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CHARLES D. WALCOTT, DIRECTOR

EARTHQUAKES IN CALIFORNIA

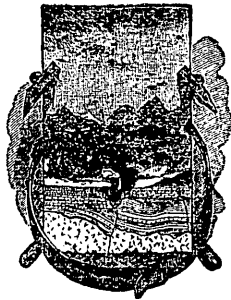
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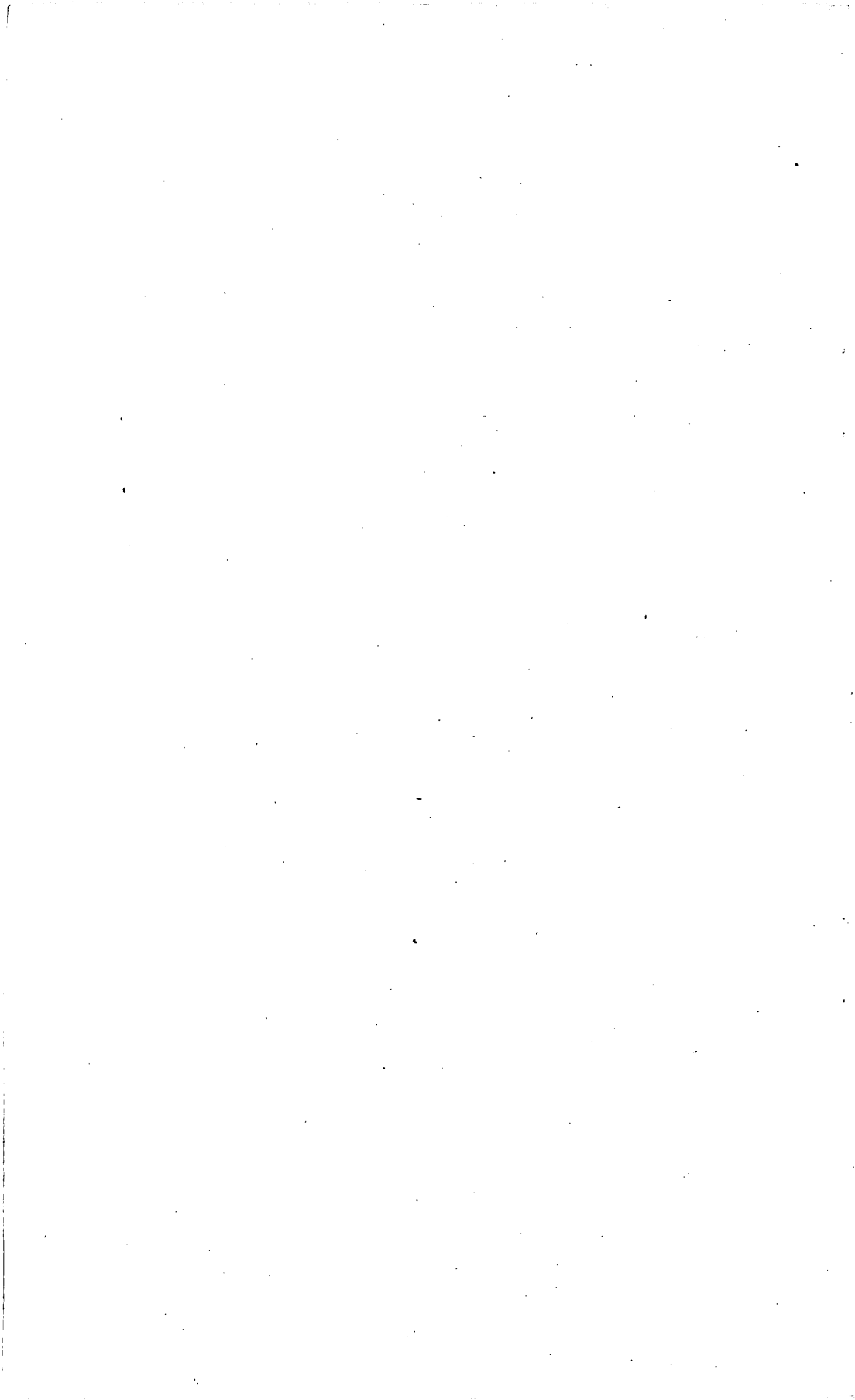
BY

CHARLES D. PERRINE

ASSISTANT ASTRONOMER IN CHARGE OF EARTHQUAKE OBSERVATIONS
AT THE LICK OBSERVATORY

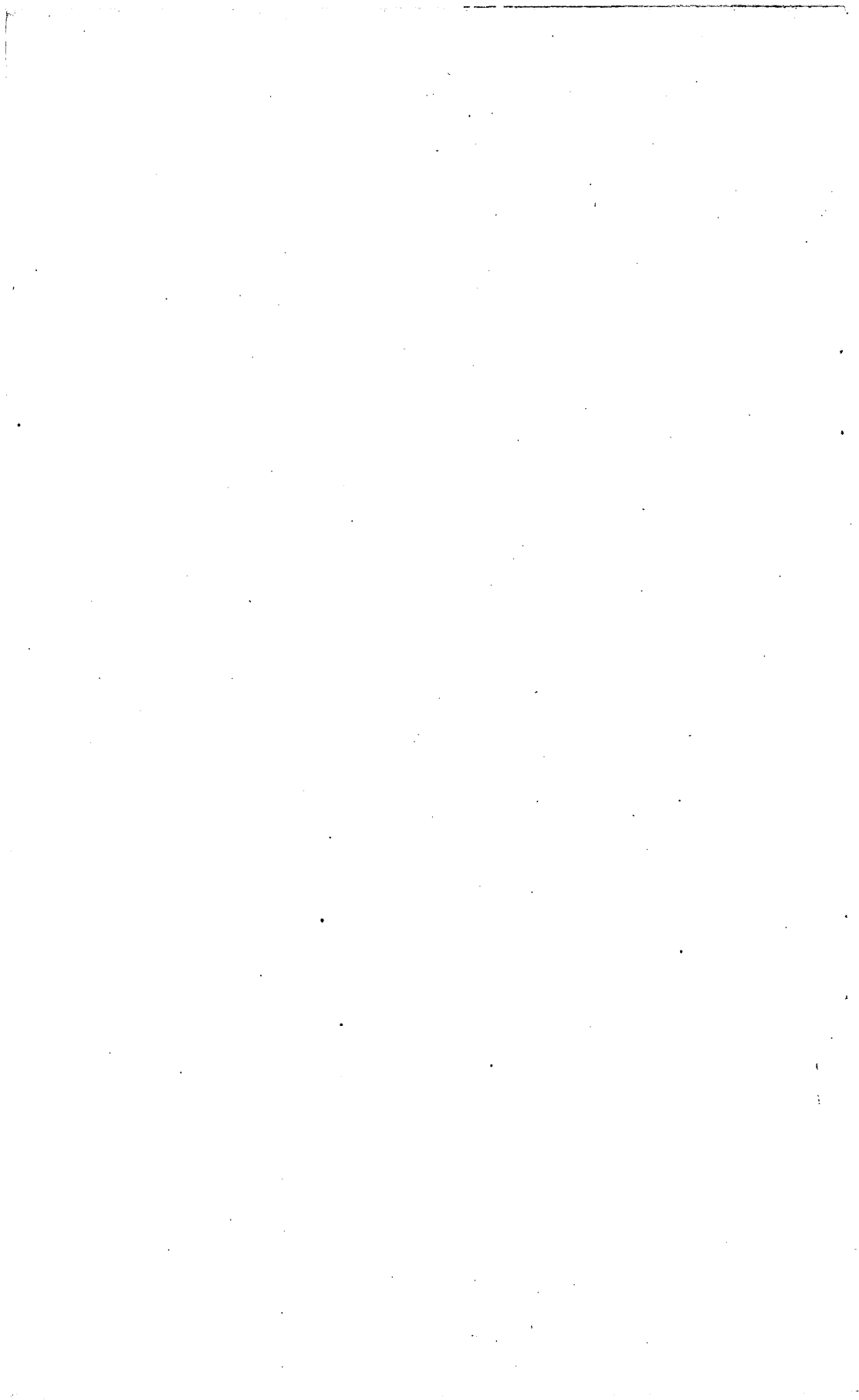


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LETTER OF TRANSMITTAL.

UNIVERSITY OF CALIFORNIA,
LICK OBSERVATORY,

Mount Hamilton, August 24, 1896.

SIR: I beg to transmit herewith the report of earthquakes observed at Mount Hamilton and throughout California in the year 1895, compiled by Mr. Perrine, and trust that it may be printed as a bulletin, as in previous years.

Yours, very truly,

EDWARD S. HOLDEN,
Director Lick Observatory.

Hon. C. D. WALCOTT,
Director United States Geological Survey.

EARTHQUAKES IN CALIFORNIA IN 1895.

By CHARLES D. PERRINE.

INTRODUCTION.

The following paper is a continuation of similar records¹ furnished by officers of the Lick Observatory, and completes the list up to the end of 1895. It records 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 such earthquakes as occurred in the State during the year. It also includes a number of shocks in various localities on the Pacific Coast which it was thought might not have been recorded in other reports. No systematic examination of newspapers has been made, however, and some reports of earthquakes may have escaped notice.

INSTRUMENTS.

The instruments used for recording earthquakes on Mount Hamilton are described in Publications of the Lick Observatory, Vol. I, p. 82. The largest and most complete instrument records the north-and-south, east-and-west, and vertical components of the earth's motion 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 at the same time graduated into seconds by the clock, which also serves to record the time of occurrence of the shock. This instrument has been called the Ewing seismograph in the notes. Another form consists of the heavy "duplex" pendulum adjusted to a long period of vibration, with a magnifying pointer or pen, which records on a smoked-glass plate both horizontal components of the motion. The vertical component and the time are not recorded. The motion of the

¹ List of recorded earthquakes in California, Lower California, Oregon, and Washington Territory, from 1769 to 1888, by Edward S. Holden, Sacramento, State Printing Office, 1887. Earthquakes in California in 1888, by Edward S. Holden: *Am. Jour. Sci.*, 3d series, vol. 37, May, 1889. Earthquakes in California in 1889, by James E. Keeler: *Bull. U. S. Geol. Survey* No. 68, 1890. Earthquakes in California in 1890 and 1891, by Edward S. Holden: *Bull. U. S. Geol. Survey* No. 95, 1892. Earthquakes in California in 1892, by Charles D. Perrine: *Bull. U. S. Geol. Survey* No. 112, 1893. Earthquakes in California in 1893, by Charles D. Perrine: *Bull. U. S. Geol. Survey* No. 114, 1894. Earthquakes in California in 1894, by Charles D. Perrine: *Bull. U. S. Geol. Survey* No. 129, 1895.

earth is magnified four 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 the 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 motion, unless otherwise mentioned.

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-Förel 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.

Shocks recorded by several semismographs of different patterns; reported by a small number of persons at rest; "*a very light shock*."

III.

Shock reported by a number of persons 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; falling of plaster; striking of church bells; general fright, without damage to buildings; *nausea felt; "violent;" "very violent."*

VIII.

Falling 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 ground; 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 by Professor Holden, and is given below in tabular form. It is, of course, a rough approximation only:

Intensity, 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 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.

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

Alameda, Cal., at the residence of Mr. P. Perrine.

Tacoma, Wash., at the residence of Mr. F. G. Plummer. (Mr. Plummer's seismograph is not a "duplex.")

The reports of the United States Light-House Board and of the United States Weather Bureau should be consulted in this connection, as they record disturbances felt at their stations, which may not be included in this list.

CHRONOLOGIC RECORD, 1895.¹

January 5.—MOUNT HAMILTON.—“3^h 4^m 57^s \pm a. m. One light shock.”—A. L. C. The duplex seismograph registered a disturbance principally northeast and southwest (one wave), the displacement of the earth being 0.5^{mm}. There was a series of vibrations at right angles to this of about $\frac{1}{4}$ ^{mm}.

January 23.—UKIAH.—A heavy shock of earthquake was felt in this city this morning. After the shock the sky cleared and the rain ceased.—San Jose Mercury, January 23, 1895.

January 26.—HELENA, MONT.—An earthquake shock was felt here at 5 o'clock this morning. Small articles were shaken off the shelves.—Newspaper report.

February 25.—PORTLAND, OREG.—4.47 a. m., standard time. Three slight shocks from northward.

TACOMA, WASH., and suburban points to the southward.—Same time. Three slight shocks from S. 10° W. My “home-made” seismograph only records horizontal shocks and showed only $\frac{1}{20}$ inch. The directions noted would place center near Toutle River, where I observed a vertical shock—already reported (1893).—F. G. Plummer, Tacoma, Wash.

PORTLAND, OREG.—Three distinct shocks of earthquake were felt here early this morning. Each shock lasted about three seconds. The first occurred at 4.47. The vibrations were from north to south.—San Jose Mercury, February 26, 1895.

TACOMA, WASH.—This morning's earthquake shock was plainly felt in Tacoma, on top of the hill, and at Edison, at Sumner, Puyallup, and Steilacoom. There were three light vibrations occurring just before 5 o'clock, the general trend being from north to south, though at Steilacoom the vibrations seemed to be from east to west.—San Jose Mercury, February 26, 1895.

March 1.—AYÁTLAN, MEXICO.—Inhabitants of southwestern Mexico are alarmed over the frequent earthquake shocks which have occurred during the last month. Although little damage has been done, the helpless people are in great trepidation. Shocks are accompanied by subterranean rumblings, followed by a discharge as from an artillery, which shakes the earth for nearly half a minute at a time. The recent outbreak of the subocean volcano off the Pacific coast, in Guerrero, is

¹This list contains several occurrences the correctness of which may well be doubted. Those cases rest upon newspaper report entirely and are of such a nature that there should be confirmatory evidence before accepting them. It has been thought best to include these doubtful cases, however, and they are indicated by some note after them.

ascribed as the reason for the frightful demonstrations.—San Francisco Examiner, March 2, 1895.

AT SEA, off the Mendocino (Cal.) coast; longitude $125^{\circ} 20'$, latitude 40° .—The recent earthquake which was reported as having disturbed the inhabitants of Mendocino proved to be a veritable terror at sea, according to the stories told by the crews of the schooners *Volant* and *C. T. Hill*, which have just arrived from that section of the coast.

The *Volant* was holding up to a stiff breeze about 52 miles off the Mendocino coast, in the vicinity of Shelter Cove, when she encountered the shlake up. It took place a few minutes before 1 o'clock on the morning of March 1. The sea had been quite calm all night, but the breeze kept up well, and there was nothing to indicate that anything unusual was about to happen. The first warning of the earthquake came in the form of a deafening roar which seemed to rise out of the sea. In an instant the ocean was lashed into a mass of foam, and in spots it rose in great geyser-like columns. The schooner stopped with a crash and then shook for fully two minutes. Every timber and bolt groaned and creaked, and it was thought for a moment that she was going down. Those on deck were knocked down. The schooner pounded up and down frightfully for a few minutes, just as if she were aground, and then all became still. We had scarcely recovered our senses when a second shock came, but it was not nearly so severe as the first. When this one was over the sea became as still as a mill pond, the wind died out, and everything was as quiet as death.

The schooner *C. T. Hill*, which was carrying lumber to this port from Willapa Harbor, was also tossed about by the temblor. She was only a few miles astern of the *Volant* at the time. Captain Forest's story of the experience is similar to that told by the crew of the *Volant*. He was unable to determine, however, what had caused the commotion until he had consulted with the mate of the *Volant* yesterday. Previous to that he was of the opinion that he had encountered a wreck or a reef, and had intended reporting to that effect to the Merchants' Exchange.—San Francisco Chronicle.

NOTE.—Inquiries addressed to the captains of the vessels named, through the Merchants' Exchange of San Francisco, elicited no reply.—C. D. P.

The following paragraphs by Dr. Edward S. Holden, from the Publications of the Astronomical Society of the Pacific, Vol. VII, 1895, page 131, is of interest:

"The San Francisco Chronicle of March 8, 1895, gives an account of a severe earthquake shock experienced by two vessels some 50 miles off Cape Mendocino, in longitude $125^{\circ} 20'$, latitude 40° (both approximate).

"My List of Recorded Earthquakes in California (1887) contains several notices of shocks felt in this vicinity, as follows:

"At sea, 45 miles WSW. of Cape Mendocino;

“At sea, 50 miles WSW. from Cape Mendocino;

“At sea, longitude $126^{\circ} 25'$, latitude $41^{\circ} 55'$;

“At sea, longitude $125^{\circ} 50'$, latitude $40^{\circ} 24'$;

“At sea, longitude $125^{\circ} 20'$, latitude 40° — (as above).’

“A relief map of the ocean bed near Cape Mendocino, made by Prof. George Davidson and Mr. Winston, shows the coast to be very ‘steep-to’; and it further shows two submarine mountains in the neighborhood. The slipping of the earth at the junction of the steep submarine cliff with the (comparatively) flat ocean floor may very well be the cause of some of these disturbances. It is also possible, at least, that they are connected with the two submarine elevations mentioned. More observations are needed to decide this question. It is a little remarkable that we have reports of shocks felt at sea in this vicinity and none, or few, at other points along the coast.”

March 10.—SAN MIGUEL ISLAND.—This is one of a chain of islands about 30 miles off the coast, near Santa Barbara, Cal. On March 17 newspapers published reports of a disturbance on this island about March 8, by which the shore in places was elevated 60 feet and other considerable changes wrought. Another disturbance is reported about March 30, by which a small schooner was wrecked in the harbor at the island.

A third disturbance was reported in July on Flea Island, an islet in the immediate neighborhood. Through the kindness of Mr. J. J. Hollister, of Santa Barbara, we learn that there was a large landslide on San Miguel Island. This fact was worked up by a newspaper reporter into a very sensational article.

CORDOBA, MEXICO.—The peak of Orizaba is reported in press dispatches to be in a state of eruption after many centuries of quiescence.

March 12.—MOUNT HAMILTON.—“9^h 34^m 17^s p. m., Pacific standard. One short, sharp, vertical shock. Rossi-Forel V.”—E. S. H.

“9^h 34^m 17^s p. m., Pacific standard. (In sitting room on Ptolemy.) Strong vertical shock, followed by two very quick weak shocks. All three lasted less than 1^s. Absolutely no horizontal component noted. Intensity of first shock IV or V.”—W. W. C.

“9^h 34^m 17^s p. m., Pacific standard. One sharp shock followed by one or two slight tremors. Doors and other objects rattled in third story of brick dwelling. Rossi-Forel V.”—C. D. P.

The duplex seismograph recorded several small vibrations without any decided tendency as to direction; the displacement of the earth being about $\frac{3}{8}$ mm.

March 22.—STEAMBOAT SPRINGS, COLO.—A letter from Steamboat Springs, Colo., which is far from railroad or telegraph lines, dated March 22, says:

“To-day about 1 o’clock a distinct earthquake shock was felt in the Yampa Valley from Pleasant Valley, about 12 miles south of Steamboat Springs, to Hayden, about 25 miles west of town. The shock was

accompanied by a report, resembling the discharge of a blast in a mine, accompanied by a long, low rumbling sound. The sound was accompanied by a distinct vibration, from east to west, and violent enough to cause windows to rattle and dishes and spoons to dance."—San Jose Mercury, March 25, 1895.

April 1.—EUREKA.—At 8.42 o'clock this morning a sharp shock of earthquake was felt here. The vibrations were from southwest to northeast.—Newspaper report.

April 6.—SAN JOSE.—The Evening News reported a shock "just before 7 a. m." The correspondent of the San Francisco Chronicle reported a shock about 6.45 a. m.

Not felt at Lick Observatory.

April 16.—PORT TOWNSEND, WASH.—Two slight shocks of earthquake were felt here shortly after midnight last night. Heavy brick buildings trembled and many people were frightened badly.—San Francisco Examiner, April 17, 1895.

April 17.—VACAVILLE.—Quite a sharp earthquake shock was felt here this morning about 12.30 o'clock. Some people were quite uneasy, it being only two days from the third anniversary of the great shock of April 19, 1892, when so much damage was done.

VIRGINIA, NEV.—There was a short, sharp seismic shock at 6 o'clock this evening.—San Francisco Chronicle, April 18, 1895.

April 18.—UKIAH.—A small unnamed island off the coast of this county (Mendocino), opposite Bournes Landing, is now in a state of eruption, according to the report of an observer. For some time past it has been reported that flames were issuing from the center of the isle. J. E. Meredith, who resides in Trinity County and who has been traveling along the northern coast for some weeks, passed the island Thursday. It was some time during the early evening, and he was attracted by a bright light in the west. The flames were so brilliant that he at first imagined they were caused by a burning ship at sea. On his return south the next day, however, he discovered smoke curling up and then saw it emanated from a peak on the island.—San Jose Mercury, April 22, 1895.

NOTE.—This has not been verified.—C. D. P.

April 19.—VICTORIA, BRITISH COLUMBIA.—A slight shock of earthquake, moving from east to west, was felt here a little before midnight. Buildings all through the city trembled and all the telephone calls came down together with a clatter.—Newspaper report.

April 27.—CITY OF MEXICO, MEXICO.—Colima volcano is again in a state of eruption, emitting great columns of smoke and fire, both night and day. The inhabitants of the immediate neighborhood of the volcano are leaving their homes.—Newspaper report.

May 1.—LAKEPORT.—Quite a severe shock of earthquake was felt here at 2.30 o'clock this morning. The vibrations were from west to east and lasted from five to seven seconds. No damage was done.

UKIAH.—May day opened with a severe shock of earthquake. It occurred at 3 o'clock and lasted some seconds.—Newspaper report.

May 21.—SAN JOSE—MOUNT HAMILTON.—The telephone operator in San Jose reported a shock of earthquake in San Jose about 10.45 a. m.

W. W. C. and R. H. T. (at Mount Hamilton) noticed *rattling* about that time, but felt nothing.

The duplex instrument shows a slight mark, probably from this shock, of 1^{mm} (earth's movement $\frac{1}{4}$ ^{mm}).—N. W.

Later it was learned that the nitroglycerin works at Pinole, Contra Costa County, had exploded at 10.40 on that morning. Doubtless the shock noted above was due to this explosion. Pinole is nearly 60 miles, air line, from Mount Hamilton.

May 28 to 31.—PERU AND CHILE.—San Francisco, July 19.—South American advices brought by the steamer *San Blas* to-day state that the south coast of Peru and the coast of Chile north of Valparaiso have been visited by a tidal wave which has done a great deal of damage. Earthquake shocks preceded the marine disturbance, and at Serena on May 28, at 1.30 a. m., a severe earthquake lasting forty-five seconds occurred. At 3.55 o'clock another shock followed. The shocks were felt along the coast, and on May 31 there were several severe shocks, and after one of them the sea made an incursion inland to a distance of 200 meters.—San Jose Mercury, July, 1895.

June 4.—SAN FRANCISCO.—A blast of 15,000 pounds of powder was exploded on Clarendon Heights.

No effect was noticed at Mount Hamilton.

June 11.—A newspaper report from New Whatcom, Wash., says Mount Baker (40 miles away) has been smoking or steaming, and that a new peak has appeared between the dome and south peak, visible at New Whatcom with the naked eye.

NOTE.—This report has not been verified.—C. D. P.

June 15.—PORT TOWNSEND, WASH., June 16.—Chimacum, a small farming center 4 miles from here, was terribly shaken last night at 8 o'clock by the falling of a huge meteor, which burst with a loud noise, and after causing a small-sized cyclone of several minutes' duration buried itself deep in the muddy bottom of a neighboring lagoon. The meteor struck with force enough to break crockery in farmhouses 3 miles away and created great terror among the residents. Ten hours after the occurrence the waters of the lagoon were still bubbling and seething, and were found to be hot. Systematic dragging of the lagoon failed to bring up any traces of the celestial messenger.—San Francisco Examiner, June 17, 1895.

June 20.—MOUNT HAMILTON.—9^h 43^m 26^s p. m., Pacific standard. "One shock of intensity II or III, northeast and southwest, third-story brick house."—C. D. P.

The duplex instrument shows a single displacement of the earth of about $\frac{1}{2}$ ^{mm} in a northeast-and-southwest direction with several very small vibrations at the end.

"About forty-five minutes after the first earthquake shock a star viewed in the 12-inch equatorial was seen to vibrate sharply over an arc of 1" or 2". The telescope was clamped at the time. If this was a second earthquake shock it was too slight to be felt."—R. G. A.

SMITH CREEK.—A lady visitor reported that the earthquake of June 20 was felt at Smith Creek. She was from San Jose, but did not feel it there.

June 23.—SAN DIEGO, June 16.—George Neal, a mining man, who is putting in a hydraulic plant at Juarez, on the peninsula, saw a sight on the desert last Sunday that filled him with amazement. He was in company with Lew Hosgate at the time. Their property is on the Tajo River. At that place the desert is in plain view for miles. Neal looked across toward the Cocopah Mountains, and was surprised to see a heavy column of smoke ascending from the central peak of the three Pichacos that rose several hundred feet. Neal and Hosgate watched the black column, and saw it shoot high into the air at intervals, and a distant booming sound was heard as of cannonading. The Indians told them that the Cocopah country was on one of its "tantrums" again, and that the mud volcanoes, gas fissures, hot springs, and fire volcanoes were all at work with more activity than ever before.

Many Cocopah and Santa Catarina Indians were reported to have fled from the mountains into the interior of the peninsula and over to the Colorado River. Gas wells or fissures exist, according to the Indians, which blow at irregular intervals, emitting a whistle which can be heard for miles.—Newspaper report.

NOTE.—This has not been verified.—C. D. P.

June 24.—MOUNT HAMILTON.—"9^h 25^m 36^s ± 2^s, standard Pacific time. One earthquake shock at the above time. I was observing with the 36-inch. Planet moved north and south over about 5" or 6".—E. E. B.

"A slight earthquake shock was noticed at 9^h 25^m 41^s, Pacific standard. The 12-inch equatorial telescope was directed at ν Scorpii at the time, and stars A and B were seen to vibrate three or four times over an arc of nearly 4" north and south in the field of view, coming back nearly to their original position."—R. G. A.

The duplex seismograph shows a single displacement of the earth of about $\frac{1}{8}$ " about north-northeast and south-southwest.

June 28.—SEATTLE, WASH.—Assistant Weather Observer E. O. Hobbs has recently been making some examinations on the summit of Mount Rainier with a small telescope and has discovered a large, dark crevasse through the center of Columbia Crest which can be seen plainly with the naked eye. A large snowslide has recently occurred at the base of Liberty Cap on the north side, and on the west side there appears to be several new crevasses of various sizes. Mr. Hobbs has also noticed the mountain steaming and smoking in the same manner as last winter.—San Francisco Chronicle, June 29.

NOTE.—This report has not been confirmed.—C. D. P.

July.—NANAIMO, BRITISH COLUMBIA.—Vancouver, British Columbia, July 9.—The earthquake shock at Nanaimo this week caused no little alarm in that city, it being thought that another explosion had occurred at the mines. The alarm was, however, soon dissipated, and the shock, which lasted a few seconds only, did no damage except the breakage of some crockery in houses and stores.

It may be worth noting, in this connection, that there are persistent reports by dwellers in the neighborhood of Hope, a small town about 100 miles up the Fraser River, to the effect that one of the small mountains in the Smimilkameen is an active volcano. Flames are seen shooting therefrom at night, and several parties have lately attempted, in consequence, to explore the vicinity.—Newspaper report.

July 26.—SANTA BARBARA.—4.10 p. m. Earthquake lasted three seconds. Vibration northwest to southeast.—San Francisco Chronicle, July 27.

August 4.—GILROY, CAL.—An earthquake shock was felt here at 2 a. m. to-day. The vibration was from west to east, and lasted but a second. No damage is reported.—San Francisco Call.

August 15-17.—VIRGINIA, NEV.—Six shocks of earthquake, two of which were quite severe, constitute the seismic record of Virginia, Nev., for the past two days.—Newspaper report.

September 1.—TACOMA, WASH.—The mountain climbers who returned to-night from Mount Tacoma report steam, smoke, and gas belching from the foot of Nisqually Glacier, where the Nisqually River has its source. The mountain climbers and mountaineers are much alarmed by the strange phenomenon.

At the rim of the crater, southeast of Columbia Crest, the ground is quite warm, notwithstanding the arctic atmosphere of the summit. Steam comes out of the crater at this particular point more freely than any other part.—San Jose Mercury, September 2, 1895.

October 7.—MILLS COLLEGE.—7.17 p. m. "With this I send a rather faint blue print of an earthquake tracing, the first I have observed for some time. The shock occurred about 7^h 17^m p. m., October 7, 1895, and was distinctly felt, though it was not severe. There was a slight premonitory rumbling, then a distinct shaking, giving one the idea of the exertion of great force."—Josiah Keep.

The tracing inclosed with the above is somewhat indistinct, and the limits of vibration consequently uncertain, but seems to be about 10^{mm} by 1½^{mm}, the longer direction being about north-northwest by south-southeast. The disturbance seemed to be composed of several nearly parallel waves.

ALBUQUERQUE, N. MEX.—The people of Sabinal and Jorales, two small settlements south of this city, are greatly excited over three distinct earthquake shocks, and many have moved from their homes into the mountains. The waves were from the southeast to the northwest and were so strong that houses rocked to and fro and household

goods tumbled from the shelves. The shocks were felt here last night but only slightly.—San Francisco Examiner, October 8, 1895.

October 14.—The tide gauge of the United States Coast Survey at Sausalito shows evidences of a heavy storm or earthquake. The irregularities in the record began at 8.20 a. m. on October 14 and lasted continuously for eighteen hours.—San Francisco Call, October 19, 1895.

October 20.—OLYMPIC MOUNTAINS, WASHINGTON.—This range was reported in active eruption about this time, but upon investigation it was found that the flames seen were those of forest fires and from a burning vein of lignite coal.

October 24.—AT SEA, off the California coast.—The ship *John C. Potter*, Captain Meyer, makes the following report to the Merchants' Exchange:

"October 24, in latitude $43^{\circ} 54'$ north and longitude $128^{\circ} 32'$ west, experienced a severe shock of earthquake, lasting 25 seconds. It made the ship shake as if it had jumped over a coral reef in a heavy swell."—San Francisco Chronicle, October 31, 1895.

October 31.—CHICAGO, ILL.—Prof. E. E. Barnard reports a sharp shock at 5^h 12^m 10^s–15^s a. m.

November 7.—MOUNT HAMILTON.—"5^h 46^m 34^s a. m., slight shock. 3^h 12^m 55^s p. m., two severe vibrations a second or two apart; direction of motion seemed to be *downward* and toward the northeast."—A. L. C.

"3^h 12^m 51½^s p. m., Pacific standard. In southeast corner room, first story, brick house. Heavy shock lasting four or five seconds; R. F., V. One or two light trembles and then two heavy waves, the principal direction *felt* being about southwest and northeast. Motion appeared to be almost entirely horizontal; could not distinguish any decided vertical motion. Some article in dark room fell to the floor after the heaviest shocks. Disturbance ended rather abruptly. Wind light, from northeast. Hazy. No noise noticed before the shock. A small notch in barograph record at this time. Barometer unsteady, but this notch seems as if it might be due to the earthquake." Notch is 0.01 or 0.02 of an inch in depth.—C. D. P.

The Ewing instrument was not started, but the pens show a vibration as follows:

East and west,	4.0 ^{mm} =1.2 ^{mm} displacement of earth,
North and south,	3.7 ^{mm} =1.1 ^{mm} displacement of earth,
Vertical movement,	10.5 ^{mm} =6.6 ^{mm} displacement of earth,

which, however, is very uncertain and is undoubtedly very much augmented by the "creep" of this pen due to temperature, which is large. The clock was started, giving the time as 3^h 12.7^m p. m.

The duplex seismograph shows a complicated series of motions, of which the greatest were east-southeast and west-northwest 7^{mm}, or 1¾^{mm} actual displacement of the earth. The greatest displacement of the earth at right angles to this direction was ¾^{mm}.

SAN JOSE.—The city was visited by a sharp shock of earthquake at

3.14 o'clock this afternoon, lasting ten seconds, the vibrations apparently being from east to west.—San Francisco Examiner, November 8, 1895.

SANTA CRUZ.—An earthquake shock, the heaviest in five years, was felt here at 3.15 o'clock this afternoon. The vibrations were from east to west.—San Francisco Examiner, November 8, 1895.

SAN JOSE.—San Jose was visited by an earthquake about 3.15 o'clock yesterday afternoon. There were two sharp shocks of short duration. No damage was done.—San Jose Mercury, November 8, 1895.

November 26.—**MOUNT HAMILTON.**—"A light earthquake shock was felt to-day at 1^h 56^m 35^s, Pacific standard. Its direction could not be noted. Its duration was but momentary. I should estimate its intensity on the Rossi-Forel scale as III."—R. G. A.

1^h 56^m 35^s p. m., Pacific standard. Light shock. Rossi-Forel II.—C. D. P.

Did not start the Ewing instrument. The east-and-west pen shows a vibration of the earth of about 0.5^{mm}, and the north-and-south pen a vibration of about 0.4^{mm}. The vertical motion is masked entirely by the "creep" due to temperature. The duplex instrument shows one (only) complete wave, about northeast and southwest, with a displacement of the earth of 0.4^{mm}.

November.—**KYUQUOT, BRITISH COLUMBIA.**—Victoria, British Columbia, November 30.—Kyuquot, an Indian village on the west coast of Vancouver Island, received a severe shock of earthquake early this month which the natives will long remember. Their little houses were shaken almost from their foundations, trees swayed, and considerable damage was done. The natives regarded the strange disturbance as the beginning of the end, when their dead relatives would rise from the earth and join them. They rejoiced greatly at the thought of such an event, and filled the air with sounds of gladness, firing off big guns, beating tin pans, and otherwise creating noises heard for miles away.—San Francisco Call, December 1, 1895.

December 8.—**FAIRFIELD.**—A few minutes before 8 o'clock this morning a heavy shock of earthquake was experienced here, lasting five seconds. Three distinct oscillations were plainly felt, the vibrations running from northeast to southwest.—San Francisco Chronicle, December 9, 1895.

FULLERTON.—A heavy shock of earthquake, closely followed by a lighter one, was felt here early this morning.—San Francisco Chronicle, December 9, 1895.

NAPA.—A distinct shock of earthquake was experienced in Napa yesterday morning, lasting several seconds.—San Francisco Call, December 10, 1895.

December 12.—**UKIAH.**—A slight shock of earthquake was felt in this city at 12.40 this morning. The oscillations were from east to west.—San Francisco Call, December 13, 1895.

December 23.—SANTA BARBARA.—About 9.30 this evening an earthquake was felt here which lasted several seconds.—Newspaper report.

December 28.—MOUNT HAMILTON.—9^h 12^m 13^s a. m., Pacific standard.—R. G. A.

9^h 12^m 01^s a. m., Pacific standard, by seismograph clock. Recorded on both seismographs.

The Ewing instrument shows a disturbance lasting about ten seconds in each horizontal component, and about six seconds in the vertical.

North and south.—The waves of shortest period and greatest amplitude occurred in this component, beginning within one second of the starting of the plate. The vibrations are of short period, but smooth and regular. The largest one measured had a double amplitude (magnified) of about $\frac{1}{3}$ ^{mm} and a period of one-fourth second, which according to the formula gives an intensity of 32^{mm} per second and would be between I and II of the Rossi-Forel scale. The main portion of the disturbance lasted about five seconds, some tremors for ten seconds.

East and west.—The first few vibrations are of short period, followed by slower vibrations of about two seconds. The greatest amplitude (double and magnified) is about $\frac{1}{4}$ ^{mm}.

Vertical.—Two waves of about two and one-half seconds each and a double amplitude of about $\frac{1}{4}$ ^{mm} (magnified).

The waves are all too small to measure with any great accuracy.

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