARDINO.—Two distinct shocks of earthquake were felt here at 2.04 p. m. The vibrations lasted twenty seconds and the motion was from west to east.

COLTON.—A light earthquake shock was distinctly felt here about 3 p. m.—San Francisco Examiner.

LOS ANGELES.—A slight earthquake shock was felt here at 3.05.—San Jose Mercury.

October 27.—**LOS ANGELES.**—A slight earthquake shock occurred here to-night at about 11 o'clock. No damage is reported.

SAN DIEGO.—An earthquake shock of 10 seconds' duration was felt here at 11.05 to-night. It caused some excitement, but no damage is reported.—San Francisco Chronicle.

November 2.—**MEXICO CITY.**—Two violent earthquake shocks occurred at 4.17 p. m., with four minutes' intermission. During the vibrations the earth seemed rocking like a ship at sea and the natives were on their knees in the streets praying frantically.—San Francisco Bulletin.

November 14.—**GOLD HILL, NEV.**—An earthquake was felt here to-day at 2.02 o'clock. There were two shocks, with an interval of a minute between them. No particular attention was paid to them, most of the people thinking that the disturbances were caused by blasts in the mines.

At 6.58 o'clock this evening a shock occurred that brought the occu-

pants of many buildings into the streets. It was of short duration, but rattled windows and glassware at a lively rate. The vibrations appeared to be from southeast to northwest.—San Francisco Chronicle.

CARSON, NEV.—6.55 a. m. (I).

LEWERS RANCH, NEVADA.—7.05 p. m. (I).—Report of Nevada State Weather Service, 1894.

November 15.—CARSON, NEV.—Three heavy earthquake shocks were felt here. The first and heaviest was at 11.05 p. m., the second at 11.25 p. m., and the third at 12. The direction was east and west. Though the shocks caused fright, no damage was done.—San Francisco Chronicle.

GOLD HILL, NEV.—Three tremors of intensity II. (No time given.)

LEWERS RANCH.—At midnight three tremors of intensity III; felt by persons all over Washoe Valley.

VIRGINIA, NEV.—11 a. m. (II); 11.18 p. m. (II); 11.52 p. m. (II).—Report of Nevada State Weather Service, 1894.

November 16-22.—VIRGINIA, NEV.—There have been, according to different calculations, over one hundred shocks of earthquake in this city within the week. It is in evidence that the greater number of vibrations have come from west to east. Theories without number have been put forward giving reasons why such disturbances should occur in Nevada, which has been almost free from earthquakes since the advent of the white man. There are no Indian traditions in reference to former earthquakes in this vicinity, nor in any portion of Nevada, as far as can be ascertained from the most intelligent of the Indian residents here.

The cone of Mount Davidson shows undoubted evidence of volcanic action formerly, and scoria is found on portions of its western slope. The great gold and silver ore producing mines on its eastern side occupy a depressed amphitheater. Lava is visible on the mountain in small patches, which goes still further to indicate that Mount Davidson is an extinct volcano.—San Francisco Examiner.

November 17.—SAN DIEGO.—A heavy earthquake shock was felt at Campo Saturday evening (November 17) at 5 o'clock, lasting several seconds. The oscillation seemed to be from northeast to southwest.—San Francisco Chronicle.

November 18.—CARSON, NEV.—Earthquake shocks continue to be felt in this section, with prospects of creating a panic if the shocks continue. Between 3 and 7 o'clock this morning six distinct shocks were felt, the first being very heavy. Thus far no damage has been done except to cause acute nausea and prevent sleep. The direction of the vibrations varies considerably, and the shocks are usually preceded by a roaring sound.—San Francisco Chronicle.

AUSTIN, NEV.—10 a. m. (II); Carson, 2.38 a. m. (I); 2.40 a. m. (I); 2.49 a. m. (III); 5.15 a. m. (I); 5.33 a. m. (I); 6.22 a. m. (I).

GOLD HILL, NEV.—Four tremors of intensity II. (No time given.)

LEWERS RANCH, NEVADA.—(No time given.) (I).

VIRGINIA, NEV.—2.28 a. m. (II); 2.30 a. m. (I); 2.40 a. m. (IV) (this shock cracked plastering; in some places walls were damaged; in many instances window glass was broken); 5 a. m. (II); 5.24 a. m. (I); 6.18 a. m. (II).—Report of Nevada State Weather Service, 1894.

November 21.—MOUNT RAINIER (TACOMA), November 26.—F. L. Lowe, a carpenter, says he and some hunting companions were within 6 miles of Mount Tacoma's top last Wednesday afternoon (November 21), and that several shocks of earthquake were distinctly felt at the mountain's base. Several great avalanches were heard crashing down the mountain side and making such a noise that it seemed, Lowe says, as if the world were coming to an end. This occurred on the north side of the mountain. Rocks were piled over 100 feet high in the Puyallup River, and returning they crossed the débris of an avalanche which was of great depth and half a mile wide and 4 or 5 miles long.—San Jose Mercury.

TACOMA, WASH.—To-night at 6.30 o'clock several slight shocks of earthquake were felt here. Windows were rattled throughout the city. The first shock was most severe, being accompanied by rumbling noises, as of a distant explosion, and simultaneously a sheet of flame was observed in the eastern heavens.

CARSON, NEV., in night (I).—Report of Nevada State Weather Service, 1894.

MOUNT RAINIER, WASHINGTON.—Much has been said in the newspapers concerning an appearance of change in the summit of this mountain. The principal facts seem to indicate some sort of change, possibly due to avalanches, and the report that smoke issued from the crater seems worthy of credence.

On the morning of November 21 five reputable citizens of Seattle report that they saw puffs of smoke coming from the west side of the top of the mountain at intervals of twenty seconds from 6.20 to 8 a. m. The smoke came up in huge, balloon-shaped masses, and after hanging suspended for a short time was wafted toward the eastern side of the mountain. Before 8 o'clock the top of the mountain had lost its whiteness, and appeared dark, jagged, and rough.

The same phenomena were observed from Tacoma and Portland.

Again, on the afternoon of Thursday, December 13, smoke was seen rising from the crater by Observer Saulsbury, of the Weather Bureau, E. C. Hobbs, J. A. McClellan, J. J. McGilvera, John Arthur, S. L. Crawford, and others, from Seattle. Mr. Saulsbury saw the phenomenon through a glass repeatedly from 9 a. m. to 1 p. m., and was positive that the substance was smoke and not vapor.

The Seattle Post-Intelligencer sent out an exploring party in the latter part of December to reach, if possible, the summit and determine the character of the phenomena. This party, owing to the dangerous condition of the snow fields, could get no farther than the foot

of Carbon Glacier, from where the following message was sent back by homing pigeon on December 26:

"The expedition has been an entire success. It has demonstrated that while the mountain has been smoking and steaming, the change is due principally to tremendous avalanches and not to an eruption. The new peak observed from Seattle is off Columbus crest, and was formed by spiral winds carrying snow and whipping it into the cone-shaped peak described. The party will be home Friday."—San Jose Mercury.

The Seattle Post-Intelligencer of January 6, 1895, contains a full report of the expedition, which was sent out under its auspices. Without being able to reach the summit, the explorers report having seen, on December 24, jets of steam issuing from the large crater and a column of black smoke from the small crater.

Of interest in this connection is the following report from Ellensburg:

"The eruption of Mount Rainier has explained to the satisfaction of many a mystery that has baffled all. The waterworks reservoir here suddenly became exhausted. Investigation showed a crevice running along the hill north and south, varying from 1 inch to 1 foot in width and of unknown depth. It ran directly through the reservoir, letting the water out. It has been traced several hundred feet along the hill. No shocks of earthquake have been felt here as far as known."—San Francisco Chronicle.

(Ellensburg is over 200 miles distant from Mount Rainier.—C. D. P.)

November 24.—CARSON, NEV.—10.03 p. m. (II); 11.22 p. m. (III).—Report of Nevada State Weather Service, 1894.

December 4.—CARSON, NEV.—9.39 p. m. (I); Lewers Ranch, 9.40 p. m. (II).—Report of Nevada State Weather Service, 1894.

December 18.—CARSON, NEV.—9.08 a. m. (II).—Report of Nevada State Weather Service, 1894.

December 21.—GOLD HILL, NEV.—2.20 a. m. (II).—Report of Nevada State Weather Service, 1894.

December 23.—LOS ANGELES.—Earthquake shocks were experienced this morning at San Diego, Riverside, Pomono, and other points. No damage was done.—San Jose Mercury.

December 24.—BOISE, IDAHO.—Boise was visited by three slight earthquake shocks this morning. The first was very slight, about 4 o'clock; the second light, about 6 o'clock. The third shock was felt everywhere in the city, and came at 7.10 o'clock. Houses vibrated perceptibly and people were awakened. The shock was accompanied by a booming sound like the roar of a gale of wind.—San Francisco Chronicle.

December 28.—GOLD HILL, NEV.—9.15 a. m. (I).—Report of Nevada State Weather Service, 1894.

December 29.—GOLD HILL, NEV.—4.30 a. m. (II); 5 p. m. (I).—Report of Nevada State Weather Service, 1894.

December 30—CITY OF MEXICO.—At 10.53 o'clock on Sunday (December 30), an oscillatory earthquake shock was felt in this city and other parts of the valley of Mexico. The movement was east and north, but of short duration. The disturbance caused great alarm among those who feared a repetition of the disastrous earthquakes of November 2, which killed 18 people and did great property damage. In the Arben Theater, the only playhouse now open in this capital, as a result of the damage sustained by other theaters in previous shocks, a stampede occurred. Women leaped from lower boxes and the audience struggled for escape at the narrow exits. The manager appeared on the stage and tried to calm the fear-crazed people, and at last a degree of quiet was restored, but not until most of the audience had taken refuge in the streets, which were full of frightened people, many in their night clothes.

The scene of November 2 was repeated in a large part, and thousands of penitents knelt in the open streets and prayed and cried in a loud voice for deliverance from death. In Belem prison, where thousands of wretched beings are huddled together in barracks, pandemonium reigned, and the guards had hard work to prevent hundreds from breaking out and flinging themselves over the walls.

Large supply pipes leading to the city burst, flooding the streets. The shock last night lasted nine seconds. It is known that three persons were seriously injured. A number of buildings were destroyed.—San Francisco Call, January 2, 1895.

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