

DEPARTMENT OF THE INTERIOR

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BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 114

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EARTHQUAKES IN CALIFORNIA IN 1893

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WASHINGTON, D. C., *March, 1894.*



DEPARTMENT OF THE INTERIOR

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UNITED STATES GEOLOGICAL SURVEY

J. W. POWELL, DIRECTOR

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# EARTHQUAKES IN CALIFORNIA

IN

1893

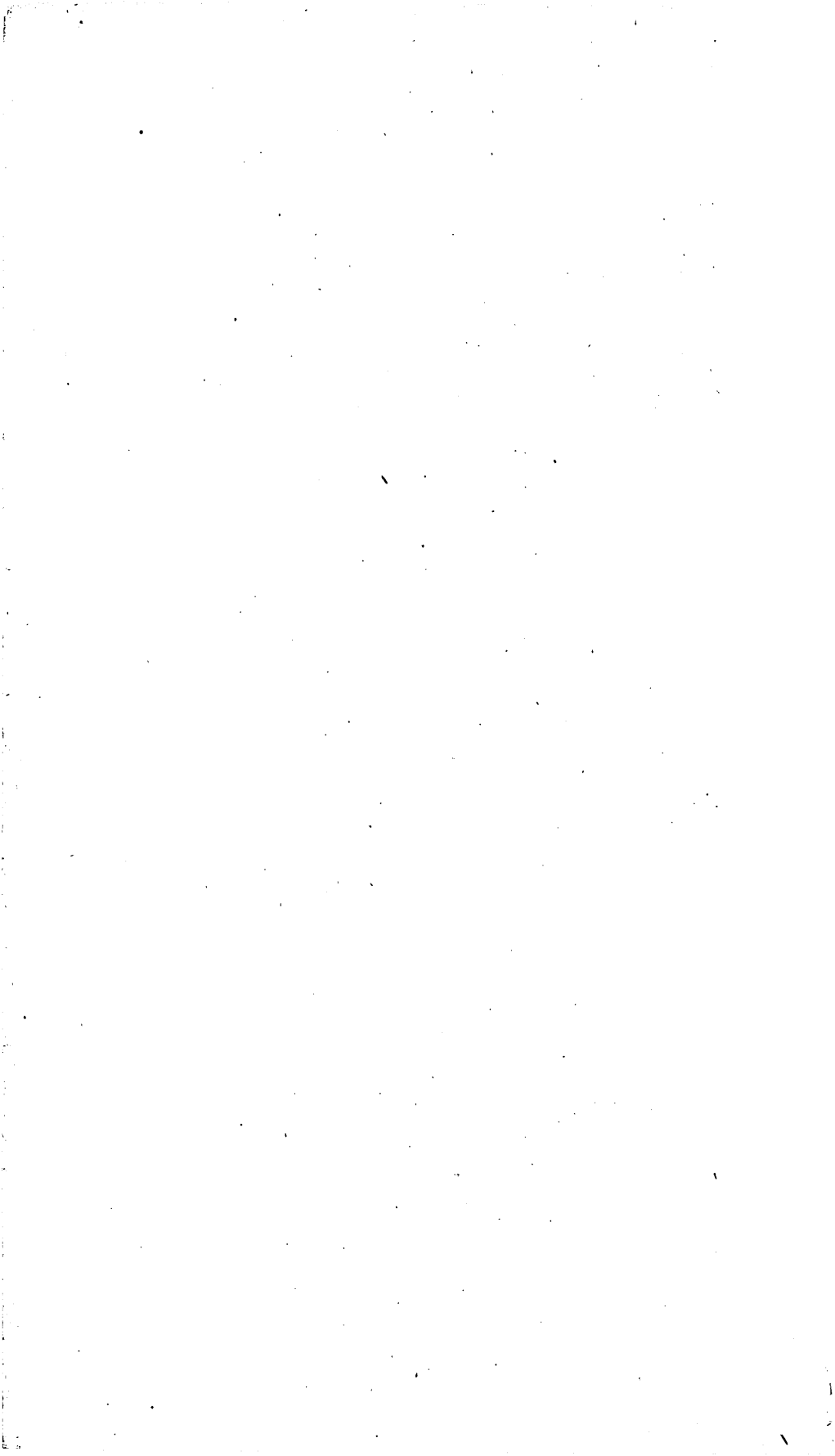
BY

CHARLES D. PERRINE

OF THE LICK OBSERVATORY



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1894



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## LETTER OF TRANSMITTAL.

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LICK OBSERVATORY,  
*Mount Hamilton, Cal., February 3, 1894.*

SIR: I beg to inclose with this a manuscript report of earthquake observations in California and Pacific coast States for 1893, compiled by Mr. Perrine, of the observatory, which I trust you may see fit to publish as a bulletin as usual.

Yours, very truly,

EDWARD S. HOLDEN,  
*Director.*

Hon. J. W. POWELL,  
*Director U. S. Geological Survey, Washington, D. C.*





# EARTHQUAKES IN CALIFORNIA IN 1893.

By CHARLES D. PERRINE.

## INTRODUCTION.

The following paper is a continuation of similar records furnished by officers<sup>1</sup> of the Lick Observatory, and completes the list up to the end of 1893. 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 that 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 uniformly 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.

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<sup>1</sup>List of recorded earthquakes in California, Lower California, Oregon, and Washington Territory from 1769 to 1888. By Edward S. Holden. Sacramento, State Printing Office.

Earthquakes in California in 1888. By Edward S. Holden. American Journal of Science, vol. 37, May, 1889.

Earthquakes in California in 1889. By James E. Keeler. Bulletin U. S. Geological Survey, No. 68, 1890.

Earthquakes in California in 1890 and 1891. By Edward S. Holden. Bulletin U. S. Geological Survey, No. 95, 1892.

Earthquakes in California in 1892. By Charles D. Perrine. Bulletin U. S. Geological Survey, No. 112, 1893.

The motion of the 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 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.

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 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 every one; 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 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, 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 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:

Student's Observatory, Berkeley, in charge of Mr. Leuschner.

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

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 Prof. Keep.

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

Alameda, at the residence of Mr. Perrine.

The reports of the U. S. Light-House Board and of the U. S. Signal Office (U. S. 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, 1893.

**January 13.**—MOUNT HAMILTON.—Prof. Holden reports the shock at 1:2:22 ± 5s. a. m. of intensity V, Rossi-Forel scale.

Mr. Colton reports the time as 1:2:25 a. m.

Mr. Townley reports the time as 1:2:16 a. m.

The duplex seismograph gives a complicated tracing, 5<sup>mm</sup> by 3<sup>mm</sup>.

The Ewing instrument shows a motion east and west in the horizontal, but none in either the north or south or vertical directions. The greatest amplitude of the Ewing *record* is 3<sup>mm</sup>, the shock lasting fifteen to twenty seconds. Mr. Colton's record shows that the first motion of the earth was to the east.

**January 25.**—WINTERS.—There was a shock of earthquake here last night at 9:40 o'clock and another about 1 o'clock this morning. Both were light, but pronounced enough to scare the timid.

**February 21.**—FAIRFIELD.—A heavy shock at 8:15 p. m., to-day.

**February 21.**—SUISUN.—A sharp shock of earthquake was felt here at 8:16 o'clock this evening.

**February 21.**—DIXON.—Quite a severe shock of earthquake was felt here at 8:20 o'clock this evening.

**March 3.**—GRASS VALLEY.—“A perceptible shock” was felt here at 6:15 a. m.

**March 6.**—UMATILLA, OREGON.—A succession of earthquake shocks were felt here to-night. One of the walls of a large stone building was thrown down by the force of the shock.

**March 27.**—SANTA ROSA.—A slight earthquake shock was felt here at 11:30 o'clock to-night. The vibration was from east to west and the shock was of only a few seconds' duration. No damage was done.

**March 30.**—INDEPENDENCE and LONE PINE, INYO COUNTY.—Mr. C. Mullholland reports as follows: "On the evening of last Thursday, March 30, at 10:30 o'clock, an earthquake occurred. The center of disturbance appeared to be at a point about 9 miles north from the south end of Owens Lake. At that point there is a strip of land 2 miles wide between the lake and the base of the Sierra Nevada on the west. But one shock was felt; this was very sharp; the earth motion may be likened to the result of a blow struck upon a plank by a sledge. At Lone Pine, 30 miles farther north, the shock was felt about the same time; the vibration was not so sharp, but more undulatory. Most of the day heavy clouds hung about the mountains, and at the time of the shock the whole sky was overcast. A very light wind was blowing from the west. No damage was done."

**March 31.**—VACAVILLE.—A sharp earthquake shock was felt here at 2:30 this morning. It lasted several seconds, and its direction was from north to south.

**April 4.**—MOJAVE.—At 11:40 a. m. to-day this place was visited by four distinct shocks of earthquake. Buildings were rocked for several seconds, creating considerable fright. At Saugus, 70 miles south, chimneys were knocked down and dishes and other household furnishings were broken. The impression is that the quake came from the northeast.

**April 4.**—SAN BERNARDINO.—A heavy earthquake, moving in a southeasterly direction, visited this city at 11:40 a. m. to-day. There was no damage.

**April 4.**—SANTA ANA.—A slight earthquake was felt in this city at 11:45 a. m. to-day, the movement seeming to be from west to east. The vibrations were so slight, however, that many people were not aware there had been any disturbance of the earth's surface until the fact was made known in the evening paper.

**April 4.**—LOS ANGELES.—At 11:48 this morning there was a slight earthquake of short duration. The movement was from west to east. In Observer Franklin's office the barometers were well shaken, and continued to oscillate perceptibly for two minutes at least. It lasted about eighteen seconds.

**April 4.**—SAN DIEGO.—There was a slight shock of earthquake at 11:42 a. m. It was felt only in the upper stories. It shook the barometer at the signal office.

**April 8.**—LOS ANGELES.—Alarming reports of seismic disturbances have just been received from the residents of the oil region of Newhall, 35 miles from this city.

Dating from last Tuesday, the day on which Los Angeles experienced a slight shake, there has been a terrifying series of temblors, accompanied by subterranean explosions. These disturbances have been frequent, and have been accompanied by landslides from the mountains of an alarming and dangerous description. A letter received

from there to-day gives an account of the shock on Tuesday. It is dated from Pico Canyon, about 8 miles southwest from Newhall. It reads substantially as follows:

"I was driving this morning when my horse became frightened without apparent cause, and there came a rumbling sound which grew terrifying. I looked up and saw an awful sight. Landslides from every peak in sight came tumbling down with huge bowlders. The mountains appeared as if myriads of volcanoes had burst forth and were combining their efforts toward universal destruction.

"When I got to the long bridge I saw Mr. Thomas standing dazed, holding to the railing, and others came running across the bridge. The earth opened in a number of places and the scene was indescribable. Men cried, prayed, and swore, and one kept shouting, 'My God, we are all going down to hell!'

"When I reached my house I found everything upset. Pictures, dishes, and everything breakable were smashed, and two stoves were broken all to pieces. All the afternoon lighter shocks continued, and also through the night."

Another letter dated on Friday says:

"On Wednesday night, just as I had gone to bed, 'Crash!' came another great shock. All night long they recurred, keeping us up until morning; and all day Thursday they continued, each preceded by a heavy subterranean explosion. The house the foreman lived in was demolished this time. Last night was less exciting, and at 3 o'clock this (Friday) morning we had another, which was fully as terrifying as the first. The shocks were worse in the canyon here than elsewhere, but at Newhall and all around this part of the county they have been terrifying."

**April 9.**—LOS ANGELES.—The San Fernando range of mountains, where the greater disturbance took place during the week, were pretty generally shaken up every day, beginning with Tuesday. The last temblor, a slight one, was felt in the canyon about 10 o'clock Sunday night. There were no shocks so severe as the first one, and they gradually lessened in force and frequency.

As far as can be learned the area of the temblors was not confined entirely to the San Fernando range, but dipped across the big Newhall ranch, past Saugus and over into the Castac and Piru mountains, north of Newhall. Strange as it may seem, although Newhall is only 8 miles from the Pico Canyon, where the shakes were more continuous than elsewhere, the people in that town did not feel many of them.

Just what connection there is between the oil region and the earthquakes is something that scientists may have theories about, but it is a fact that the greatest disturbance was in and around the oil wells of the Pacific Coast and San Francisco companies at the head of Pico Canyon. A picturesque and excellent road winds around among the hills and mountains up into the canyon. It gradually ascends and is

forever crossing and recrossing a briskly running creek, which tumbles down from the hills with a decided scum of oil on its surface.

A sudden turn in the road brings Mintryville in sight. This is a little town with a schoolhouse, and is the residence of the superintendent of the oil companies. Scattered about are pretty little cottages, the homes of employés. The canyon winds around and about, and at every little distance on the road to Pico, where the central engine house and wells are located, are the quaintly situated houses of employés.

One who has not visited the peculiarly formed canyon can hardly have a clear conception of the consternation with which the earthquakes were received by the 130 people who live in this vicinity.

Temblors that would, as these did, tilt up great oil tanks full of oil, detach immense bowlders from the mountain sides, weighing tons, and cause big surface fissures in the ground in various places, are not calculated to make people rest well at night, and when these disturbances continue at irregular intervals for five days it is a wonder that the women and children in the canyon bore the ordeal as bravely as they did.

Shortly after reaching Mintryville Mr. Mintry was found at home, and gave his recollection of the big earthquake of Tuesday.

"It was a few minutes after 12 o'clock," he said, "and I was just starting down for dinner. The men had nearly all left the derricks. Suddenly there was a peculiar swaying of the ground and an explosion which I can hardly describe. It was heavier than any blast I ever heard. I was on horseback, and the horse was frightened very badly. At first I thought of a boiler, but looking along the San Fernando range, as far as I could see east and west, there was a blinding cloud of dust. It rose directly up from the top of the range and was thick. All around me the dust rose from the hills in the near vicinity and earth and bowlders came tumbling down. The shock lasted between ten and fifteen seconds.

"I looked across the valley and saw the same thing in the Castac hills. That shock was the worst and it was accompanied by a rumbling sound. The shocks since that time have been smaller ones. They have not affected the flow of oil by either increasing or diminishing it. There was not the slightest disturbance in any of the wells. I have been here for nineteen years as superintendent of the oil wells, and this is the first time there has been an earthquake in this vicinity."

In conversation with other residents it was learned that both at the head of the canyon and at Mintryville, which is nearly 2 miles below, the first shock played havoc with the crockery in nearly all the houses in both places, and a lot of milk pans full of milk, a quantity of eggs, and the stove and nearly every loose article in one house were thrown in a jumble on the floor and mixed up with the ashes.

In another house the cellar was caved in at one corner, and had it not been for a stout underpinning the house would have fallen over.

One young man was in a cellar in Mintryville, and the shock caved in the walls so that he was nearly buried alive.

The schoolhouse had a large brick chimney, and after the shake there was not a whole brick left. Women ran out of their homes, nearly frightened to death; the chickens ran for cover as fast as they could, and the horses and cattle went tearing up or down the roads. An immense stone came tumbling down a mountain side and landed in among the pipe lines and tanks below, smashing things generally.

Strange to say, not one of the many huge derricks, which are from 40 to 70 feet in height, was overturned, although they swayed in an alarming manner. The roads were filled with dirt and bowlders, and it required a great deal of work to make them passable again.

The motion in all the shocks was a swaying motion, and the direction was from northwest to southeast.

An old and strong adobe house on what is known as the middle Newhall ranch, northwest of Newhall, was shaken completely down by one of the temblors.

It will take but one more heavy shake to depopulate the canyon, for the effect of the strain on the people's nerves is extremely severe.

**April 6-8.**—ALBUQUERQUE, N. MEX.—The inhabitants of the river towns south of the city are much alarmed over what they regard as the coming of a devastating earthquake. During the past forty-eight hours the earth has frequently shaken very distinctly. The depot at Las Lunas shook to such an extent early this morning that the agent fled in terror. The Indians living in the valley are also much excited, and, being naturally superstitious, fear that the earth is about to be rent asunder and their villages engulfed. No earth tremors have been felt here.

**April 8.**—ALBUQUERQUE, N. MEX.—Las Lunas, Belin, and several other towns along the Rio Grand River are all in excitement over what appears to be a series of infantile earthquakes. Four shocks have been distinctly felt since Thursday. There was one this morning, attended by ominous rumbling underground and of three seconds' duration, during which time eight or ten vibrations were felt. Glass was broken, dishes rattled, and a few frame houses in the towns swayed as if shaken by a terrible windstorm.

**April 13.**—HYDESVILLE.—An earthquake shock was felt here at 5 o'clock this morning. It was followed in fifteen minutes by another and severer shock, lasting fifteen seconds, and this was followed in fifteen minutes by another heavy shock.

**April 13.**—EUREKA.—A light shock of earthquake was felt here this morning at 5:10. No damage.

**April 21.**—SAN RAFAEL.—A slight earthquake shock was felt here at 11:15 o'clock this evening. The vibrations were from north to south.

**May 18.**—SANTA BARBARA.—A distinct shock of earthquake was felt here at 4:35 o'clock this afternoon. Buildings shook so that the people



in the second stories ran out. No damage has been reported. The vibrations were from northwest to southeast.

**May 18.**—**SATICOY.**—Three distinct shocks of earthquake were felt at this place at 4:36 this afternoon, lasting for forty-three seconds, with vibrations from north to south, causing dishes to rattle and hanging lamps to swing to and fro.

**May 18.**—**SAN PEDRO.**—Two distinct earthquake shocks of about six seconds duration, from north to south, were felt here this afternoon at 4:35.

**May 18.**—**SANTA ANA.**—The earthquake at 4:25 this afternoon was one of the hardest ever felt here, but no damage was done. A few people above the ground floors started for the streets, but it was a momentary fright only.

**May 18.**—**LOMPOC.**—A shock of earthquake was felt here at 4 o'clock this afternoon. The vibrations seemed to be from east to west. No damage is reported.

**May 18.**—**VENTURA.**—A very distinct shock of earthquake was felt at 4:35 this afternoon, lasting about fifteen seconds. The oscillation was east and west. Many people ran out of their houses.

**May 18.**—**OAKLAND.**—Yesterday morning at 10:03 o'clock two severe shocks of earthquake were felt in Oakland. The buildings on Broadway were shaken quite hard, and some of the people ran into the street.

**May 18.**—**CARSON, NEV.**—The monthly review of the Nevada State Weather Service for May, 1893, reports a shock on May 18, at 2:55 p. m. Mr. C. Mulholland reports from Los Angeles under date of May 18, as follows: "It is now 4:30 p. m., and an earthquake has just strongly shaken the building in which I am. Furniture in the room vibrated so much as first to attract my attention. The motion appeared to be from west to east. There were several—four to six—short, jerky vibrations. Atmosphere still, sun shining brightly, no damage observable."

**June 1.**—**SANTA BARBARA.**—Santa Barbara felt another earthquake this morning about 4 o'clock, which lasted several seconds. It was considerably heavier than the one two weeks ago.

**June 6.**—**SAN FRANCISCO.**—"There was an earthquake yesterday morning and either the people of the city show a decided tendency to exaggerate such incidents or the seismograph kept by Prof. George Davidson has a method of misrepresenting things peculiarly its own. The shock was felt all over the city, but the little instrument which recorded it testified that it did not amount to anything.

"It happened at 9:25 o'clock yesterday morning. Buildings shook, windows rattled, and men employed in down-town houses rushed out to see what it was all about. The city has not had a shock worth noticing in a long time, and that of yesterday reminded everybody within its walls that such affairs do come occasionally.

"The shock was felt very differently by the people living in different parts of the city. On Telegraph Hill and out on Pacific Heights it was felt very much more keenly than in the Mission and on lower ground.

"Its motion was from east to west. In consequence those houses with their longest length running in that direction felt it most. In Oakland it was considered to be more than usually severe, but it appeared to have materially spent its force when it reached this city.

"In the office of Prof. Davidson, in the Appraisers' building, a curious occurrence was noted. There were three men in the room. One was standing and facing west at the moment the shock came. The other two were sitting, one facing south, the other north. While the two men who were sitting felt the earthquake and thought it a severe one, the man standing did not feel it at all."

The earth trembled only for two seconds.

**June 6.**—ALAMEDA.—Quite a shock of earthquake was felt in Alameda this morning, at about 9:30 o'clock.

**June 18.**—SANTA ROSA.—This city experienced a slight earthquake shock at 5 o'clock this morning. The vibrations were quite distinct, but no damage was done.

**June 30.**—VALLEJO.—Two pronounced earthquake shocks were felt this morning which created considerable excitement for the few moments they lasted. The first shock was felt at 5:30 o'clock, and was closely followed by the second shock, which awakened people and was accompanied by a distinct rumbling noise. The vibrations lasted about two minutes. No damage was done beyond the breaking of crockery.

Lieut. Pond, of the Naval Observatory, states that the shock was quite noticeable on Mare Island.

**June 30.**—SAN RAFAEL.—A heavy earthquake was felt at this place at 5:35 this morning; the shock lasted upward of seven seconds. The vibrations were from the north to the south. Some glassware in some of the hotels in and around town was broken.

**June 30.**—PETALUMA.—A slight shock of earthquake was felt here at 5 o'clock this morning. The vibration was from north to south and was of short duration.

**June 26-30.**—The San Francisco Call of July 7 contains a story of terrible earthquake shocks and other calamities experienced on San Nicolas Island (one of the Santa Barbara group, off San Diego some 70 miles) as brought by the captain of the steamer *Jennie Griffin*, but further investigation renders it very doubtful whether any great disturbance occurred.

**July 12.**—ALBUQUERQUE, N. MEX.—Three shocks of earthquake that shook from west to east, every house in the city and vicinity and every movable article were distinctly felt here this morning between 6 and 7 o'clock. The chandeliers in the Commercial Club, a stone structure, rocked for at least ten minutes, and the early risers at the club became very much agitated. A number of clocks throughout the city

stopped, and a lodger at one of the hotels became so frightened that he jumped out of bed and cried for help. The wave came from the west.

**July 30.**—SAN FRANCISCO.—An earthquake aroused many people about 1:30 o'clock yesterday morning. It was a short, sharp shock. The motion was from the southwest.

**July 30.**—OAKLAND.—Two light earthquake shocks were felt in Oakland at about 1:30 o'clock this morning. The shocks followed in quick succession, with scarcely a second elapsing between them. No damage was done.

**August 5.**—MOUNT HAMILTON.—A very light shock of earthquake started the clock (only) of the Ewing seismograph at 9:16 p. m. and registered on the duplex as a very simple tracing of only one or two vibrations nearly east and west, the maximum amplitude of the tracing being 2·5<sup>mm</sup>. It was not felt by anyone at the Lick Observatory.

**August 9.**—SAN FRANCISCO.—A sharp earthquake shock was felt at 1:15 this morning. Messages by telephone from Santa Rosa and Sacramento state that it was quite severe in those places. So far as known no damage was done.

**August 9.**—SAN DIEGO.—Two slight shocks of earthquake were noticed by the local observer of the weather bureau to-day, one occurring at 11:02 a. m. and the other at 4:07 p. m.

**August 9.**—ALAMEDA.—Quite a sharp shock was felt at 1:15 a. m., Mr. Perrine's duplex seismograph giving a tracing 5<sup>mm</sup> in a northwest and southeast direction, and at right angles to this 1·5<sup>mm</sup>.

**August 9.**—PETALUMA.—A lively shock of earthquake was felt in this city at 1:10 this morning, followed for some time afterwards by tremors. In all, six shocks were felt, the first one being the heaviest. It was the most severe felt here for years. The vibrations were north to south, and lasted fifteen seconds. No damage is reported, but several clocks stopped, plaster cracked, and crockery was thrown from the shelves. Many people were badly frightened.

**August 9.**—SANTA ROSA.—The severest earthquake felt here since 1868 occurred this morning at 1:12 o'clock. The oscillations were apparently southeast and northwest. Considerable damage was done in the way of falling chimneys, broken windows, etc. The court-house was badly shaken up, and the plastering extensively damaged.

**August 9.**—SONOMA.—The residents of this valley were awakened at 1 o'clock this morning, by a heavy shock of earthquake. The vibrations were from east to west.

**August 9.**—SAN RAFAEL.—This morning at 1:10 o'clock, two severe earthquake shocks were felt here. The vibrations were from east to west. The second shock was the heaviest.

**August 9.**—HEALDSBURG.—A sharp shock, or rather three continuous shocks of earthquake, occurred here at 1:10 o'clock this morning. The sky which was clear was in a few minutes overcast with fog clouds—something not witnessed here for several weeks, although usual in summer.

**August 9.**—SAN FRANCISCO.—Yesterday morning the Catholic churches of this city celebrated the feast of St. Emigdius. High mass was celebrated in the principal places of worship in honor of the day, with the especial object of obtaining the protection of St. Emigdius and his prayers to Almighty God, asking for his protection against the calamity of earthquakes, for he is patron against such disastrous visitations.

This observance with high mass was introduced by Archbishop Alemany after the alarming earthquake which visited this city in 1868, and has been celebrated in most of the Catholic churches in the United States since that time and received the sanction of the Pope.

At St. Mary's Cathedral the services were celebrated by Father Prendergast at 9 a. m. A large congregation was present and offered prayers to the holy saint. The father reviewed the life of St. Emigdius, showing the many godly deeds which had brought him to the light of Christ and made him the guiding star of his many followers. The choir, rendered excellent music, which added much to the grandeur and solemnity of the occasion.

**August 12.**—MILLS COLLEGE.—Prof. Josiah Keep sends a tracing of a slight but quite sharp disturbance recorded on his seismograph, at 12:50 p. m. The record shows a displacement of the pen amounting to 5 mm.

**August 12.**—ALAMEDA.—A very light shock was felt about 12 m. Mr. Perrine's duplex seismograph gives a tracing of but a single vibration.

**August 14.**—TOUTLE RIVER, WASHINGTON.—Mr. Fred G. Plummer reports a disturbance as follows: "Earthquake observed August 14, 1893, at 5:07 a. m., at camp of my exploring party on Toutle River N. 40° W.—11 miles from summit of Mount St. Helens, Washington. One sharp shock *vertical* about 1½ inches. Distinct rumbling preceding for four seconds, near at hand toward the mountain."

**September 1.**—GILROY.—A sharp shock of earthquake occurred tonight at 11:20 o'clock. It was of several seconds' duration.

**September 2.**—SAN JOSE.—Mr. Colton reports that he felt a slight shock of earthquake shortly after 10 p. m., exact time not noted, while in his room at the St. James Hotel.

**September 6.**—REDDING.—Quite a severe shock of earthquake was felt here at 8:22 o'clock this morning, preceded by rumbling. It lasted several seconds and the vibration was north and south. No damage.

**September 7.**—LAS LUNAS (N. MEX.)—Central New Mexico, has been subject almost daily for more than three months to violent earthquakes. Five commotions Thursday, September 7, threw down a score of old adobe buildings already shaky from previous earthquakes. No lives were lost, but a peculiar feature is that there were numerous cases of nervous sickness, even convulsions, among the inhabitants as soon as the rumbling commenced. The center of the disturbance is Sabinal,

where a spring has appeared in a place which always had been dry and barren.

**September 28.**—MOUNT HAMILTON.—Prof. Holden reports the time as 6:20 a. m. Intensity II, Rossi-Forel scale. Mr. Colton was awakened by the shock and reports "one slight shock," the time being 6:20:10 a. m., Pacific slope time. The Duplex seismograph shows a slight mark of disturbance.

**October 15.**—SANTA CRUZ.—A severe shock of earthquake was felt at 5 o'clock this morning. The undulations were from west to east.

**November 7.**—GUADALAJARA, MEXICO.—A severe earthquake has occurred here during the past ten days. The Colima volcano is in a violent state of eruption, and people living at the base of the mountain have left their homes in search of a place of safety.

At the town of Americus the first severe shock did great damage to property, and several persons were wounded by falling houses. The disturbance was felt in the States of Oaxaca, Puebla, Guerrero, Morelos, and Jalisco.

**November 6.**—VICTORIA (B. C.)—The steamer *Topeka* brings word from Alaska that there have been four earthquakes during the summer at St. Augustine Island (Chorna Borna), where the mountain is now emitting dense clouds of smoke, forewarning another eruption. The natives, remembering the devastation caused by the eruption twelve years ago, are deserting the island in haste, abandoning all their interests. The last eruption rendered useless all existing charts of the neighboring waters, causing no fewer than five shipwrecks.

**November 21.**—CAPISTRANO.—A slight shock of earthquake was felt here to-night about 7:48 o'clock, which lasted only about two seconds, but made the buildings creak. Judging from the motion of the swinging lamps, the vibrations must have been from west to east.

**December 6.**—VICTORIA B. C.—An active volcano on the American side of the straits was one of the scenes witnessed by the passengers on the steamer *Maud*, which returned from Alberni to Victoria, British Columbia, yesterday.

**December 12.**—LAKEPORT.—Quite a severe earthquake was felt here at 3 o'clock this morning. The vibration was from west to east. No damage was done.

**December 12.**—UKIAH.—This city experienced a sharp shock of earthquake at 3:15 o'clock this morning. The clocks in the public buildings were stopped. Vibrations were from south to north.

**December 17.**—ONTARIO.—Quite a sharp earthquake shock was felt here at 10:50 o'clock to-night.

**December 18.**—RIVERSIDE.—A slight shock of earthquake was felt here last night at 10:40 o'clock. The vibrations, which lasted only a few seconds, were from south to north. No damage was done.



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