Reports

of

The Great California Earthquake

of

1857

Reprinted and Edited

With Explanatory Notes

Version 1.01

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Abstract

This publication reprints 77 primary accounts that describe the effects of the "Fort Tejon" earthquake of January 9, 1857, which was caused by the rupture of the San Andreas Fault from Parkfield to San Bernardino. These accounts include 70 contemporary documents (52 newspaper reports, 17 letters and journals, and one scientific paper) and seven reminiscences, which describe foreshocks, felt effects, faulting, and some of the aftershocks associated with this earthquake. Most of the reports come from the major populated areas: Los Angeles, Santa Barbara, Santa Cruz, San Jose, Sacramento, and Stockton, but other areas are also covered. Notes on toponomy and other historical issues are included. These documents were originally published as a microfiche supplement to Agnew and Sieh (1978); this reprinting is intended to make them more widely accessible on the occasion of the 150th anniversary of this earthquake.

1 Introduction

The collection of earthquake reports reprinted here began in 1972, as a project for a class on seismology taught by Clarence Allen, in which I learned that the southern extent of faulting in the 1857 "Fort Tejon" earthquake was uncertain. From reading Arrington (1958) in a previous course in Western US history, I knew that there had been a Mormon colony in San Bernardino in 1857, and that most colonies kept a daily journal. A trip to the Church Historical Office in Salt Lake City found such a journal, and a search through available newspapers showed many more accounts than had been used by Wood (1955). Over the next few years I continued to collect reports as time allowed. In 1976 Kerry Sieh, with help from an undergraduate assistant, Dan Burd, began collecting 1857 reports to add to what I had done for Clarence Allen. When Kerry learned that I was still working on this earthquake, we combined our efforts to produce a single collection of sources, which was published (with interpretation) as Agnew and Sieh (1978), and also led to a separate paper on foreshocks (Sieh, 1978a).

In order to save space in the 1978 publication, the original accounts were included as a microfiche supplement—which, by now, makes them nearly inaccessible. Recognizing the approach of the 150th anniversary of this earthquake, it seemed appropriate to make these accounts more widely accessible by reprinting them in a document that would be permanently available on the Internet through the University of California eScholarship initiative.

The source material here is from the typescript version put on microfiche, though all accounts have been re-compared with the original notes or with photocopies of the original sources. In some cases elisions originally made have been restored, and I have used the greater flexibility of computer typesetting to match the original printing more closely. I have added the original Spanish-language versions from *El Clamor Publico* in Los Angeles, as well as the translations. The notes have been converted to a running set of footnotes, which have been modified in a few cases. Agnew and Sieh (1978) contained a table of geographic locations; for this reprinting I have replaced this with an index of places (at the end of this document).

I have not added any additional sources to this collection. As was noted in the original publication, we omitted any newspaper accounts that simply reprinted reports that

were directly available from other newspapers. Martindale and Evans (2002) indicate that additional sources are available, but their work has not yet been published.

Additional research on this earthquake since the publication of Agnew and Sieh (1978) has largely covered two areas. One is the generation of synthetic ground motions from a model source for this event; for example, Bouchon and Aki (1980), Butler and Kanamori (1980) and Evernden *et al.* (1981). The other is estimating the fault slip from offset features, which was first done by Sieh (1978b). Additional studies using offset streams are Lienkaemper and Sturm (1989). Grant and Sieh (1993), and Lienkaemper (2001); Grant and Donnellan (1994) and Runnerstrom *et al.* (2002) have used survey corners set in 1855 and remeasured much later, and Meisling and Sieh (1980) looked at the effects of the earthquake on trees close to the fault. Other studies (Pollitz and Sacks, 1992; Sanders, 1993; Harris and Simpson, 1996; Smith and Sandwell, 2006) have looked at the effects of this earthquake on the stress field and on later seismicity.

Finally, Meltzner and Wald (1999) have revisited the accounts here, and other records of aftershocks, to get sizes and locations for some of the largest aftershocks of the 1857 mainshock.

2 Sources

As in Agnew and Sieh (1978), the sources are numbered, and arranged from south to north (with a few accounts, found at the end of the process, making up the last few numbers). The following table shows the page on which each account starts; the index of places (page 59) can be used to locate accounts for particular locations. Maps and some coordinates are available in Agnew and Sieh (1978).

List of Sources

1. Portion of a letter from Albert Johnson to "Mother and all", February 3, 1857. (Johnson Papers, Arizona Historical Society, Tucson, Arizona)

I must tell you about the earthquake we had down the river. We were tied up along the bank waiting for the vessel one day. [1] Alonzo was in the aft-cabin and Mr. Neah and the second engeneer and myself were in the cabin, when all at once the boat began to rock. The tide was on the ebb and we thought that it was the boat slipping off the bank. Just then Alonzo came in and sad there was an earthquake. We all ran out. The boat rocked so that we could hardly stand. We looked up the river and the water all drawed off of one place and left it dry. Then in a moment all rushed back again foming and tumbling. That was the only earthquake I ever saw on the river.

2. San Diego *Herald*, January 10, 1857 p. 2

Our city [2] was visited with a slight shock yesterday, (Friday) morning, at half past 8 o'clock. It lasted about half a minute, and appeared to pass from east to west.—Considerable alarm was manifested by a few of our citizens, and many seats around breakfast tables were vacated without a request to leave. At the storehouse of C. Gerson, several articles of merchandize were thrown from the shelving. The shock, so far as we have been able to learn, was unattended by any noise or other signs of premonition.

[1] Unfortunately neither the time nor place of observation is given, but we can make some inferences about them. Another portion of Johnson's letter shows him to have been aboard a river steamboat. It would appear that the steamboat was waiting to pick up supplies from an ocean-going ship at the mouth of the Colorado River (for a discussion of this river trade, see Sykes (1937)). That this is consistent with a date of January 9 is confirmed by the diary of Louis Jaegar at Yuma (Beattie, 1929), which says that a steamer went down the river January 2 and returned January 21, having picked up supplies from "the vessel", The most reasonable location for Johnson is that one at which Ives (1861) said he found the steamboats waiting in December 1857, a point 15 miles above Robinson's Landing. Comparison of the maps in Sykes (1937) leads a location near 31.88°N, 114.93°W.

[2] This would be what is now "Old Town".

3. Extracts from MS Meteorological Journal of Andrew Cassidy, January 1857 (R4.3, Public Records Collection, San Diego Historical Society, San Diego).

[January 9] [3] At 8^h 50^m A.M. [4] A shock and vibrating motion from N.E. to S.W. lasted two minutes & 10 seconds felt at this place. [5]

[Undated] Since we have had the shock on the 9th the spring of water in this vicinity discharge about three times the amount they did before. One in particular about fifteen miles from this place which discharges treble if not more.

16^{th} A shock felt here at 5^h 10^m P.M. lasted 0^h 1^m 20^s—apparently horizontal motion E. to W.

4. Record of Dr. John S. Hammond, San Diego, as provided to Benjamin Hayes (p. 908, Hayes MS "Pioneer Notes", Catalog No. CE 62 (Photostat), Bancroft Library, Berkeley)

January 9^{th}, 1857, 8^h 31^m A.M.

Horizontal oscillatory earthquake moving N. and S. with a rumbling noise. The duration was about three minutes. [6]

5a. Portion of a letter from D. M. Thomas, January 18, 1857, San Bernardino (In MS "History of San Bernardino", compiled by Andrew Jenson, Historical Department, Church of Jesus Christ of Latter-Day Saints, Salt Lake City)

On Friday morning, the 9 inst., about 8 o'clock, we had a very severe shock of earthquake. The vibration continued about two minutes; the motion was from north to south, and apparently undulating. Many of the people ran out of their houses. It was accompanied with a rumbling noise, and produced a sensation of giddiness, and some were sick similar to sea sickness; every thing (houses, trees, cattle and people) had the appearance of being drunk. I have felt many shocks before but this was different and caused a sensation unlike any I have ever experienced...There has been more or less vibration every day and night since. On last evening we had quite a shake of the regular kind. There is quite a fissure caused by the earthquake in the western part of the city... [7]

At the Monte and Los Angeles the shock was about the same as felt by us here...

5b. Portion of a letter from Amasa M. Lyman, January 1,p, 1857 (In MS "History of San Bernardino", as above)

...We have a succession of shocks of earthquakes, which have, in our locality, raised more excitement than they have done real damage...

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[3]The first two entries are not dated; the first one is on the line for January 9. Lack of adequate space results in each entry running over several lines and therefore several days.

[4]This time is exceptionally bad (see the times in (55)), especially since Cassidy, according to an 1853 entry in his MS notebook "Miscellaneous Notes on the Tide Gauge ... at San Diego, Cal" (R4.3, Public Records Collection, San Diego Historical Society, San Diego) had a chronometer which was kept set to San Diego mean time.

[5]This would be where the tide gauge was located, at La Playa, on the east side of Point Loma.

[6]This would be at Fort Stockton, on the hill adjacent to Old Town.

[7]See note 8

6. Extracts from MS Journal of San Bernardino Mission, kept by R. R. Hopkins, official recorder, January 1857 (Catalogue #1421, Historical Department, Church of Jesus Christ of Latter-Day Saints, Salt Lake City)

Friday 9 At 25 minutes past 8 o'clock this morning our city was visited with a violent Earthquake which crack the walls of most of the Houses in the place the water in the stream was violently agitated and thrown several feet high. The trees swayed to and fro as if in a strong gale, though the air was calm. There was two shocks the first lasted two minutes and in about ten minutes there was a second shock not so violent which lasted about one minute.

Saturday 10 ...Last night there was two quite severe shocks, though not so severe as yesterday.

Tuesday 13...The Earth oselates slightly though preceptible every day.

Friday 16 At 15 minutes of five o'clock p.m. we had a very severe shock of an Earthquake though short. The house shook peceptably for a minute. The Inhabitants of the City fled from the houses to the Street.

Saturday 17 ...The Earth quakes slightly throughout the day & night.

Monday 19 ...There was several slight Earthquakes yesterday & last night.

Saturday 31 There was a severe Earth Quake ~~last night~~ at 10 minutes past one o'clock pm accompanied with loud reports Similar to the discharge of Cannon. The reports were in the mountains.

7. Reminiscence by Augusta J. Crocheron (From Crocheron, 1885, pp. 371-372)

Can any one who has ever experienced an earthquake, overcome a dread of its recurrence; or mistake the signs that are usually premonitors of its coming? One pleasant morning I was searching through garden paths for roses for the breakfast table, when the air seemed to hold still, not a breath stirring. I heard a far off smothered, rumbling sound, that I scarcely noticed, for I thought I was growing dizzy, and not understanding why I should feel so, I started for the house. As I stepped across a narrow stream, the opposite bank seemed first to recede from me, then instantly to heave upward against my feet. As this threw me from my equilibrium, the water emptied out on either bank, and hearing an Indian's voice in loud supplication, I turned and saw our Lothario on his knees, the ground rising and falling in billows around him. At the same instant I saw my parents and sisters clinging to large trees, whose branches lashed the ground, birds flew irregularly through the air shrieking, horses screamed, cattle fell bellowing on their knees, even the domestic feathered tribe were filled with consternation. Voices of all creatures, the rattling of household articles, the cracking of boards, the falling of bricks, the splashing of water in wells, the falling of rocks in the mountains and the artillery-like voice of the earthquake, and even that awful sound of the earth rending open—all at once, all within a few seconds, with the skies darkened and the earth rising and falling beneath the feet—were the work of an earthquake. It passed—we rejoined each other, thankful that life was spared, and looked around with trembling, upon the scene, where utmost terror had reigned. Said father, it is scarcely time to congratulate ourselves, another shock may occur in half an hour. In suspense we waited, and it came. Then the skies cleared, the air moved with cool, swift wings,

the stream ran clear, and the earthquake's spell had passed. When we ventured to walk around at a little distance from the house, we found, about twenty rods away, a rift in the solid ground, a foot wide, a hundred feet long, and so dark and deep, we feared even to measure it. [8]

8. Los Angeles *El Clamor Publico*, January 10, 1857, p. 3, col, 1

Ayer á las 8 de la mañana se sintió aqui un terromoto tan fuerte y prolongado que duró cerca de dos minutos. La undulacion de la tierra fué de norte à sur. Los habitantes llenos de la mayor conternacion abandonaron precipitadamente sus casas y se reunieron en la calle. No ha habido desgracia en ninguna persona, y solo algunas casas se cuartearon. Este temblor no fué tan fuerte y pronunciado como el del año pasado, pero duró mucho mas tiempo que aquel. Se han visto fenòmenos bastante curiosos: se salió el agua de las sanjas, y los pájaros se juntaron y chillando seguian el movimiento de la tierra, impelidos por alguna fuerza invisible.

Parece que los temblores están a la òrden del dia. En la tarde de ayer y esta noche se han experimentado otros sacudimientos mas o menos fuertes. Algunos dicen que son seis los temblores que se han sentido en menos de 24 horas, coas que nunca se habia visto aquí.

At 8 o'clock yesterday morning an earthquake of great strength and duration, lasting about two minutes, was felt here. The undulation of the earth was from north to south. The inhabitants fled from their houses in terror and gathered in the streets. No one has been injured and only some houses were cracked. This earthquake was not as strong as last year's, but it lasted much longer. Very strange phenomena were seen: water sloshed out of zanjas, and flocks of birds, screeching loudly, followed the motion of.the earth as if impelled by some invisible force.

Earthquakes seem to be the order of the day. Yesterday afternoon and tonight there have been other tremors of different strengths. Some say that six earthquakes have been felt in less than 24 hours, which has not happened here before.

9. Los Angeles *El Clamor Publico* January 17, 1857 p. 2, col. 2

A las 8 de la mañana comenzó el primero que duro entre 80 a 90 segundos, poco sensible en su principio, fuerte en su medio, y un poco menos fuerte en su conclusion; percibiéndose muy bien que el centro de la parte de la tierra que pisamos, se

[8] Twenty rods is about 100 m. This fissure is very probably the crack mentioned in (5). Crocheron (1885, p. 340) says that their farm lay on the edge of Lytle Creek, which is west of San Bernardino. According to Beattie and Beattie (1939, p. 303), Augusta J, Crocheron was the daughter of Caroline and Alden A. M. Jackson. The deeds registered in the San Bernardino County Recorder's Office show one land purchase by Alden A. M. Jackson before 1857, of "five acre lots number One, Two, Three, and Twenty-Eight in Block number Twenty Four" and "lot number Nine in Block Sixteen" (deed of November 17, 1855, Deed Book A, pp. 106-107). The maps in the Recorder's Office (particularly Map Book 7, pp. 1-3, and Map Book 2, pp. 9, 26, and 65) and the maps in Raup (1940) show the latter parcel to be near 2nd and Sierra, on the east side of town and not near Lytle Creek. The lots in block 24 fall within a rectangle measuring 388 meters north-south by 314 meters east-west, and bounded on the east by Mount Vernon and on the north by 5th. This area does border on Lytle Creek. It is interesting to note that the crack could not have coincided with the active Claremont fault as shown by Sharp (1972) and Sieh *et al.* (1973).

estremecia a manera de un mecimiento violento. Un temblor de tanta duracion y extraño movimiento pocas veces se esperimenta. Las agueas, en charcos estancadas se batieron haciéndo olas y salian de su centro: las de las asequias, que circundan la poblacion y que corrian cristalinas, se batieron igualmente, espesándose con el lodo del sedimiento y desbordaban. Los perros hullaban; las bestias se detenian, como estacadas, inmoviles sobre sus cuarto pies los pajarillos, atónitos, seguian agrupados, dando chillidos, en movimiento, parece, que de Sur a Norte, como impulsados por una corriente invisible. La gente se salió a las calles, mucha casi sin poder sostenerse en pié, y atemorizada, pedia de rodillas, *¡misericordia Señor!* Las casas se cuarteáron, y a no estar lijeramente techadas de asfalto, se habrian desplomado, y el terremoto hubiera sido tan funesto como el de San Salvador en Centro-America.—No pocas personas se resintieron de nauceas y revolvimiento de estómago; y las márgenes del riachuelo inmediato, han resultado, en una larga estension grietas, mas ó menos abiertas. Unos cuantos minutos despues de las 8 hubo otro sacudimiento de corta duracion: a las 11 de la noche se repitió el tercero, que duró 4 segundos; sintiéndose otros tres en el curso de ella, siéndo seis el total que la generalidad ha sentido; pero hay fenomenamente algo mas. Desde el primer sacudimiento a las 10 de la mañana hasta las cinco de la tarde, la tierra ha estado en una continua oscilacion, que ha necesitado poner mucho cuidado para percibirla, pudiendose asegurar que ha habido, no pocos, sino varios periódos, y hasta de a 20 minutos, temblores imperceptiblemente. Parecia que la tierra cansada de resistir tanto nuestras maldades, se sacudia de nosotros, como las aves sacuden lo que a sus plumas estorba.—Un dia antes, las nubes chocaban unas con otras, semejando un combate aereo. Una Señora, observándolas, predijo estar próximo algun suceso en la tierra; y hasta el canto de los gallos ha parecido indicativo. De cuatro o seis semanas a esta parte, estamos observando una nueva especie de niebla blanca y polvorosa desconocida, que aparece no todos los dias, en la atmósfera, y algunos que han pasado un rato debajo de ella, les queda pegada en los cabellos a manera de polvorizar harina o ceniza en la cabeza. Y si no es una equivocacion, nos estan pasando por encima algunas corrientes sordas aereas, que si no son la causa, han influido en estos temblores.

Tales fenómenos desiariamos fueran consignados al exámen de naturalistas; deben tener presente que, el invierno pasado, entre 1855 al 56, fue tan escaso de aguas que los campos no se vistieron de todas sus periodicas veperaciones; y que el actual invierno, estacion regularmente prencipia entre Octubre y Noviembre, se ha retardado notablemente, y tanto, que la primera lluvia cayó el 28 de Diciembre. La superfine de esta comarca se cree, con fundamento, este sentada sobre capas, ó tal vez profundas corrientes, ó grandes concavidades de asfalto, segun los diversos ojos, ó veneros que de ese mineral se encuentran en ella. Tenemos, pues, que á los doce dias, de estar bañando las lluvias á esta comarca, contados desde el 28 de Diciembre hasta el 8 del presente, se han pronunciado los temblores, como si produjera una alteracion elemental, el dilatado periodo de resequedad, con las recientes lluvias.

En la noche del 9 al 10, se repitieron, por tres veces mas, los temblores, aunque no momentáneos; continuando el tiempo, bajo un aspecto, todavia amenazante.

Las noticias que nos estan llegando de fuera son de que se han dejado sentir a largas distancias. En el puesto militar del Tejon, 35 ó cuarenta leguas distante de aquí, fueron mas sensibles; la tierra se abrió tres millas a lo largo, tragándose la arboleda de

encinas, y quedando formado en esa estension, un nuevo zanjón; unas cuantas casas cayeron, matando una de ellas a una muger. En San Buenaventura a 26 leguas de aquí, la iglesia sufrió mucho, y parte de la torre cayó.

Ayer a las cinco de la tarde se experimento otro temblor. Fué casi tan fuerte que el primero, aunque no de tanta duracion.

The first shock started at 8 in the morning and lasted between 80 and 90 seconds. It began very gently, became strong, and was a little less strong when it ended. The ground immediately around us seemed to shake violently like a cradle rocking. Only rarely do earthquakes last so long and have such strange motions. The water standing in pools was thrown about and splashed over their edges. The water in the ditches around the village was also thrown about and over the banks, and from being crystal clear became thick with mud. Dogs howled and the beasts stood like statues while flocks of startled birds flew shrieking from south to north as if moved by an invisible force. The people fled into the streets; many could not stand and in terror fell to their knees and cried out, "Lord have mercy". The houses cracked and if they did not have light roofs of asphalt would have fallen in, which would have made this earthquake as destructive as the one in San Salvador in Central America. Many people were nauseated. Along the banks of the creek near here the earthquake has produced long open cracks of varying width. A few minutes after 8 there was another earthquake, which lasted for a short time. At 11 at night there was a third shock which lasted 4 seconds; during the night three more were felt, making a total of six that were noticed by most people. There is also another phenomenon. From the first shock at 10 A.M. until five P.M. the earth has been moving constantly, though it has required close attention to notice this. There have certainly been more than a few periods, up to 20 minutes long, of almost imperceptible earthquakes. It seemed as though the Earth, tired of suffering our sins, was shaking herself free of us as birds shake off what disturbs their feathers.

The day before the shock the clouds collided with each other, as if in aerial combat. One lady, seeing this, predicted that something was about to happen in the earth. Even the cocks' crows have seemed prophetic. For the last four or six weeks we have seen a new kind of white and dusty fog that has never appeared before. Some people who have spent time in it say that it stays in one's hair like flour or ashes. If I am not mistaken, some silent air currents have been passing over us, which have influenced even if they have not caused these earthquakes.

We hope these phenomena will be studied by naturalists. They should bear in mind that last winter (1855-56) there was so little rain that the fields were not covered with vegetation, and that this winter was very late, the first rains not falling until December 28 instead of October or November as is usual. There is reason to believe that in this region the Earth's surface is underlain by layers, or perhaps deep streams, or great pits of asphalt, as is shown by the springs and seeps of this mineral found in this area. The earthquakes began after 12 days of rain (counting from December 28th to the 8th of this month), as if they had been produced by an alteration of the elements, the long drought being ended by the rains.

On the night of the 9th and 10th, three more shocks were felt, though all were brief. The aspect of things remained threatening.

The news we have received from other areas is that the earthquakes were felt even far from here. At Fort Tejon, 35 or 40 leagues from here, the shocks were much stronger. The earth opened up for 3 miles, swallowing up a grove of oaks and forming a large trench. Some houses fell, one killing a woman. In San Buenaventura, 26 leagues from here, [9] the church suffered much damage and part of the tower fell.

Yesterday at 5 P.M. another earthquake was felt. It was nearly as strong as the first one but did not last as long.

10. Los Angeles *El Clamor Publico* January 31, 1857 p. 2, col. 3

En Santa Barbara fuè muy fuerte y duró casi *media hora* segun nos escribe une persona de ese lugar. Se sintiò en Monterey, Santa Cruz, Stockton, Sacramento y San Francisco. En este ùltimo punto apenas fuè perceptible, y una sola parte de la cuídad—extraño fenomeno.

Una persona que ac eba de llegar de Sonora nos informa que el viernes 9 de Enero, sintiò un fuerte temblor en al Carricito á 200 millas de este cuidad. Segun esto aquel dia se sintiò un temblor general en todo California.

A person who just arrived from Sonora informs us that on Friday, January 9th, he felt a strong earthquake in the Carricito [10] some 200 miles from this city. This means that on that day an earthquake was felt all over California.

11. Los Angeles *Star* January 10, 1857 p. 2

Yesterday morning, about half-past eight o'clock, a very severe shock of an earthquake was felt here, the vibrations continuing for fully two minutes. The motion was from North to South. During the day as many as four or five shocks were experienced, but all less intense than the first. Several houses were slightly cracked by the first shock, but no material damage was sustained. Doors were slammed to and fro, water was turned out of bowls and pitchers, and in the river the water rushed violently to one bank and then back again, the motion being repeated several times. In some places the earth is represented as having undulated as a field of wheat moved by the wind. It caused a general turn out, some rushing from their beds without stopping to dress.

An infinite variety of incidents are related of the effects of the shock, some amusing, others astonishing—but all such as are likely to take place when people are tolerably well frightened.

12. Los Angeles *Star* January 17, 1857 p. 2, col. 1-2

Elsewhere we have given ample details of the effect of the late convulsion of nature by which we have been visited. Here, we do not intend further to refer to that matter;

[9] The airline distance from Los Angeles to both Ventura and Fort Tejon is about 100 kilometers, or 21 leagues (for a league of 3 statute miles). The distances given here must therefore be measured along the road. The route to Fort Tejon (see note 42) was rather roundabout.

[10] We have not been able to identify this place. It is not even clear whether Sonora refers to the Mexican state or the mining town in the Sierra Nevada. The former is more reasonable, as Carricito could refer to either the Carrizo Creek area southeast of Borrego Springs or Carrizo Creek southeast of Lake Henshaw. Either Carrizo Creek location is consistent with the distance given, which is presumably measured along the road.

but as the subject has been the great topic of conversation during the week, and reference made to the frequency of earthquakes here, and the great danger we were all subject to, in being engulphed by one of those visitations, we have taken some trouble to inform ourselves on the subject generally, and we have come to the conclusion that no great danger need be apprehended from earthquakes in this country—judging of the future by the past, and we suppose the laws of nature will not be materially departed from, either to punish or reward the new race which now possesses the land.

Regarding the history of earthquakes in this part of California, as a matter in itself well worthy of investigation and record—apart from its present overwhelming interest—we have sought information on the point from a gentleman well versed in the history of his country—Don Jose Antonio Carrillo, who was born in San Francisco April 1796, and has resided here ever since, except when completing his education in the city of Mexico, and afterwards when representing his native State in the National Congress. During this long period, there have been but two earthquakes of a more serious character than those experienced here lately, and no tradition exists of any damage having been sustained in the "olden times."

In passing, we may observe, that the causes of earthquakes have not as yet been satisfactorily explained, but they are generally supposed to be connected with volcanic agency. It is conceded that they are produced by gases confined in the molten interior of the earth. Such gases, prevented by local circumstances from escaping, may, it is thought, thus shake the solid ground over a large tract, and even cause it to rise to a certain extent above its former level.

Such convulsions of nature have occurred in this country, but not to the extent, or accompanied by the danger, usually supposed.

Earthquakes are of two kinds—vertical and oscillating—.the late one being of the latter description.

The first serious earthquake, of which there is any remembrance, occurred on the 8th of December, 1812, about seven o'clock in the morning. The motion was vertical, and was felt over the whole of Southern California. Its effects were disastrous, probably more so from defective architecture than from the force of the shock. By it, the roof (which was a stone arch) of the church of San Juan Capistrano, in this county, was thrown down; the congregation were at service at the time, and thirty-six persons were killed in the ruins. A circumstance, which at the time was considered very singular, but which can easily be accounted for, is narrated of this catastrophe—that a woman and child who were buried in the ruins, were dug out the next day, alive and well. This church had been but lately built, having been finished on the 8th of September, 1806—thus it was occupied only six years and three months.

At the same time, the tower of San Buenaventura church, was so much injured by the shock, that it had to be taken down—from perpendicular, it changed to a leaning position, and the safety of the people required its removal,

1812 seemed to be a year of earthquakes. From December to the following March, there were frequent shocks—as many, it is said, as 300 distinct and well-defined quakes.

On the 21st December, 1812, another severe earthquake occurred. By this one, the church of Santa Purissima, in Santa Barbara county, was destroyed. The new church

(the present one) was built six miles from the site of the old Mission buildings. The church of San Luis Obispo was very much damaged, but not entirely destroyed.

Of this latter earthquake, a circumstance is related similar to what has just now occurred in several places. On the rancho Las Posas, there had been a very small stream, but by this great convulsion of nature, it became a large stream, and remains so to the present day.

Another occurrence is worth stating. An American ship, engaged in smuggling, was laying anchored off a cañon at the Rancho Refugio, in Santa Barbara County. The sea became violently agitated by the earthquake, and the captain let go his cable; the vessel was drifted ashore and up the cañon, the receding waters bringing her back to her proper element. The captain's name was Geo. Washington. He afterwards settled in Guadalajara, in Mexico. [11]

These are the two great earthquakes known to the oldest inhabitants. That of the 8th of December was equally destructive here as in what was then called the upper country; that of the 21st was more destructive above.

Since that time, there have been only slight shocks of earthquake, till that of July, 1855. It was vertical, and shook the houses considerably, doing no further damage than cracking the walls of the buildings,

The late shock was of longer duration than any preceding one; its effect was more gentle here; elsewhere, it has been the most violent of any, as may be conceived by its effects on the substantial buildings at Fort Tejon, and by the terrible disruption of the earth.

We may here relate what has come to our knowledge through the Rev. Mr. Bateman, who was traveling to Fort Tejon at the time. Previous to feeling the earth's vibration, his attention, and that of his party, was attracted by a tremendous noise issuing from a mountain in that neighborhood, south of the Fort. Immediately after, they felt the shock. In conversation with Mr. Botts, in charge of the mill at the Fort, he stated that his attention was also attracted by the same noise, and on looking towards the mountain, he saw issue from its topmost peak, a mass of rock and earth, which was forced high into the air—this was unaccompanied by smoke or fire. The shock immediately succeeded. Thereafter, a noise from that mountain was premonitory of every succeeding shock, no matter how slight. This was certainly produced by an explosion of the gas above referred to, and which has been discovered in action elsewhere in that region.

The earth's disturbance, as far as heard from, seems to have been most severe in the vicinity of Fort Tejon. There the ground was seen to open a width of at least twenty feet, and close with great violence, leaving a ridge which can be traced for forty miles, passing through mountains in its course.

Great anxiety is felt by our citizens for the safety of San Francisco. Judging from the line of disturbance, and we have it recorded from the Mohave to the Tule rivers, running north-west and south-east, if the line be continued, or not materially diverged from, the concussion would reach and probably exhaust itself in the ocean, and not

[11] Bancroft (1886, vol. 2, p. 268) states that this story (in a different source) was probably due to Alexander S. Taylor, renowned among historians of California for his fancifulness Cowan (1933). There was in fact a ship, the *Mercury*, captained by George Washington Ayres (also spelled Eayrs) along the California coast in the years 1812-1813, but Ogden (1941) indicates that she was at Sitka in December 1812.

extend to that city. If it be felt there, we think it will not be as severe even as we have had it. At all events, we most sincerely hope so.

An effect of this earthquake may be noticed—that it very generally produced a sensation in the human system similar to sea-sickness, some persons vomiting severely.

13. Los Angeles *Star* January 17, 1857 p. 2, col. 2

At five o'clock yesterday afternoon a very severe vertical earthquake was experienced here. The earth moved from south to north. It was almost as strong as that a week ago.

14. Los Angeles *Star* January 17, 1857 p. 2, col. 3-5

In our last, we noticed the occurrence of a severe shock of earthquake in this locality, but without particularizing any of the incidents. At the time of publication, we had no information concerning the effects of the earth's disturbance elsewhere. Since then, we have received a mass of information on the subject—thanks to our friends in the various localities—which we lay before our readers to-day. The subject is one of peculiar interest; and although nothing can be known positively as to the cause of this terrible phenomenon—notwithstanding many plausible theories are advanced on the subject—yet all take a deep interest in the effect produced in different localities, and are anxious to become acquainted with the facts. We devote a large space to the matter to-day, not alone from its vast importance, but as it has formed almost the exclusive topic of conversation, and also as it is a matter for historical record.

On Friday morning, the 9th of January, at twenty-five minutes past eight o'clock A.M., the morning being calm, cool, and clear, the sun shining brightly, a shock of an earthquake was felt here. The earth's motion was very gentle at first, those sitting at table supposing some one was shaking it; it gradually increased in violence till every house, with all its contents were seen to rock from side to side, as if about to topple over. There were three distinct shocks, the pause between them being perceptible only to those who have long lived in countries where earthquakes are more common than here. The duration of the oscillation was fully two minutes. The vibration was North and South.

In half an hour after, another shock occurred, much less violent; another within an hour from that; and during the day a number of slight vibrations. At five o'clock in the afternoon, a shock occurred almost as severe as the first, which was followed at intervals by slight motions, till about eleven o'clock, when another heavy one occurred. During the night several other vibrations were felt.

On Saturday several slight shocks occurred—with a severe one about eleven o'clock at night.

Sunday was quiet, till about eleven o'clock at night when a pretty strong vibration was felt, and thereafter at intervals throughout the night.

Monday was generally considered free from shocks, although many say they felt them distinctly throughout that day also. Since then the earth has remained quiet.

It was not, for the moment, thought of, what produced the rocking of the tables, chairs, beds, and furniture generally; but there was little time given for reflection. In another instant, the fearful cry of "earthquake" issued from every mouth—then a rush, shouting and screaming, such as may well be conceived, but cannot be described. At the hotels, the breakfast tables were instantly deserted; people wildly rushed to the streets, tripping and tumbling over each other in their hurry and dismay—in some cases, blocking up the door, so as to prevent egress for the moment. Many, used to indulge in a comfortable snooze of a morning, were unceremoniously turned out of their comfortable quarters, in anticipation of having the roof about their ears before they could make their exit. These took no thought of their toilet but gallantly gave their linen to the breeze, in hopes of bringing up in safe quarters. One gentleman, who, in his hurry, mistook his window for a door, was seen running along the roof of an adobe building, thinking, should it fall, it was better to be on top of it, than it on top of him. Another, enjoying the luxury of a bath, stood the rocking for some time, but at last was compelled to evacuate the premises, and rush to the yard, where to his horror a number of ladies had also sought refuge and were seeking consolation in prayer. Whether from the shock to his feelings, or the shock of the earthquake, he was immediately brought prone to the earth, when he managed to creep under cover, unobserved,

The most ludicrous scenes occurred on every hand—in some cases men falling down in the streets on their knees, without well knowing why, perhaps because persons of a devotional nature suddenly took to prayer in the streets, moved thereto by their fears rather than their habits.

The effects on the lower animals was very apparent. Horses, mules and cattle took to flight, or if tied up trembled and fell down with fright. Domestic fowls, and the birds, flew wildly about, uttering the most piteous cries.

The river was thrown out of its bed over the banks, and receded; pools of standing water were driven about; so was the water in the zanja. In several stores, goods were precipitated to the floor; in one house, about $30 worth of bottles were broken. In the mill at the upper end of the town, a pile of flour sacks were overthrown and blocked up the doorway—the mill sustained no damage.

On the whole, no damage of any consequence, has been sustained by our citizens, although elsewhere considerable property has been destroyed, and we regret to say, severe personal injuries inflicted, and one life even sacrificed by the awful visitation.

On a ranch belonging to Mr. Temple, on the San Gabriel River, the earth for a considerable distance was rent asunder, leaving a ditch some three feet wide. The disruption was traced for miles along the river, which was turned out of its bed for many rods in length. [12]

[12] Temple's Ranch was the Rancho El Cerrito, which covered an area that is now to the north of Long Beach. The ranch headquarters were on a hill overlooking the Los Angeles River, in what is now north Long Beach (Hoover *et al.*, 1966, pp. 152-153). The cracks presumably occurred in the floodplain of the river. The account says the San Gabriel River because at this time, as shown on the map of Williamson (1856), the San Gabriel River ran down what is now Rio Hondo and joined the Los Angeles River about 18 kilometers above its mouth, the combined streams being called the San Gabriel River. The present San Gabriel River channel was established during floods in the 1860's (Troxell, 1942).

The upper school house is cracked in one place; private houses are also cracked, some of them very considerably.

On Friday night, a number of people who had been started out of their bed by the heavy shock about eleven o'clock, made a fire in the street, intending to remain up all night, rather than run the risk of being killed by the falling of the houses.

The disruption passed near to a house on Reed's Ranch, in which were several persons, all of whom effected their escape, except a woman, who was killed by the falling of the house. [13] The wall struck her head which was smashed, no other part of the body being injured or even marked. Her remains were brought to this city and interred.

We have heard a rumor that a man who was riding along the line of disruption having dismounted from his horse, was partly engulphed, but managed to extricate himself from the loose earth with which he was covered up.

We have it, on reliable authority, that an old man, name unknown, but who was familiar to all our citizens, was walking on the Plaza at the time towards the church, when he fell down and was taken up a corpse. He was very old, supposed to be between 80 and 90.

It is reported that the church at San Buenaventura has been nearly destroyed by the shock of the earthquake. The rumor is vague, and not relied on by many.

We shall now proceed to give the communications of our friends, whereby will be seen the effects of the earthquake in various localities;, embracing a very large section of the southern country:

OPENING A RIVER.

On a range of hills, about fifteen miles from the coast, in the district of San Fernando, we understand that a surveying party have discovered quite a large stream making out of the mountain and down a cañon, where, to their knowledge and complete satisfaction, not to say to their sorrow, no water was running or could be found previous to the earthquake. [14] By the letter from Tejon, it will be seen that a similar circumstance occurred in that vicinity.

VOLCANIC ACTION.

We were lately informed by Mr. Stanley, of Capt. Greenwell's coast surveying party, that on the side of a high mountain, in the vicinity of San Fernando, he discovered a fissure in the rocks, from which a hot gas was fiercely issuing. The rocks and ground were almost too hot to be touched. [15] Farther down the mountain, was a precipice, where he was informed by the natives, light was frequently seen at night, but no one ever attempted to discover the cause. It was no doubt caused by the ignition of the gas, produced by a favorable action of the surrounding atmosphere.

[13] According to Conkling and Conkling (1947), Reed's was on the south side of the old road (later U. S. 99) in Gorman. It must therefore have been nearly on the fault trace.

[14] This was probably Limekiln Canyon, in the San Fernando valley south of Oat Mountain. See (18) for a fuller description and discussion of this identification.

[15] This was almost certainly a burning petroleum seep; see (18).

EFFECTS AT CAHUENGA.

A person who was at this place [16] at the time of the shock, describes it as being very violent; trees were knocked about as if mere willows, the earth turned every way; he was knocked down, and for a time could not get up again. Altogether the report makes it much more violent than it was here.

EFFECTS AT SAN FERNANDO.

The shock here was also very violent. It knocked down two houses, but did not effect the mission buildings.

EFFECTS AT THE MISSION, MONTE, &C.

In this district, the shock is represented as having been much more severe than in the city. In the Mission [17] several houses are badly damaged, and the church is represented as having been very much cracked.

At the Monte, [18] we have been informed that men were dashed to the ground; that horses were overthrown; and that several houses were greatly cracked. No personal injury sustained.

The dwelling house at Carpenter's Ranch, [19] we understand, is very much cracked.

From Fort Tejon.

FORT TEJON, Cal., Jan. 11th, 1857

Editor of Los Angeles Star:

SIR—Presuming that your readers would be pleased to obtain some information. respecting the effects of the terrific earthquake experienced at this post, I will endeavor to give you a slight description of the same. The first shock took place about thirty minutes past six o'clock, A.M., on Friday, January 9th, which was succeeded, at twenty-seven minutes previous to nine o'clock A.M., by the most terrific shock imaginable, tearing the Officer's quarters to pieces, severely damaging the Hospital, and laying flat with the ground the gable ends of nearly all the buildings erected, including the Quartermaster's storehouse. Immense trees have been snapped off close to the ground, and every building between Fort Tejon and Lake Elizabeth leveled with the ground. Many persons have been seriously injured, and one woman killed at "Reed's Rancho." The officers and troops at this post have thus far escaped any injury.

The shocks and vibrations have continued at regular intervals up to the present time, say five o'clock P.M. It is very evident that a powerful volcanic eruption is in

[16] Cahuenga was at the northern end of Cahuenga Pass, in the San Fernando valley, near Universal City (Hoover *et al.*, 1966, p. 164).

[17] Presumably Mission San Gabriel, in the city of San Gabriel.

[18] King (1971) states that the "Monte" was on the banks of the San Gabriel River above Whittier Narrows, a little to the south of the present El Monte.

[19] Hoover *et al.* (1966, p. 153) identify Carpenter's Ranch as Rancho Los Nietos, in the vicinity of Downey.

progress a few miles to the southward of the garrison. You can well imagine the alarm constantly existing in the minds of every person, caused by the frequency of these frightful shocks.

The earth has opened in many places for a distance of twenty miles. Many instances occurred of narrow escapes from injuries by the falling buildings.—Amongst them, the lady of Capt. R. W. Kirkham, Assistant Quartermaster, who is absent from the Post on official duty; also, Lieut.-Col. B. L. Beall, commanding the Post, who had barely sufficient time to escape from his bed amidst the falling of plaster, the crashing of material, falling of chimneys, &c. It is a miracle that no lives were lost, for which mercy we are indebted to the protecting influences of an All wise Providence.

We feel quite anxious to learn the effects at Los Angeles, as the line of disruption seems and does extend from south-east to north-west.

Mr. David Alexander has come into garrison from the vicinity of Santa Amelia, [20] and reports that the beds of many small streams have been enlarged, and now form almost rivers; and that immense numbers of fish have been thrown out of the Lakes [21] upon dry land.

The effect of this convulsion of nature will be felt far and near. I have just learned that some of the buildings at the Reservation [22] have been much injured.

Yours, truly, ALONZO C. WAKEMAN
Quartermaster's Deputy, U.S.A.

P.S.—The driver of the wagon which conveyed Lieut. Col. Ripley to Fort Miller, has just arrived, and reports that the shock of the earthquake was experienced at Tule River, 100 miles distant, at about the same time on Friday morning, but that no serious damage was sustained. A.C.W.

From San Bernardino.

SAN BERNARDINO, Jan. 8th, 1857

SIR—We experienced a very heavy shock of an earthquake this morning about eight minutes past 8 o'clock, which lasted nearly three minutes. While I was washing, Mr. Glaser was emptying a ten-gallon keg of wine into another by my side, when he said "an earthquake!" Shovels in the store fell on the floor, and the tin ware hanging on the joists swung every way. We then ran out of the store to the street, and felt the earth move as sensibly as if we were walking on shipboard. Every person believes that it lasted at least over five minutes. As the teamster is about to leave, I am unable to give you any more particulars than what we have seen and felt ourselves. The people are all out on the streets conversing and relating what they were doing when they first felt the shock. I have just seen a bucket of water drawn from a well since the quake,

[20] Santa Amelia presumably refers to the Rancho San Emigdio, which is on the slope to the north of Mount Pinos at the extreme southern end of the San Joaquin Valley. Brewer (1966, p. 385) found a Mr. Alexander holding this rancho in 1862. Contemporary spelling of this name varied considerably; for example, Antisell (1856, p. 206) gives it as San Emilia.

[21] Probably Buena Vista and perhaps Kern Lake; Tulare Lake is too far north to have been observed.

[22] The Tejon Indian Reservation; see (24) and (25).

and it is white as milk. A bucket full of water was drawn an hour previous, and it was clear as crystal. People observed the standing waters on the streets emptied out of their places. Peach and shade trees were seen shaking for five minutes afterwards. The store of Harris & Meyer was cracked; also, the store of Chas. Glaser, and the schoolhouse. Goods were thrown from the shelves in several stores. The shock ranged from East, and lasted over two minutes; then changed to South.

The people from outside the city are coming in and relating the circumstance, but I have no time to give you any more items.

Everybody is drunk from the effect of the quake,

Yours respectfully, L. GLASER

From other sources, we have a confirmation of the above facts, with this addition, that immediately after the shock, a terrible report was heard along the mountains on the north, towards the Cajon Pass, which lasted a considerable time.

Reports of the shock having been felt a considerable distance from town, but no damage reported.

On Saturday, a plummet was suspended which vibrated nearly all day, sometimes as much as four inches past the centre.

On Sunday another shock was experienced; next morning another, but quite gentle. The people, however, were in a state of continual alarm.

From the Mohave.

We have received the following intelligence regarding the earthquake from Wm. Denton, Esq., engaged in surveying in the Mohave country, who has just arrived from his camp on the Desert.

The camp is situated at Kingston Springs, 200 miles north-east from San Bernardino. On Friday morning, between 8 and 9 o'clock, Mr. Denton was at the upper crossing of the Mohave River, about fifty miles from San Bernardino. [23] His attention was attracted by hearing a peculiar harsh, grating noise, immediately after which he perceived the motion of the earth, which became very violent, and lasted thirty or forty seconds. With great difficulty he could keep his feet. The earth seemed to have two motions, vertical and oscillatory. After the shock, towards north and north-west, heard a tremendous noise, as if thunder, accompanied by the grinding of rocks and the crashing of mountains. There was then a short pause, when the appalling noise was again heard. During the earthquake, Mr. Denton was at the hot springs.[24] In such localities, the ground when trodden or stamped on, generally gives forth a hollow sound, which may account for the extreme violence of the oscillation at that point.

At night he camped in the Cajon Pass, when he experienced two more shocks, about nine and eleven o'clock, which were not very severe. He does not know whether these were accompanied by noise, as the wind was high at the time. Next day he arrived at San Bernardino, when he experienced the shocks mentioned by our correspondents.

[23] The presumed location of Mr. Denton (34.6°N, 117.4^circW) is based on the map and reported latitudes in Whipple and Ives (1856).

[24] Whipple and Ives (1856) describe only cold springs at this crossing and Waring (1965) does not locate any hot springs near this point.

The weather at his camp at Kingston Springs was intensely cold—rain, sleet and snow, with hard frost every night.

Mr. Denton states, that the violence of the shock he experienced, had it reached this city, would have leveled every building in town.

15. Extracts from a letter of H. R. Myles to Benjamin D. Wilson, January 28, 1857. (Box 6, Benjamin Davis Wilson Papers, Huntington Library, San Marino) [25]

We will finish [ra]cking [26] off the wine about the same time, the wine is not very clear that is the most of it owing to two causes. One is many of the casks were closed too tight before the wine was done fermenting, and the other is we have had about fifty earth-quakes in the last two weeks, three of which rocked the house very much, and cracked the plastering and walls in many places but has done no serious damage... I will take out some brick and a Brick Mason to day to take down and rebuild the S[outh] [27] chimney. [28]

16. Reminiscences of H. D. Barrows, August 5, 1906. (In Lawson (1908, p. 450)) [29]

The great earthquake of January 9, 1857, in southern California, opened the ground for nearly 40 miles in a straight line near Elizabeth Lake. I had a brief account of it in the San Francisco Bulletin about February 1, 1857—my letter (signed "Observador") being dated January 28, 1857. [30]

Only one life was lost by that great convulsion of nature, a woman being killed at Fort Tejon by the falling of adobe walls; and, considering the colossal disturbance, very little damage was done to buildings here in Los Angeles. This is probably accounted for by the fact that our buildings were of only one story, with walls 2.5 and 3 feet thick. At the time of the great upheaval, I was in the yard at the south side of the adobe house of William Wolfskill, the pioneer, near the present site of the Arcade Depot in Los Angeles. I first stumbled toward the west, and was almost thrown down; then, after a brief period, I commenced to stumble in the opposite direction. Other persons near me stumbled in similar fashion. The long wide corridor on the south side of the Wolfskill house was hung with grapes, and I noticed that they swung back and forth clear up to the rafters. Water in tanks was thrown out in numerous instances, clocks were stopt, etc. The movement seemed to be comparatively slow, giving things time to recover after moving in one direction. [31] If the motion had been short and sudden, the damage would have been appalling.

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[25]This letter was sent from Lake Vineyard, Wilson's ranch. McFarland (1949, p. 289) says that this covered much of what is now Pasadena and San Marino, Wilson's house being in what is now the northwest part of San Marino.

[26]This word is partly illegible and our reading is conjectural.

[27]This word is partly illegible and our reading is conjectural.

[28]Much of this letter deals with construction, and it is not certain that this sentence should be read as implying serious earthquake damage to a chimney.

[29]Barrows' diary (in the possession of Mrs. Thomas. P. Cullen, Monterey Park) contains no information not in (16) and (41).

[30]This letter was published February 3; it is reprinted here as (43).

[31]Compare Barrows' comments at the time (41).

17. Reminiscences of Harris Newmark, ca. 1915 (From Newmark, 1926, p. 204)

In the beginning of 1857, we had a more serious earthquake than any in recent years. [32] At half-past eight o'clock on the morning of January 9th, a tremor shook the earth from North to South; the first shocks being light, the quake grew in power until houses were deserted, men, women and children sought refuge in the streets, and horses and cattle broke loose in wild alarm. For perhaps two, or two and a half minutes, the temblor continued and much damage was done. Los Angeles felt the disturbance far less than many other places, although five to six shocks were noted and twenty times during the week people were frightened from their homes; at Temple's *rancho* and at Fort Tejón, great rents were opened in the earth and then closed again, piling up a heap or dune of finely-powdered stone and dirt. Large trees were uprooted and hurled down the hillsides; and tumbling after them went the cattle. Many officers, including Colonel B. L. Beall—well known in Los Angeles social circles—barely escaped from the barracks with their lives; and until the cracked adobes could be repaired, officers and soldiers lived in tents.

18. Letter of W. E. Greenwell to A. D. Bache, February 24, 1857 (pp. 130-133, Vol. 23, 1857 Correspondence of the Superintendent, Records of the Coast and Geodetic Survey, Record Group 23, U. S. National Archives microfilm MC 642, Roll 176, frames 280-282)

Coast Survey Camp
Conejo Station
February 24th 1857

Dear Sir—Since my last letter I have finished my station San Fernando & in about 3 weeks will have completed my observations at this, when I propose to break up my camp & resume the work on Santa Cruz Island. The winter has not been favorable for my work, fog & hazy weather kept me at San Fernando much longer than I had reasonably expected & here it has been no better. There seems to be no precedent in California upon which to rely. One winter brings forth one thing, the following altogether different so that it is unfair to base a seasons work upon that which precedes it.

I have been in the field since December. In this time I have gotten through with but two Main Stations with lines averaging from 25 to 35 miles in length & to accomplish this much have been obliged to use heliotropes at two of the stations. My work comes out well however & in this much I am satisfied.

Whilst occupying the San Fernando station this lower Coast was visited by a most fearful earthquake whose centre seemed not far from us. We were encamped in a canon at the foot of the mountain, my station in full view some 2212 feet above us. [33] I was

[32] As Wood (1955) pointed out, this very likely refers to the date of composition, sometime before 1915.

[33] This is station "San Fernando (Old)" (Mitchell, 1927), now identified by National Geodetic Survey PID EW7392. The NAD83 position of this triangulation station (34.31892°N 118.57101°W) is on a subsidiary peak of Oat Mountain, specifically the one that is at the head of the stream that is the first westerly branch of Limekiln Canyon, counting upstream from Horse Flats. The stated elevation difference puts the camp on the valley floor, probably in Limekiln Canyon or perhaps Wilbur Wash.

seated in my tent about 8 o'clk in the morning the wind blowing a gale from the N.W. when we felt the first shock. We started to our feet & ran out. The Earth was in fearful agitation with undulations so quick & rapid as almost to throw me from my feet. The sensation was very much as that felt on the deck of a small vessel in a heavy "chopped sea".

I was interested to know whether my stations remained unchanged but in subsequent measurements I could detect no difference in the angles.

Some three weeks previous to this earthquake I had erected a signal on the Santa Clara 32 miles from my station San Fernando. This signal I could never see whilst others equally distant were plainly visible. This one line kept me at this station three weeks after my other angles were all observed. Twice I sent to have it re-erected supposing it to have been pulled down, the second time in exploring the mountain we found a vent directly in the line "San Fernando—Santa Clara" from which sulpherous steam was issuing. [34] To this cause I attribute my ill success in seeing the signal.

Subsequently I moved this signal some 8° out of the line but eventually found it necessary to send a heliotrope in order to observe the angle.

Just back of my camp was the dry bed of a stream, where in heavy rains water had at one time run; in this bed two weeks before I had sunk a well some 20 feet hoping to find water, but at that depth the earth was so dry I gave it up as fruitless. Two days after the first or heavy shock a little stream of muddy water was running by my camp which continued to increase each day, until when we moved was quite a little rivulet: no doubt the result of some new fissure in the mountain.

I send you an extract from my Journal giving the time of the different shocks as felt at our camp. It may interest you in as much as the tidal wave [35] may have been in some measure affected by them.

January 9^{th} "At $8\ 25^{\text{m}}$ A.M. had a severe shock of an earthquake which lasted about one minute. Wind N.W. strong.

At $8^{\text{h}}\ 31^{\text{m}}$ another slight shock.

At 9^{h} a very slight shock—At $9^{\text{h}}\ 31^{\text{m}}$ another shock similar to the 2nd.

At $4^{\text{h}}\ 47^{\text{m}}$ P.M. another slight shock.

Had the above several shocks to day. The wave seemed to travel from East to West"

Very respectfully
W. E. Greenwell

Prof. A. D. Bache
Supt U. S. Coast Survey
Washington D. C.

[34] This almost certainly refers to a burning petroleum seep; the descriptions given here and in (14) tally very well with that of another occurrence provided by Arnold and Johnson (1908). Such seeps are not uncommon in southern California; Whitehead (1976) gives the history of several in the Santa Barbara region. The Santa Clara station was on South Mountain, south of Santa Paula.

[35] This does not refer to a tsunami, but to the regular ocean tides, which at this time were thought of as a propagating wave,

19. Letter of W. M. Johnson to A. D. Bache; January 19, 1857 (pp. 139-145, Vol. 23, 1857 Correspondence of the Superintendent,. Records of the Coast and Geodetic Survey, Record Group 23, U. S. National Archives microfilm MC 642, Roll 176, frames 294-297)

Camp Sycamore Valley [36] Cal
Jan 19th 1857

Prof. A D Bache
Washington City

My dear sir

On the morning of the 9th inst we experienced the most violent shocks of an earthquake ever remembered to have been felt in this state and should it extend to San Francisco without diminution of its force as felt here, we may expect to hear a melancholy account of the loss of life and property.

The motion to me was vibratory only, though others contend that it was also undulatory, in a direction from SE to NW and was first felt at 24m past 8 A.M. on the 9th inst and lasted about 2 minutes. During that time we with difficulty [37] kept on our feet. Many things in camp were thrown violently to the ground. The tents shook as by a gale. My sensations at the time were those of exhilaration and yet the cause producing them made us also feel sensible of a nausea similar to that occasioned by being at sea: several persons have since told me they were so powerfully affected as to vomit.

At 34m after 8 A.M. a second shock, lasted but a few seconds and not so violent as the first: at 36m after 8 A.M. a third shock quite violent lasted about 10 seconds at 38m past 8 A.M. a fourth shock accompanied by a loud rumbling noise like distant thunder. This was the only sound occasioned by this phenomenon during the whole time. At 12m of 9 A.M. a fifth shock slight and momentary.

On the evening previous I received a note from Mr. M. Bache whom I had sent to San Francisco two weeks before to purchase stores and make arrangements for getting a vessel to move us, informing me that he could get no conveyance to camp and desired to be sent for at Santa Barbara: wishing to see the effects if any produced by this earthquake I availed myself of the occasion & accordingly left camp shortly after the last shock for San Buenaventura 30 miles distant: in going there we ford the Santa Clara River six.miles from its mouth. The stream in itself is insignificant its bed however is from a half to three quarters of a mile wide from bank to bank and it was here I met with the first evidence of the terrible power exerted by the awe-inspiring convulsion of nature as recently felt: long cracks were visible in the bed of the river many of them being six or eight inches across and extending in a direction SE and NW. These openings must at one time have been considerably wider for many of them had evidently been filled with water from the River and when the earth closed was thrown up with sand to the surface for on either side of the crack lay a mound of wet sand: these appearances were visible as far as I could see up and down the bed of the River. In crossing I tried to avoid those places as much as possible but finally a wheel got into

[36] Sycamore Valley was probably what is now Big Sycamore Canyon, just east of Point Mugu.

[37] The words "we with difficulty" are repeated twice in the original.

one and down went the wagon to the axletree. This crack I was satisfied was at least two feet deep but did not stop to investigate it further nor was I ambitious to sound another in the same way.

Near the mouth of the River the cracks are much longer & wider. Several persons residing on its banks within a mile of the mouth tell me they saw the water thrown up as high as six feet and that large blocks of earth sunk several feet below their former level & there remained. Others say they distinctly saw Anacapa and Santa Cruz Islands sink. In this last assertion I place no confidence for on that evening I saw through the "Arch Rock" at the east end of Anacapa as distinctly as I ever did.

On arriving at San Buenaventura in the evening. The Spanish population is about 250. I found the inhabitants in the greatest consternation: at the first alarm they without an exception deserted their tile roofed houses for the streets and the open country and there began to offer up prayers and lamentations for safety: in the mean time the roof of the old mission church, founded 1782, fell in with a tremendous crash and the square bell tower supporting at present four large bells, it formerly boasted eight, hung in the arches of the wall, one on each side, was so much shattered that the key stones of the different arches settled $2\frac{1}{2}$ inches below their former beds. Several of the mission buildings, vacant at the time, were entirely destroyed and other houses in the place were more or less injured but no lives lost.

The old mission church is a large structure built of sundried brick it is 100 feet long by 30 feet wide on the inside. Its walls are about 45 feet high and six feet thick at the top: curiosity prompted me to visit the bell tower and roof. Till then I had no conception of the immense weight supported by the walls or how the weight was distributed as the interior room of the church is unbroken by a single column.

At 40 feet above the floor of the church firmly imbeded in the walls are large girders 18 inches apart. The walls being built up about 4 feet above them they have no connection with the rafters & do not act as tie-beams. On those girders is a flooring of two inch planks, then a course of mortar in which are set burnt brick. The framing of the roof is of the most miserable description being tied together with raw hide without any other kind of fastening. The roofing consists of small willow poles placed near together and bound to the rafters by thongs of raw hide. On these poles is a layer of mud from 8 to 12 inches thick and in this the tiles are imbeded: the whole being supported by centre posts and purline posts resting on the flooring of the girders. The weight of the tiles alone has been computed at 35 tons, and the whole weight on the walls at about 250 tons.

At San Buenaventura (Jan 9^{th}). This evening the shocks were continued. The first was at 27^{m} past 8 P.M. slight and momentary. At 15^{m} of 9 P.M. a second, quite violent but momentary. At 36^{m} past 10 P.M. a third strong but momentary. To night the people deserted their houses and went into the street, the open country and on the hill-tops back of the mission buildings where they lit camp-fires and passed the night.

At Santa Barbara but little damage was done only two or three houses having been injured.

During my absence from camp every shock felt was noted in the Journal. The times of their occurrence may I think be considered as correct but their duration appears to have been judged of more by the recorder's feelings than his watch. The following is

transcribed from the Journal

9^{th}	"At 30^{m} past 8 P.M. felt a shock which lasted about $1\frac{1}{2}$ minutes not so severe as the first one of this morning"
''	"At 40^{m} past 8 P.M. felt a second shock which lasted about 1 minute, Slight"
''	"At 10 P.M. a third shock lasted about half a minute. Slight"
Jan 9^{th}	"At 40^{m} past 10 P.M. felt the most severe shock of any though much shorter than the first of this morning"
Jan 10^{th}	"At 20^{m} after 8 A.M. a slight shock"
Jan 11^{th}	"At 40^{m} past 9 P.M. slight shock"
''	"At 5^{m} past 10 P.M. quite severe lasted about $1\frac{1}{2}$ minutes"
Jan 15^{th}	"At 40^{m} past 10 P.M. a slight shock"
16^{th}	"At 48^{m} past 12 A.M. a severe shock, lasted $1\frac{1}{2}$ minutes"
''	"At 50^{m} past 12 A.M. another more severe than the last, preceded by a rumbling noise"
''	"At 46^{m} past 4 A.M. a slight shock"
17^{th}	"At 27^{m} after 7 P.M. slight shock"
28^{th}	"At about 3 o'clock this morning felt a very severe shock"

The two last I recorded myself.

Since writing the above I have learned from good authority that at the Tejon and in the Tulare country the earthquake was very severe. A crack was there made several miles in length and six to eight feet wide. Many persons were killed [38] and most of those who escaped are moving away from what they consider a dangerously volcanic country:

I feel that this long letter from me will hardly repay you the time lost in looking over it but knowing that you take a great interest in this as in other natural phenomena I believe I can't give you a better idea of it than by simply stating what we felt and saw.

Very truly, your ob't svt
W M Johnson

20. Santa Barbara *Gazette* January 15, 1857 p. 2

On Friday last, January 9th, this city and adjacent settlements was visited by a succession of earthquake shocks, one of which was the most severe which has been experienced on this coast for a long series of years. So far as our present information extends, it was felt as far south as Los Angeles. It extended to Point Conception westward. No information has yet been received from towns situate north of this place, but we shall doubtless hear of its effects in many localities as yet unheard from.

[38] This is the only mention of there having been more than one or two fatalities; on the basis of our other sources we suspect this to have been based on false rumors.

In this city, the morning of the eventful day was ushered in by the same genial sun; the air was tranquil, and no unusual atmospheric phenomena indicated that any sudden danger was so near at hand: At about 10 minutes past 8 o'clock there was a sudden vibration of the earth, which was of brief continuance. By many it was unnoticed, but was distinctly observed by those persons who have felt this peculiar sensation at former periods. At about half past 8, or at 22 minutes past 8 o'clock, according to those who assert that they had the "correct time," the severest shock commenced, and which continued from 40 to 60 seconds. It was universally noticed throughout the city, and was so violent in its vibrations that all the inhabitants fled from their dwellings, the majority of whom, on bended knees, and hearts throbbing with terror, made fervent supplications that the imminent and impending danger might be providentially averted.

This "shock" (for we have no more expressive phrase in the English language to denote the peculiar phenomenon,—the Spanish appellant "temblor" is more significant) commenced with a gentle vibration of the earth, which gradually increased, accompanied with an undulating motion, until it attained its culminating intensity, and then as gradually decreased, until it ceased its action altogether. The vibrations were in an easterly and westerly direction. The peculiar motion experienced during its continuance very much resembled that on board a vessel in a moderate sea. Happily, it passed away without causing material damage to this city. Many walls of buildings were cracked, and we candidly acknowledge that most of us were very severely frightened. We have heard of no unusual action of the sea during the above mentioned period. The slight damage which ensued therefrom to our dwellings can doubtless be attributed to the great thickness of their "adobe" walls, and the fact of their being built, with a few exceptions, of but one story in height.

Some three or four hours after the occurrence we took a short walk up to the old mission church. Near that building is a water reservoir, built of stone laid in cement. The earthquake, we noticed, had caused the water therein to be forcibly ejected over each of the four sides, which had found its way to the ravine near by in a large stream,— indicating the strong, vibratory, upheaval motion at that place. [39] During the evening of the above day some two or three brief "shocks" or vibrations were felt; indeed, throughout the entire day and evening the earth, to us, seemed to be more or less agitated with a tremulous motion, but up to the present period we are happy to chronicle the fact that our beautiful valley continues "in statu quo." The steamer Senator arrived the next morning, (January 10th,) bringing us the news from Los Angeles that the earthquake was severely felt at that city at about the same time of its occurrence in this locality. It was thought, on comparing notes, that its effects were

[39] Any estimates of ground motion for this earthquake could be checked by using them to predict water motion in this reservoir using the method of McGarr (1965). The description of the mission water supply system in Engelhardt (1923, pp. 85-88) and in Geiger (1965) enable us to identify this reservoir as the lower of the two northeast of Mission Santa Barbara. It was built in 1806, and was 33.5 meters square and about 2 meters deep; it has since been relined and is now the #3 reservoir of the Santa Barbara city water system. The depth of water in the reservoir before the earthquake is not stated, but Trask (1864) mentions that in Santa Barbara the earthquake threw water "over the surface from a shoal well, seven feet deep, the water in which was less than three feet in depth." This depth is about the same as that shown in the 1847 sketch of Hutton (1956).

more severe in that place than here.

Through the politeness of Mr. W. M. Johnson, U. S. Coast Surveyor for this District, we are placed in possession of the following interesting account of the earthquake phenomenon which occurred at San Buenaventura and vicinity. [40] The mission church at San Buenaventura is badly injured. The roof has fallen in, or rather is supported by the walls and ceiling of the edifice, and the belfry is badly damaged. The greatest vibration and agitation of the earth is supposed to have taken place in the vicinity of the Santa Clara river. Mr. Johnson's position was some thirty miles southeast of San Buenaventura, in a cañada called Sycamore Valley, (Cañada de los Alisas,) sixty miles by land from this city. He noted the following observations: The first shock occurred at 24 minutes past 8 o'clock in the morning; vibrations heavy and violent, and continued 2 minutes. Second shock occurred at 34 minutes past 8. The third at 36 minutes past 8; was quite violent, and continued 10 seconds. The fourth shock took place at 38 minutes past 8; this was accompanied with a loud, rumbling noise, a distinguishing feature, which was observed in no other shocks, either before or afterwards. The fifth shock was noticed at 12 minutes of 9, which was slight, and the sixth at 2 minutes past 9, which was also slight. The vibrations were N.E. and S.W. In the evening of the same day three momentary shocks were distinctly felt, the last one being the most intense. They occurred at 27 minutes past 8, at 10 minutes of 9, and 36 minutes past 10, respectively. At Santa Clara river the following interesting effects of the "temblor" were observed: There were large cracks in the bed of the river, running parallel to each other, for some ten or fifteen yards in length, in a N.E. and S.W. direction. About one mile from the mouth of the same river large square blocks of earth had sunk below the surrounding surface, and there remained.

Mr. Bodie called upon us on Tuesday and informed us that the earthquake was distinctly felt at Point Conception and at Santa Cruz Island. At the Point it shook the lighthouse and damaged the reflector. At Santa Cruz a portion of the bluff at that place fell down.

We fear we have trespassed too much upon the time of our readers already by the somewhat unusual length of this article, but will add a word or two more, which is a request that some of our patrons may feel disposed to give us their opinions as to what is the cause of "earthquakes." Let us hear from all who take an interest in elucidating the mysterious and sometimes apparently incomprehensible operations of Nature.

P.S.—We have to record two more "temblores" in this place since writing the above. One light shock occurred about midnight, and another strong shock at about 6 o'clock this morning.

During the observations of Mr. Johnson, above noted, no deflection of the magnetic needle was apparent. We are informed that in the vicinity of the Hot Springs at the period of the severe shock on Friday morning, large rocks on the neighboring peaks were detached from their position and rolled down the mountain side into the cañon. We trust that we shall not be unwilling chroniclers of any further "quakes" in this quarter.

[40] The material in this paragraph, being derived from Johnson, is not independent of his letter (19), though it is a little more full in some details.

21. Santa Barbara *Gazette* January 22, 1857 p. 2

Some poet thus exclaims:[41]

> "How awful is the thought of the wonders under ground
> Of the mystic changes wrought in the silent dark profound"

Very expressive language, and quite descriptive of the feelings of many in regard to the subterranean commotions which have visited us of late. Last week we gave a lengthy account of "earthquakes" recently felt in this city and neighborhood, and this week we herewith continue their chronicle.

On Friday, January 16th, there was another earthquake at or about 4 o'clock, P.M. Fortunately, it was of brief continuance. No damage ensued therefrom. It was sensibly felt throughout the city, and was of sufficient intensity to cause people to leave their houses. There was a slight shock on Sunday morning, the 18th inst., and another moderate shock on the night of the 20th instant.

From the surrounding country we have received the following information. The severe shock which occurred on the 9th inst., was felt to the north and west of this city as far as Point Arguello, also at Santa Catalina and Santa Rosa islands.

Mr. Warner arrived here on the 17th inst. from Fort Tejon, via Elizabeth Lake and San Buenaventura, [42] to whom we are indebted for the following interesting account of the effects of the recent earthquake as experienced at the above locality and vicinity. From his statement, the earthquake of the 9th instant, as there experienced, exceeded in intensity and severity that observed in any other locality, so far as heard from. The main disturbing force of the shocks which were so widely felt on the 9th, without doubt, was in the vicinity of the Fort, and extended to an unknown distance in the Desert. The earthquake occurred on Friday morning, the 9th instant, at about the same time that it was felt here. All the houses, with two exceptions, were thrown down or otherwise injured so as to be rendered entirely useless. The shock was preceded with a peculiar rushing or rumbling noise, and for more than a week thereafter noises somewhat resembling distant thunder were heard. Fortunately, no serious damage to life or limb occurred. Mrs. Kirkham, wife of the Quartermaster, was slightly injured. Immediately after the shock had passed, an express messenger with advices was dispatched to General Wool. All of the public works at the Fort are necessarily suspended. The damages are estimated at $50,000.

Two companies of U. S. troops, who had just arrived from New Mexico, were having their horses herded in Kern river valley. When the shock occurred, the men in charge were around their camp fires in the morning. It very unceremoniously tipped over their coffee pots, their camp kettles, and themselves also. Upon looking at the river,

[41] These lines are from the poem *The First of March* by Horace Smith (1779-1849); see Smith (1846, p. 144)

[42] In reading this account it should be remembered that at this time the road between Fort Tejon and Los Angeles did not follow the present route. As shown in Williamson (1856), the road ran along the line of the fault from Gorman to Quail Lake, and thence left the fault trace to go through the Antelope Valley, reentering the mountains at Oakgrove Canyon and following the fault to Elizabeth Lake. It then traversed San Francisquito Pass and went down San Francisquito Canyon to Castaic Junction in the San Fernando Valley. At this point the road to Santa Barbara went down the Santa Clara River to Ventura.

they were astonished to see Kern river running *up stream*. Large trees were uprooted, and in the language of some who were *thar*, "all creation seemed to be going into one eternal smash." The water in Tulare Lake was upheaved to an unknown height, and large quantities of fish were thrown upon its banks, where they have remained. At the "Mill," some twelve miles west of Tejon, [43] the shock was very heavy. It tore up large trees and twisted off branches, threw people on the ground, and when over, caused a general stampede for the Fort, upon the supposition, we suppose, that that place was "safe as any," and that "misery loves company." One mile and a half this side of the Fort a lady was badly hurt. When the shock was first felt, she ran out of the house and crept under a cart for safety. A limb of a tree standing close by, fell down directly across the cart, which it crushed to pieces, injuring her severely. Mr. Gale, whose dwelling was situated about the same distance from the Fort, experienced a severe injury during his exertions to rescue his children from the ruins of his falling house. At Reed's Rancho, six miles from Tejon on the Los Angeles trail, [44] the wife of Mr. Reed's vaquero was killed. A beam fell in the house on her head, killing her instantly.

A large rent in the earth was traced by Mr. Warner a distance of eight leagues. [45] When on the high ground by Elizabeth Lake it could still be discerned running in an easterly direction towards the Colorado river. This rent was in some places five to 10 yards wide, the earth at times filling it up like ploughed furrows; at others the ground stood apart, leaving a deep fissure. Its course was in a straight direction, across valleys, through lakes and over hills, without regard to inequality or condition of surface. On either side, the ground had been more or less disturbed for a long distance.

While on the way hither, when traveling between Cumola and San Francisco Ranchos, [46] some thirty miles distant from San Buenaventura, a heavy shock was felt in the afternoon at the same time that it was noticed here on Friday, January 16th, which we have already above described.

22. Journal History of Las Vegas Mission, January 9, 1857 (From Seismological Notes, Bull. Seism. Soc. Am., 49, 117-118)

Friday, Jan. 9. Quite a reeling of the earth took place at 9 o'clock A.M. It lasted $1\frac{1}{2}$ minutes.

23. Letter of Lt. Col. B. L. Beall, January 9-10, 1857 (Letter #B4, Letters Received, 1857, Department of the Pacific, Records of U. S. Army Continental Commands, Record Group 393, U. S. National Archives, Washington, D. C.)

Fort Tehon, California
January 9th 1857.
8 o clock P.M.

[43] Cullimore (1941, p. 66) locates this at Mill Potrero, about 22 kilometers (14 miles) west of the Fort, and probably less than a kilometer from the fault.

[44] See (14), note 2.

[45] About 40 kilometers; this is roughly the distance along the fault from Gorman to Elizabeth Lake. This is the distance the road followed the fault line.

[46] Map 36 in Beck and Haase (1974) shows the latter rancho to be along the Santa Clara River at the present Los Angeles-Ventura county line.

Brevet Major W W Mackall
Asst Adjt General
Department of the Pacific
Benicia Cal

Sir

I have the honor to report for the information of the Commanding General of this Department, that at about six o'clock this morning, the shocks of an earthquake commenced and have continued with more or less violence, at intervals of five or six minutes, up to this time. The greatest shocks took place at 27 minutes before 9 o.clock A.M. The destruction to property, both public and private, has been immense. Many of the buildings at this Post have been so injured as to be totally uninhabitable, as follows.

1st—The unfinished building, intended for a Quartermaster's Storeroom and Office. One end of this has been thrown down, and the remaining walls badly cracked in several places. It can be repaired.

2nd—The unfinished building intended for Captain's Quarters. This had one end thrown out of perpendicular and badly cracked. It can be repaired.

3rd—An unfinished building, containing two sets of Quarters. This had one end thrown down, and the other end thrown out of perpendicular, so that it will have to be taken down. The walls sustaining the roof are secure, and the building can be repaired. The two ends of the kitchen attached to this building are thrown down, and the main walls are cracked and injured, but the kitchen can be repaired without destroying the roof.

4th—The unfinished building, occupied by Major Blake and Lieutenants Ogle and Magruder. This has been cracked and injured in many places, but has suffered no material injury. I think it can be occupied with safety. Both ends of the kitchen attached to this building have been thrown down, and the remaining walls are badly cracked, but it can be repaired without removing the roof.

5th—The Quarters occupied by Company "H" 1st Dragoons. This has been cracked and shaken in many places, but no so much as to injure the stability or security of the building

6th—The Quarters occupied by Company "G" 1st Dragoons. One of its chimneys has been thrown down. Its walls are more or less cracked, but it is sufficiently secure to be occupied, and can be repaired with but little expense

7th—The end wall of the unfinished company kitchen has been badly shaken and cracked. The building, otherwise has received no material injury

8th—The building occupied by Brevet Major Grier. This has been badly shaken. Its chimney tops have been thrown down, its walls cracked in many places, and its plastering thrown down and injured. I think the walls of the building secure, and that it can be occupied with safety.

9th—The Quarters occupied by Lieutenant Colonel Beall. This has received more damage than any of the finished buildings of the Post. Its chimnies have been thrown down, its plastering broken off in many places, and one of its ends so badly shaken and cracked, as to be in my opinion too insecure to be occupied

10th—The Quarters occupied by Captain Kirkham. This has been badly shaken and cracked, its plastering broken off in many places, and its chimnies thrown down. I think the walls secure and capable of sustaining the roofs.

11th—The kitchen attached to Colonel Beall's house. This has been badly shaken and cracked. I consider it insecure.

12th—The building occupied as a commissary store house, and hospital. This has been badly shaken and cracked throughout, and its plastering very much injured. Its main wall has been but little disturbed from the perpendicular, and is, I think, secure, and capable of sustaining the roof.

13th—The unfinished building intended for two sets of Quarters. Upon this, I can observe no material injury.

Most of the chimney tops have been cracked and there is danger of fire being communicated through these cracks to the roofs.

Fortunately no lives have been lost at the Post. The sick of the command are now in tents, although the weather is very cold. The shocks have been very extended, and less severe at the Post, than on the Los Angeles road, or in the Tulare valley. Several of the houses in the vicinity have been completely demolished, but the injury to life, so far as heard from, has been slight. Large fissures have been opened in the Los Angeles road, and in some places on the road there have been immense land slides. It is said that ~~the water~~ in the Tulare lakes, the water was thrown twenty feet into the air, during the greater shock. The largest trees have, in many instances, been torn from their roots.

In order that the General Commanding, may [be] informed of the havoc done to the Post, at the earliest possible moment, I have thought it necessary to forward this by an express.

I have the honor to report for the information of the General, that I shall repair to the Head Quarters of the Department by the next steamer. [47]

January l0th—9 o.c. AM.

I have the honor to report that during the night, and up to this time, the shocks have continued with much violence, at intervals. The buildings have been much damaged since 8 o clock P.M. of yesterday.

I am very Respectfully
Your obdt servt
B. L. Beall Lt Col. 1 Drags Cdmg Post

[47] Wood (1955, p. 55) took this to mean that a later written report was made. We think it more likely that this sentence means that Beall was going to report in person to headquarters. The January 1857 Post Return for Fort Tejon (Post Returns from Military Posts, Records of the Adjutant General, Record Group 94, U. S. National Archives microfilm MC 617, roll 1257) shows that Beall received a letter from headquarters on January 8, ordering him to report to San Francisco for duty at a court-martial. It would have been natural for Beall to acknowledge this order in his next letter to headquarters. We have found no other material in the 1857 correspondence of the Department of the Pacific relating to earthquake damage. The only report made by the San Francisco headquarters is a letter to the Adjutant General's office in New York. (General J. E. Wool to Lt. Col. L. Thomas, January 17, 1857, Letters Received by the Office of the Adjutant General, Main Series, 1857, Records of the Adjutant General, Record Group 94, U. S. National Archives microfilm MC 567, roll 565, frames 353-359). This includes a copy of Beall's letter but no further information.

24. Portion of MS "Report of Labor on Sebastian Military Reservation" (Letters Received, California Superintendency, 1857, Records of the Bureau of Indian Affairs, Record Group 75, U. S. National Archives microfilm MC 234, roll 35, frame 1027)

Friday Jan'y 9th—In the morning experienced a tremendous shock of Earthquake, which damaged the greater portion of the houses and threw down one. [48] Ten slight shocks during the day.

Saturday Jan'y 10th—Shocks continue,

25. Portion of a letter from Thomas P. Madden to Col. Thomas J. Henley, Tejon Agency, September 20, 1857, entitled "Labor Report for Tejon Reservation for the 3rd quarter 1857" (Letters Received, California Superintendency, 1857, Records of the Bureau of Indian Affairs, Record Group 75, U. S. National Archives microfilm MC 234, roll 35, frame 1287)

The public buildings—all of them need repairing, more or less. The large granary was very much injured by the recent earthquakes, more so than was at first supposed. The whole north end of the building has bulged out and the top adobes immediately under the peak of the roof have fallen. It is the general opinion that unless something is done for its preservation before the rains set in the entire north wall will fall during the approaching winter. The Goat house near Bicente's Rancheria needs roofing and the chimneys rebuilt, the latter having crumbled away by the action of the Earthquakes and the weather.

26. Visalia *Weekly Delta* November 26, 1859

The curiosities are the Hot Springs on the opposite side of the river from Keyesville, the water of which is almost boiling hot where it comes up through the ground. [49] The spring runs a large sluice head. The taste of the water is very similar to that from the Blue Lick Springs of Kentucky. We were told that during the time of the earthquakes of 1857 the water from this spring was intensely hot, and continued so for some six months after. There was another spring some fourth of a mile distant, which was entirely closed up by the earthquake, and is now dry ground where it once run.

27. Reminiscence by Stephen Barton, 1876 (from the Visalia *Iron Age*, December 28, 1876, p. 1, col. 2)

During the fall of 1856 [50] the heaviest earthquake shock which has ever been experienced in this valley occurred. Houses and trees vibrated furiously, and most of the population were seriously frightened. The solid earth seemed to have lost its stability, and a wave-like motion was experienced, as if on ship-board. Lowing herds capered over the plain; wild fowls rose in the air with screams, and for a moment nature seemed filled with horror. The line of disturbing force followed the Coast Range some seventy

[48] The Sebastian Military Reservation (also known as the Tejon Agency, or Tejon Indian Reservation) was located at the mouth of Tejon Canyon, in the southeast corner of the San Joaquin Valley (Boyd, 1972).

[49] Gudde (1975) locates Keyesville 6 kilometers west of Isabella. There are a number of hot springs along the Kern River in this area.

[50] As Wood (1955, p. 49) pointed out, this is almost certainly an error for winter.

miles west of Visalia, and thence out on the Colorado desert. This line was marked by a fracture of the earth's surface, continuing in one uniform direction for a distance of some two hundred miles. The fracture presented an appearance as if the earth had been bisected, and the parts had slipped upon each other. Sometimes the earth on one side would be several feet the highest, presenting a perpendicular wall of earth or rocks. In some places the sliding movement seems to have been horizontal—one side of the fracture indicating a movement to the northwest, the other to the south-east. The fracture pursued its course over hill and hollow, and sometimes this sliding displacement would give to the points of hills and to gulch channels a disjointed appearance.

28. Reminiscence of John Barker, ca. 1900 [51] (From California Federated Women's Clubs, History and Landmarks Section, 1913)

In 1857 I was a young man of twenty-five, and for four years had lived on a cattle ranch through which Kings River ran. Its source was near Tulare Lake. The only settlement between Los Angeles and Stockton, at that time, was the hamlet of Visalia; so neighbors were far apart.

One morning in the month of November, 1857, [52] I started out on horseback in company with an old Englishman, my nearest neighbor, to search for some horses of ours that had strayed away. We shaped our course to skirt the shores of Tulare Lake between what is known as Cross Creek and Kings River.

At this time Tulare Lake was a very large sheet of water, about one hundred miles in length by thirty miles in width at its widest place. For a couple of miles from the shore, the waters in the shallows were covered with burnt tules and other refuse matter unfit for use for man or beast, until a distance of two miles from the shore was reached.

We knew that our horses would not drink from the lake, but there were sloughs and holes of water in depressions outside of the lake, where the water was clear and fit for use.

To one of these water-holes, which was surrounded by a fringe of tall willows, we directed our course in order to look for tracks of our missing stock. As several of them were shod, we knew if we found the shod tracks that we were on the right trail.

There was a keen frost, and when we reached the water-hole a thin film of ice was seen upon the water. I dismounted and led my horse by the bridle, and walked to the edge of the water. Just as I reached it, the ground seemed to be violently swayed from east to west. The water splashed up to my knees; the trees whipped about, and limbs fell on and all around me.

I was affected by a fearful nausea, my horse snorted and in terror struggled violently to get away from me, but I hung to him, having as great a fear as he had himself. Of course, all this occupied but a few seconds, but it seemed a long time to me.

The lake commenced to roar like the ocean in a storm, and, staggering and bewildered, I vaulted into the saddle and my terrified horse started, as eager as I was to

[51] The book containing this account is undated; Eisman (1972) suggests that it was printed in 1913. Many of Barker's reminiscences (though not this one) were published in newspaper articles in 1904 (Boyd and Rogers, 1955) and we have therefore given a date of about that time. Barker died in 1909.

[52] Undoubtedly a misremembrance of the date. Note that the season given is correct.

get out of the vicinity. I found my friend, who had not dismounted, almost in a state of collapse. He eagerly inquired, while our horses were on the run and the lake was roaring behind us, "What is this?" I replied, "An earthquake! Put the steel to your horse and let us get out of this!" and we ran at the top of our speed for about five miles.

We observed several hundred antelopes in a state of the wildest confusion and terror. They ran hither and thither, creating a great dust, stumbling and failing over each other in mortal fear. It is their habit at this season of the year, while rearing their young, to congregate in great numbers for mutual protection from coyotes and other vermin; the males also herding in bands by themselves until the new grass starts.

We returned next day and found that the lake had run up on the land for about three miles. Fish were stranded in every direction and could have been gathered by the wagon-load. The air was alive with buzzards and vultures eager for the feast, but the earth had acquired its normal condition.

We can only imagine what the consequences would have been if a great city had stood upon the eastern shore of the lake.

29. Meteorological Report for January 1857, Fort Miller, [53] California) (Climatological Records, Records of the Weather Bureau, Record Group 27, U. S. National Archives, Washington, D. C.)

Three distinct and very perceptable shocks of the earth ~~was~~ felt this morning (the 9^{th}) at 8 A.M. A slight tremor occured during the night previous at $2\frac{1}{2}$ A.M.

30. Diary of Dr. C. A. Canfield, January 9, 1857 (From Holden, 1898, p. 49)

...15 or 20 miles N. W. of San Benito, Dr. Canfield's Diary [54] says 3 shocks, the first about sunrise [7:23 AM–Holden's note], lasting not over 5 seconds, accompanied by noise. The second about 8 a.m., "very much more violent—pieces of mortar fell from the walls—I was almost thrown from my seat—this lasted for a minute or two and I then went out of doors, when the oscillation returned and lasted perhaps a minute, but was quite gentle." The direction was S. to N. A person lying down reported a shock at 10 a.m., which was not felt by persons in motion.

31. Santa Cruz *Pacific Sentinel* January 10, 1857 p. 2, col. 1

Yesterday morning was experienced two severe shocks of an earthquake, the first between 5 and 6 o'clock A.M., and the other about 8 o'clock A.M., which lasted for several seconds, and caused a shaking of things generally. As yet, we have heard of no damage resulting from them.

32. Santa Cruz *Pacific Sentinel* January 31, 1857 p. 1, col. 5

The shock of earthquake, or rather earthwave was felt in the counties of Santa Cruz and Monterey, on Friday morning, the 9th inst. It came from the west and north, and

[53] Our location for Fort Miller (37.01°N 119.68°W) is from Whiting and Whiting (1960). The site of the Fort is now beneath Lake Millerton reservoir.

[54] Holden (1898, p. 3) specifies this more fully as the diary of "Dr. C. A. Canfield, who lived 15 or 20 miles northwest of San Benito, Monterey County". We have not been able to locate this document, or any more precise reference to Canfield's location; this description would put him in the vicinity of Paicines.

its direction was to the south and east. It was a pretty hard shock, yet no buildings were affected, and many persons did not even experience its movement and were entirely ignorant of its occurrence until informed of it. We understand from other parties that shocks were felt also at one o'clock A.M., and another at 8 o'clock A.M.

33. Santa Cruz *Pacific Sentinel* January 31, 1857 p. 2, col. 7

Our readers will find to-day, on our first page, the most corrected accounts yet published. It appears from what we have observed of the phenomena and the observation of our friends in Monterey county, that three distinct shocks were experienced—the first at one o'clock A.M., the second which was the sharpest, at seven A.M., and the third at 8 A.M. The vibrations were all undulatory, coming from the North and West, and passing directly to the South-East. On the Salinas river and the lagoons of the plain, at the 7 A.M. shock, the waters were much agitated—the trees on the banks were tossed to and fro with violence, chains around carts, houses and walls set up a-rattling; dogs a barking; men and women startling, and horses to get wild, rearing and snorting. In taking into consideration the exact time of the visitation of these earth-waves, and the great discrepancy in the accounts of the different observers throughout the State, it must be borne in mind, that out of San Francisco, and Sacramento, (where there are proper chronometers corrected daily for science and navigation) there are not two watches which keep the same time—generally they differ by fifteen minutes, and often half an hour.

34. Santa Cruz *Pacific Sentinel* February 21, 1857 p. 2, col. 2

The earthwave which occurred on 9th ultimo visited the southern part of Monterey county with great force. We understand, that at the Ranch of San Benito, fifteen miles east of San Antonio Mission, the force of the shock was so violent, that every person in the house, which is a heavy adobe and stone affair, involuntarily ran out into the open air with great fright, except an old gentleman who was laying very ill, and his wife who, was attending him, and who in the extremity of peril, clung to the old man with a most rare presence of mind. The old man is an Englishman, the old lady is a Californian. The oldest son, a strapping boy of twenty-two, with a strong revulsion of feelings, rushed back into the house and took up his father, to carry him off, when the shocks ceased, and the family became quiet.

The rancho is about twenty miles from Monterey, [55] and lies in a line with the Tejon pass, of northwest and southeast—which we conceive, is the indubitable direction the seven o'clock shock followed.

35. San Jose *Telegraph* January 13, 1857 p. , col. 3

On Friday morning at about five minutes past eight o'clock, a severe shock of an earthquake was felt in this city. The movement was undulating and slow, and seemed to proceed from southwest to northeast, and produced a sickening sensation precisely as one feels when upon the rocking waves. We were standing in front of the fire at

[55] This is not correct. The San Benito land grant, which does lie 25 kilometers (16 miles) northeast of Mission San Antonio, is about 90 kilometers (55 miles) from Monterey (Beck and Haase, 1974, Map 31).

the time of its occurrence, and so much and so suddenly were we affected by it, that a fainting dizziness came over us, and we were obliged to recline upon a sofa. The vibrations were slow and gradual, and continued for about a minute. The effect upon some of the artesian wells in this neighborhood was remarkable for a moment the water ceased to flow from the pipes, and then gushed out in greater volume and with more power than usual; we have heard that the channels of other wells, which had become obstructed, and ceased to discharge water, have become re-opened and the subterranean current is now flowing out from the orifice. It is said that at five o'clock, and again at about six, of the same morning, very distinct shocks of an earthquake were felt, but the motions were short and quick.

The shock was heard with equal violence at San Francisco and Sacramento and has doubtless been perceived for a great distance along the Pacific coast.

36. San Jose *Tribune* January 14, 1857 p. 1, col. 2

At about four o'clock on Friday morning last, Jan. 9th., a pretty severe shock of an earthquake was felt in this city, and a still stronger one on the same morning at about half past eight. The vibrations were from East to West, and continued for the space of nearly if not quite, a minute. The San Francisco papers state that the shock was felt there at a few minutes after 8 o'clock; and a telegraphic dispatch from Sacramento announced that it came off in that city between 7 and 8. If such was the relative time of the occurrence of the phenomenon, we would request our friends in Sacramento on the next repetition of the performance, to send us a telegraphic dispatch forthwith; which will enable us all in this section of the State to be prepared for the catastrophe. Those of us particularly who dwell in houses of brick or adobe, would much prefer to step out on such occasions into the street, and there quietly wait for the wagging, rather than to be surprised within four trembling walls of untried solidity, and compelled either to watch suspiciously the vibrations, and calculate our chances of being buried beneath the ruins of our own domiciles, or else to compromise our dignity by rushing incontinently forth into the open air.

The effect of the motion in San Jose was such as to produce in almost every one to whom we have spoken on the subject a severe nausea, in several instances even to vomiting, and a similar effect is said to have been produced on certain hotels and boarding houses, which threw out the contents of their breakfast saloons with emetical precipitancy. At Hillman's Temperance House, when the Earthquake motion was laid on the table, the motion to adjourn to the street was immediately put, and unanimously carried. And we have been informed of another instance, where several strangers who were just finishing their breakfast at one of the city restaurants, were so alarmed by the unwonted movements of the knives and forks, that they not only gathered up their hats and rushed out of the room, but altogether forgot to return and settle their bills.

To speak seriously however, the only important damage effected by the earthquake in this valley that we have heard of was the cutting off or reducing in volume the streams of several of our artesian wells. In some instances the water has entirely ceased to flow to the surface, and in others the stream was for a time greatly increased, and then subsided to about its former size. This was the case with the well at the distillery; while the public fountain on Market St. has been permanently reduced in its volume.

With regard to the operation of the shock on the large brick edifices of the town, we deem it worthy of notice, that while the Post Office building, which is regarded as the most solid and substantial structure in the city gave manifest indications by the creaking of the timbers, of the severity of the vibration, the City Hall moved quietly to and fro without any such noises occurring—a pretty good proof that the fears entertained by some concerning the stability of our buildings are groundless.

37. San Francisco *Daily Alta California* January 10, 1857 p. 2, col. 1

A severe shock of an earthquake was felt in this city yesterday morning, a few minutes after 8 o'clock, causing a considerable degree of consternation and alarm, particularly in the lower part of the city, where the shock was more severely felt than in the upper portion. A frame house, situated in the rear of the intersection of California and Market streets, occupied by Peter J. Evans and family, was shaken from its foundation and moved several feet to the southward. The house was elevated some four or five feet from the planking, and stood upon piles; beneath it were placed a number of barrels and boxes. When the under-pinning gave way, the floor of the house rested upon the boxes and barrels, and was broken through in several places. A little girl who was in the house, asleep at the time, narrowly escaped, as the floor beneath her bed was broken through. The shock was generally felt throughout the city—clocks were stopped, gas burners were shaken, crockery and tin rattled in the stoves, and at a hotel on Davis street, where the boarders were breakfasting at the time, the shock was so severe that men, women and children left the table and rushed to the street. By telegraph from Sacramento, we learn that the shock was felt in that city between 7 and 8 o'clock A.M. About a year ago, a similar, though much more severe, shock was felt in this city. It is stated that no less than sixty shocks of earthquakes have been felt in this city within the past five years.

38. San Francisco *Daily Alta California* January 13, 1857 p. 1, col. 1

This day will long be remembered by the people of Santa Barbara.[56] We have had six shocks of an earthquake up to this minute, two since I commenced writing, consequently my nerves are not in as good order as usual. The first shock was at six in the morning, the second at nine, one and a half minutes in duration, the most severe shock ever felt in this part of the country. Scarcely a house in town that escaped damage; people and animals were thrown down—the earth opened in many places—water gushed up some places seven feet—the water in all the wells arose from ten to twenty feet—people frightened badly at every shock. Third shock at ten, slight—the three last this evening, two slight, one heavy. If we have many more, we shall begin to think we are going elsewhere.

39. San Francisco *Daily Alta California* January 28, 1858 p. 1

EDITOR ALTA: The earthquake of January 9, 1857, more powerful in its effects and more extensively felt than any shock that had been experience in this State since the advent of the Americans, would seem to have called for an extended account from the pens of one of our California *literati*.

[56]This is from a letter of R. E. Raimond, of Santa Barbara, dated January 9, 1857.

Having seen none, however, and believing that a succinct statement of observations, noted at the time of its occurrence in various widely separated localities, would be important auxiliaries in the endeavor to solve the problem of the *cause* of such convulsions of the earth, I herewith present the results of my collections on this subject. These, owing to the place of collection, are necessarily imperfect. San Francisco would have offered far greater facilities for this purpose; but, as they are, together with other remarks germain to the topic, they will doubtless be found rather lengthy for the columns of a newspaper.[57] SANTA BARBARA.—The morning of the 9th January, was ushered in with a clear sky and cool atmosphere. First shock of earthquake felt at 8:10 A. M. It was brief and passed unnoticed by many. At 8:22 A. M., the heavy shock occurred and continued from 40 to 60 seconds. The inhabitants in the city generally fled from their dwellings. There were two motions during its continuance. The earth vibrated from side to side, accompanied by a peculiar rolling motion like that experienced on a vessel at sea. In-doors the creakings of the house roof resembled the noise like that of straining timbers of a ship in a gale. The vibrations seemed to come from the N.E. and proceed to the S.W. There was no rumbling or other sound during this earthquake, or any other succeeding shocks felt here. No damage ensued beyond cracking a few adobe house walls. At the sea-beach, water and mud spouted up out of the ground to the height of several feet. Several new springs were caused in the mountains by this earthquake. Throughout the entire day and evening the earth seemed at times disturbed by tremulous vibrations. The sensation experienced by the writer during the above heavy shock, was as if the centrifugal motion of the earth had been suddenly checked, and for the time being, thrown from its accustomed equipoise.

SACRAMENTO.—The Sacramento Union says: "The earthquake of Jan. 9th was felt at 2:15 A. M. and 8:15 A. M. [58] The last shock was of few seconds duration, but sufficient in force to cause chandeliers to vibrate about a foot from the centre, and to create a rattling among crockery and other wares. The motion seemed to be *from W. to E.*, like successive undulations." Another account in the same paper states that the vibrations seemed to proceed *from S.E. to N.W.* Thos. M. Logan, Esq., states that the motion of the earth was horizontal, and the intensity of the earthquake force sufficient to cause chandeliers to vibrate a few inches from the centre. From all accounts, it would seem that the terrestrial wave came *from W. and N.* and made its way *to S. and E.* [59]

[57]This article describes the effects of the earthquake throughout California. Most of this article is reports reprinted from other newspapers that are contained elsewhere in our report, so we have not reprinted them. The exception is the parts describing the effects at Santa Barbara and Sacramento, which are eyewitness accounts. Note that C. H. Randall, the author of this article, was also an editor of the Santa Barbara *Gazette* (see the *Gazette*, January 15, 1857), so that this account is not independent of those in that newspaper, reprinted here as (20) and (21).

[58]The original account, (65) says 10:15 A.M.

[59]This conclusion would appear to be Randall's.

The other phenomena, &c. in connection with the present topic, will be given in a future article. [60]

Respectfully yours,
C. H. RANDALL
Santa Barbara, Jan. 21, 1858

40. San Francisco *Daily Evening Bulletin* January 9, 1857

Several shocks of an earthquake were felt in San Francisco last night and this morning, the principal one occurring at a quarter past eight o'clock this morning. The shock seemed to be much more severe in the lower than in the upper part of the city. The printers of the *Bulletin*, in the third story of a building on Merchant Street, being at work at the time, felt the house trembling and moving. One of them grabbed his coat to run; another was in such great tribulation that he could not find his hat. "The fat man," thinking there was no chance for escape, held on to a printing case, perfectly resigned to his expected fate. In some of the hardware stores in the lower part of the city there was a great clashing among the crockery and tin pans. Several clocks were stopped. In a house on Second street, a lady who had lately arrived on the *Orizaba*, said that the motion of the house resembled that of the vessel at sea. An ironing board, five feet long, which was hung up against the wall, vibrated to and fro several times. The shock, however was not so severe as that one which occurred last spring, and many persons did not notice it at all ...What between fire and earthquake it is hard to say whether wooden or brick houses are the safest to live

41. San Francisco *Daily Evening Bulletin* January 12, 1857 p. 2, col. 2

Our regular Los Angeles correspondent, "Observador", [61] (whose letter will be, given in full to-morrow) writes: "A severe shock of an earthquake was felt here this morning [Friday, 9th January] [62] at half past eight o'clock. The motion seemed to be East and West. The motion of the earth resembled the long swell of the sea—it literally swayed backwards and forwards like the rocking of waves, so that it was with great difficulty one could stand up. Articles hung overhead in houses, swung to and fro like so many pendulums. Clocks were stopped. The water in the river and zanja was turned back or overflowed the banks. The people generally fled from their homes into the open air. The vibrations apparently did not cease for some minutes. The damage done to buildings was slight, as the motions were long and lateral, instead of sudden, violent, and vertical. Almost an hour later another shock was felt."

"A. S. T." of Monterey, [63] so well known as a writer on California topics and a man of science, writes us on the same subject as follows:

"A smart shock of earthquake—apparently a wave coming from the West and North, and making its line for the South and East was felt in Monterey about 7 o'clock in the

[60] This was published in the *Alta* on February 8, 1858. It contains no additional information, but is a summary of times, directions, and so on, derived from the accounts in the first article.

[61] H. D. Barrows; compare his reminiscences, (16).

[62] The bracketed material is in the original.

[63] Alexander S. Taylor, California historian and bibliographer (Cowan, 1933).

morning of Friday, the 9th inst. It shook some of the oldest adobe buildings in the town, but did no harm whatsoever to things animate or inanimate. The earth seemed moved with the motion of a heaving, rolling wave. It was certainly a horizontal movement, and not a vertical one. Many people in the town, who were about their occupation, did not experience the sensation in the slightest degree; while those who were in bed felt it distinctly."

42. San Francisco *Daily Evening Bulletin* January 13, 1857 p. 2, col. 2

As the late earthquake did not do any serious damage in this immediate vicinity, [64] many persons were not aware of its occurrence until they read of it in the papers.

43. San Francisco *Daily Evening Bulletin* February 3, 1857

Los Angeles, January 28, 1857

We have been having exciting times in the Southern country since the last steamer left. The great earthquake felt here on the morning of the 9th inst. was rather more extensive in its operations than we at first anticipated; it did some appalling execution in various localities in this vicinity. At Temple's Ranch, twenty miles south of this point, [65] the ground opened several feet wide for some distance, partly in the bed of the San Gabriel river and partly across the stream. At Paredes, thirty-five miles south-east, [66] the ground cracked and several streams of water commenced running. At San Bernardino, and on the Mohave, the shock was tremendous, but we have heard of no disruptions. In various places streams have started where no water ran before the convulsion, and Mr. Stanley, of Capt. Greenwell's coast surveying party, (a gentleman who may be relied upon) reports that he discovered on the side of a high mountain in the vicinity of San Fernando, a "fissure in the rocks from which hot gas was fiercely issuing. The rocks and ground were almost too hot to be touched." [67] In the vicinity of Fort Tejon, 100 miles north of Los Angeles, (from which place you have doubtless heard ere this) the effects of this convulsion of nature seem to have been the most violent. The ground opened in places for thirty or forty miles, and from ten to twenty feet wide! The line of disruption runs nearly north-west and south-east in an almost straight line, passing near Lake Elizabeth. The ground appears to have opened in the form of a ridge and then to have fallen back, leaving the earth pulverized and loose about twelve feet wide generally, so that in many places it is almost impossible to pass. An eyewitness saw large trees broken short off near the ground; he saw cattle roll down steep hillsides from the violence of the shake; he had to hold on to a post himself to stand up. The people in the Fort were unceremoniously honored with a shower of plastering and a general tumbling down of walls and chimneys, and it seems providential that none of them was killed. He judged that it would take months to repair the buildings at the Fort. The officers and men are now camping out in tents. At the Reservation much

[64] This is part of a letter from Sacramento, dated January 12, 1857.

[65] See note (12).

[66] Meadows (1966) says this was on the edge of the Santa Ana River 800 meters east of Brookhurst, in what is now Fountain Valley.

[67] This quote is from the Los Angeles *Star* (14).

damage was done, but I have not heard particulars.. The body of the woman killed by the falling of the house at Reed's Ranch, was brought to Los Angeles and buried; her head was badly bruised. Quartermaster Wakeman reports the time of the shock at twenty-seven minutes previous to 9 o'clock, which agrees very well with the time as noted here. The motion was preceded there, and accompanied here, by a heavy rumbling report.

There are no signs of aught being thrown up from the openings at Tejon. It is supposed that though the causes of these disturbances may be subterranean fires primarily, the secondary and immediate causes are the escape or explosion of gases generated by those fires. This we conclude from the entire absence of all signs of volcanic matter, although the disruptions of the earth and the force that caused them, in the movement of the earth on the 9th instant, were tremendous.

We had at Los Angeles five or six shocks during the same day and night, and within about eight days time we had twenty shocks—some violent, some light. Since that time we have had none to speak of. For about a week we were "well shaken" and expected to be "taken," as the doctors phrase it. Reports were constantly coming in of the doings of the first great temblor in the sections of the country about us, interspersed with "lesser shakes" of the earth, so that the public nerves were kept up to rather an uncomfortable tension.

—Observador [68]

44. San Francisco *Daily California Chronicle* January 10, 1857 p. 2, col. 2

A shock of an earthquake was felt in this city yesterday morning about eight o'clock. It seemed to commence on a range with Clay Street, and spread towards Rincon point, and was felt in Sacramento. Singularly enough, none of the vessels in the bay north of the line of Clay Street shook in the least, while on vessels south of the line the shock was quite severe. Clocks were stopped, tin pans and articles of crockery upset, frame buildings trembled, and brick houses were considered dangerous. A great many people were frightened, but no one was hurt. "Gabriel" did not come this time, although there was a general "rattling of the dry bones," and people ran out of their rooms without stopping to attire themselves in full dress. No buildings were cracked or injured that we have heard of.

45. San Francisco *Daily Morning Call* January 10, 1857

At about half-past five o'clock yesterday morning, a slight shock of an earthquake was felt, and at eight o'clock, another much more severe. The last frightened a good many people, and occasioned some little damage. A small frame building on "stilts", was thrown over, several piles of lumber changed positions, a few plates from the breakfast table of a hotel on Front Street were thrown on the floor, and some of the compositors on an evening paper were only prevented from breaking their necks by jumping out of a third story window to avoid the danger to life by the falling in of the roof, by their more cool and collected fellow-craftsmen. It was in reality such a shock

[68] H. D. Barrows. See (16).

as to furnish a good item for our local. The shock was sensibly felt in Sacramento at the same instant.

46. San Francisco *Daily Globe* January 10, 1857

A slight shock of an earthquake occurred in this vicinity yesterday morning, at fifteen minutes past eight o'clock. The shock lasted about twenty seconds. The motion was undulating and ranged from North to South. From all that we can learn, the shock was most severe in the neighborhood of Happy Valley, [69] where the people rushed out of doors and a scene of general consternation prevailed for some minutes. Those who experienced the shock were reminded of the earthquake which happened on the morning of the 15th of February last year.

47. San Francisco *Daily Herald* January 10, 1857 p. col. 2

At five o'clock, yesterday morning, and again at fifteen minutes after eight o'clock, the earth was shaken to its centre by the throes which seem to have become a part of the peculiarities of our State...

The motion of the earth is as variously described on this as on former occasions—some contending for north and south as the direction of the movement, while others insisted on east and west, and others still—though fewer in number—for all the possible combinations of the points of the compass;—though it is universally conceded to have been felt with greater violence in the south part of the city and that part reclaimed from the Bay—all below the former water-line being particularly susceptible. Subjoined will be found such incidents of the result of the shock as could be obtained:

INCIDENTS

The clock in the office of the Pacific Express Company, on the corner of California and Montgomery streets was shaken from an upright position and did not recover its perpendicular. One of the hands was loosened so that it fell from the face.

In the store of Morgan, Hathaway & Co., a large pile of tea-boxes were thrown down by the vibration, and gave evidence of the severity of the motion in that neighborhood.

On Steuart-street wharf the shock produced an emptying of the houses of their human contents—upwards of fifty persons ran frightened and confused into the street.

The Rassette House was not exempt from the visitation, and the inmates were no less frightened than when canvassing the effects of the February shake.

On Market Street a small frame house was shaken from its foundation and fell a distance of five or six feet—though it is probable a high wind would have done as much for it just at that time.

In the lumber yards the boards not securely placed were toppled over; and in the whole lower part of the city light articles of furniture were moved from their positions, crockery crashed on shelves, glasses jingled in cupboards, water slopped in pails—and all the accompaniments of a second-class earthquake were experienced.

[69] See note (83) for the location of this place.

48. San Francisco *Daily Herald* January 12, 1857 p. , col. 1

From passengers by the steamer *Senator*, we learn that the earthquake, on the 9th inst., felt in Sacramento and this city, extended to the southern coast, was the most alarming experienced for the last half century. In San Diego, Santa Barbara, Los Angeles. and San Pedro, it was peculiarly severe, and continued for upwards of twenty minutes or a half an hour. They represent the motion as from north to south. In all the places named, several houses were cracked—the people rushed out into the streets—but as most of the dwellings in that section of the country are one-story adobes, stoutly built, no injury to life ensued. From the representations made to us, we have not the slightest doubt that if the earthquake was as severe in this city as in the southern portions of the State, San Francisco might possibly have been in ruins to-day. In San Diego, houses were thrown to the ground [70] moveables were scattered—about in the wildest confusion, and for a time intense excitement prevailed.

TERRIBLE EARTHQUAKE DOWN SOUTH.—It seems there has been a terrible Earthquake down South. The papers received by the Senator from Los Angeles are only to the 3d of Jan., and Santa Barbara to the 8th, therefore no mention is made of it. From a private letter dated Santa Barbara, Jan. 9th, received by a gentleman in this city, we have been permitted to make the following extract: "One hour past we had shocks of the most terrible earthquake experience for the last forty-six years in California. They lasted some twenty minutes. Several houses were injured but no lives were lost. The inhabitants all fled from their houses. For a time I could scarcely keep on my legs. It occured at $8\frac{1}{4}$ o'clock this morning (the same time the second shock was felt in this city.—ED. HERALD.) God help you if it should be felt in San Francisco just as here. It would be a heap of ruins."

49. San Francisco *Daily Sun* January 10, 1857 p. 2

On just such a morning as that of yesterday, on the 15th of February, now nearly one year, our city was visited by a most severe shock of earthquake. The weather was not as cool at that time, but the sun rose in cloudless majesty, and the shores of Contra Costa appeared as if not more than half a mile distant. Very little air was stirring, and nature seemed hushed in quiet repose. Within the last twenty-four hours we have again felt the upheaving of Earth's foundations, and although the shock, or rather tremors, were not very severe, yet they were sufficiently so to cause much agitation to some persons. They seem to have been more severely felt in the lower portion of the city. The first shock was at 11 o'clock and 20 minutes, P.M.; the second at 1 o'clock and 33 minutes, A.M.; the third at 4 o'clock and 15 minutes; the fourth at 6 o'clock and 8 minutes; the fifth at 7 o'clock precisely, and the sixth at 8 o'clock and 14 minutes. The tremors of the fifth shock, four in number, produced a circular motion, of the pendulum, and in the other five, the oscillations were apparently from northeast to southwest. The last shock was much the strongest, and created considerable alarm. The scenes that occurred on the 15th February, 1856, seemed about to be re-enacted, and many persons ran out of their houses on experiencing the shock.

[70] This report of severe damage in San Diego (unfortunately widely copied) was shown to be false by Trask (55).

Earthquake in Sacramento—A severe shock of earthquake was experienced in Sacramento yesterday morning. It commenced at nineteen and a half minutes past 8 o'clock, and lasted a few seconds short of four minutes, being very sensibly felt. Its oscillation appeared to be from southwest to northeast. The acme or severest tremble seemed to be about the middle of the "shake." From the statement of a gentleman who came down on the boat last evening, it appears that it was fully as sensible as that felt in this City in February last. The weather was excessively cold, and the thermometer was far below the freezing point. The sky was almost cloudless.

50. San Francisco *Daily Sun* January 20, 1857 p. 2

The agent of the Pacific Express Company, at Mokelumne Hill, has kindly given us some valuable information in regard to the shocks of earthquake experienced at that place on the night of the 8th inst. He says:

So firmly are we fixed upon the bosom of mother Earth, that severe indeed must be the shock which can disturb our equanimity, or in fact, our equilibrium; but on the night in question, we were suddenly aroused and many seriously alarmed by a rapid succession of slight stocks, which caused our windows and doors to rattle as if they were breaking. The shocks were accompanied, at intervals, by flashes of light, from east to west. These were witnessed by many persons, who were aroused from their slumbers, and had assembled in small knots to speculate on the unusual occurrence. A committee was appointed, including many of our scientific and professional citizens to investigate the phenomenon, and in a few moments it was ascertained that a jubilee had been declared for the election of our esteemed friend, Mr. Broderick. [71]

This was all we saw, heard or felt of earthquakes, until the arrival of the Stockton stages on the day following. [72]

51. San Francisco *Daily Sun* January 24, 1857 p. 2

"The Late Earthquake"

At the time of the occurrence of this phenomenon, we had some doubts of the extent of its action, as reported by the morning papers of this city, and therefore have taken some pains to ascertain the facts relating to it in this particular. Through the kindness of the Pacific Express Company, who have forwarded letters of inquiry for us throughout the interior, we are now enabled to state that in no locality east of Stockton and Sacramento, and north of Marysville was any shock felt whatever. In neither of the mountain towns that were paraded in the columns of the city press was there any occurrence of the kind.

52. San Francisco *Daily Town Talk* January 10, 1857 p. 2, col. 4

The prevalent cold weather has had an effect on Mother Earth, who, during the night of Thursday and early yesterday morning, evidenced the power of the chills.

[71] David C. Broderick. Bancroft (1888, vol. 6, pp. 705-706) gives the details of his election as Senator. Though not actually elected by the legislature until January 9, he had been nominated by them in caucus before, so a celebration on the night of the 8th and 9th is perfectly comprehensible.

[72] The jocular tone of this piece makes it hard to tell if any earthquakes were felt or not. From this sentence it appears that the main shock was not felt.

At eleven o'clock on Thursday night the first shock occurred, a moderate one ensued, and we suppose the old lady took a *tissane* and retired. The effects of the Thompsonian cure, however, passed off by sunrise yesterday, and at seven o'clock the paroxysm returned, being followed by a severer one at twenty minutes past eight. All three shocks were perceptibly felt in our vicinity, and the latter traveled as far as Sacramento. The vibrations of the second shock were north and south, those of the third, three in number, were more violent in effect, and moved from east to west. The pictures on the walls rattled, clocks stopped, and in one instance a pile of merchandise in a store, in the lower part of Clay Street, was thrown to the ground. The effects were more severely felt in the entire northern section of the city. On Powell Street the sensation affected those at breakfast, causing dizziness and nausea. We have not heard of any serious damage except to nerves. A gentleman residing on Minna street informs us that he determined the direction of the shocks and the extent of the vibrations from the results of the same on the material of his breakfast table, while engaged in his matinal meal, previous to the last shock. A plate of beefsteak, swimming in gravy to its very edge, was the instrument. After the motion ceased, it was found that the gravy had been ejected from the dish on two sides for about two inches each way, in a line east and west by the compass. The distance thus mapped on the table cloth, from the edge of the dish, clearly demonstrated the extent of the vibrations. Who will work out this problem from the start?

53. Portion of a letter from George Davidson to Alexander Dallas Bache, San Francisco, January 19, 1857 (Vol. 16, Superintendent's Correspondence for 1857, Records of the Coast and Geodetic Survey, Record Group 23, U. S. National Archives microfilm MC 642, roll 169, frames 164-165)

We had an earthquake here on the morning of the 9th. 1st shock about 7:14 A.M. second and more violent about 8:14 A.M. The latter toppled over piles of lumber, threw down a small frame building and one of my friends witnessed a large can buoy rolling about the wharf. I have not been able to get any reliable means of showing its force and direction, but am certain the motion was from W.S.W. to E.N.E. (Mag) or vice versa or nearly in the direction of the E. & W. streets in the North part of San Francisco. It occurred at Santa Barbara and San Diego later in the A.M.

54. Reminiscences of George Davidson, 1906. (Conflation of the quoted material in Lawson et ca, 1908, p. 450, with extracts from Davidson's MS notes dated May 25, 1906, in folder 4 (Earthquakes and Volcanos), Davidson papers, Bancroft Library, Berkeley)

We have no reliable record of the times of the shock at different points, and very little of the direction. Means of communication were underdeveloped. The times were local at the places where it was recorded.

It occurred at San Francisco 8^{h} 13^{m} 30s on the morning of Friday, January 9th; and was marked by one sudden sharp shock from the northward; minor details I have kept no recollection. A friend lying in bed east to west was thrown out sideways; I was lying North to South and disturbed also by the shock. Our boarding house was just on the east side of St. Mary's Cathedral.

The wholesale grocery store of Goodwin Brothers faced east on Battery or Front Street, with its length of about 100 feet on Commercial Street. It was a 1-story brick structure about 15 feet high, with a flat metallic roof and a fire-wall of 3 or 4 feet above and around the roof. There were no windows nor doors on Commercial Street. The fire wall along Commercial Street was thrown bodily from the main structure into the street. The inner edge of the bricks was a straight line, at a measured distance of 6 feet from the base of the wall, while the general mass was scattered across Commercial Street. In the hardware establishment of Philip T. Southworth, along the west side of the east wall, there was a line of nail kegs, every one exactly 12 inches from the baseboard. Before the shock they had been placed close to the baseboard. These two conditions would indicate a movement of the earth from the northward and westward—roughly, from the north-northwestward. I do not remember damages to other buildings, but am satisfied there were no serious results to property. Among minor details were the effects of the shock upon one of the piled wharves, where a lot of bar-buoys had been left. They had been rolled about in every direction.

55. Paper read by Dr. John B. Trask before the California Academy of Natural Sciences, San Francisco, March 30, 1857 (First published in Proc. Calif. Acad. Sci. 1, 109-110; republished as Trask (1858))

The earthquake which occurred in various parts of this State on the morning of the 9th of January last, excited at the time considerable attention. This arose from two causes; first, from the varied reports that appeared on the following day through the press of this city, detailing its occurrence in remote mountain towns, and for which there was no foundation; secondly, from the great extent over which the commotion was felt, as was subsequently proved.

Immediately following the occurrence of the phenomenon, letters were addressed to all the principal towns between Mariposa and Downieville, east of the valleys, for the purpose of learning how far the shocks may have extended eastward of this city. These letters were forwarded by the Pacific Express Company to their agents, and through them answers were returned in every case but two through the same source. From the facts thus obtained, it was found that in no locality east of the foothills, *was any shock felt whatever on that day or night.* [73] Another report, equally unfounded, reached us on the arrival of the steamer from the southern coast, to the effect that several houses had been demolished in San Diego from its violence, while the facts in the case are, *that the steamer left that port twenty-four hours before the shock occurred there.*

This earthquake, or more properly speaking, the series of shocks that began on the night of the 8th in this city, and which continued in the south part of the State during the following day and night of the 9th, was probably the most extensive of any on record on this portion of the Pacific coast, excepting, perhaps, that of the wave of the Simoda earthquake in December, 1854. The linear distance over which we are able to trace its course, amounts to six hundred and two miles, and its breadth, so far as now ascertained, is two hundred and ninety miles. It has all the appearance of having

[73]The similarity of this and the account in the *Sun* is obvious. Trask has added a detail, that answers were not returned in two cases, which indicates that he was not simply using that article as a source. He may have talked to someone at the *Sun*, or may himself have been the source of their information.

been the terminal movement of some more violent commotion at a distance from our coast.

From the best evidence attainable at present, it seems to have had its origin to the west and travelled in an easterly direction. This is conclusively proved from the fact that it was felt earlier at San Francisco, than at any other locality east of this city within the State. We have no record as yet of its occurrence along the coast of Mexico or Oregon.

I have been able to determine with considerable accuracy the period of time at which the shock between eight and nine o'clock in the morning of the 9th took place, at four localities east of the city of San Francisco, in this State, as the shock at that hour seems to have been more generally noticed than those which either preceded or followed it here or elsewhere, though at this city it was much less marked than the shocks at 1h.33m, 4h.15m, and 7h, these three latter occurring at those hours of the morning when most persons are sleeping. The shock at 7h, produced a circular motion in the pendulum, the diameter of which was about five inches. The oscillations of the pendulum in all the others were in an easterly and westerly direction. [74]

The precise period of time at which the shock took place at San Francisco, between eight and nine o'clock, is determined by the stopping of a time-piece belonging to J. W. Tucker, whose rate of error was three seconds fast. The time at San Diego was furnished by Mr. Cassidy of the army, and that of the Tejon Reserve is by persons at that post. To private gentlemen at Sacramento and Stockton we are indebted for the time at those places. The accompanying table of latitudes and longitudes, of localities named, gives the hour at which the shock took place at each; the difference or elapsed time, from which the velocity was deduced, are the mean times corrected for the places named, the time as given above being taken as the standard at San Francisco.

It is proper here to state that three minutes four seconds was the greatest error in time found, and the least was twenty-two seconds:—

	Latitude ° ′	Longitude ° ′	Time of shock h. m. s.	Elapsed time m. s.	Velocity miles
San Francisco	37 48	122 25	8 13 30	0 00	0.0
Sacramento	38 32	121 23	8 20 00	7 30	6.6
Stockton	37 32	121 34	8 23 00	8 30	6.5
Tejon	35 00	118 42	8 45 00	32 30	6.0
San Diego	32 42	117 13	8 50 00	36 30	7.0

The velocity is given in miles per minute; and by dividing the sum of the same by their number, it will be found that the movement of the wave at that time averages a fraction over 6.2 miles per minute.

The results obtained from the above data approximate closely to the deductions of Prof. Bache on the wave which reached our shores resulting from the earthquake at Simoda on the 23d of December, 1854, and which will be found in a paper read by that

[74] Again Trask's account is nearly that of the *Sun* (49), but with an added detail. It should be noted that he makes the main shock weaker than the foreshocks (at least in San Francisco), while the *Sun* says just the reverse. The latter is more likely to have been right, as most of the foreshocks were not mentioned in most of the San Francisco accounts.

gentleman at the meeting of the American Association for the Advancement of Science, during the early part of last year. [75]

From the facts before us, there can be little doubt of the direction of the commotion, and that it proceeded from the west, or a little south of that point. The motion of the earth, as described at the different localities at which it was felt, with the motion of the pendulum—which was slightly south of a west line—leads to the latter conclusion. Time is an important element in aiding us to form correct conclusions regarding their phenomena, and it is to be hoped that our friends in different parts of the State, in reporting the same, will be precise in this particular. Of the incidents attending the shocks, many and varied reports have reached us; and it seems to have acted with greater violence in the vicinity of the Tejon Reserve and upper Tulare county than at any other places. It is most remarkable that so small an amount of intensity was manifested when the area over which it extended is taken into consideration.

The effects were felt in San Francisco several hours before they are reported to have been observed at any other place north or south. They began here at twenty minutes past eleven, on the night of the 8th, and continued till thirteen minutes past eight the following morning—six shocks occurring in the interim; while to the south, the first shock that was noticed at the Tejon was at 6 hours 30 minutes, on the 9th. In Los Angeles they continued at long intervals through the day until 23 hours 30 minutes of the same date. I have learned from persons who were present in Los Angeles at this time, and also at the shock of the 14th July, 1855, that the severity of the latter exceeded that of the 9th January last past.

56. Stockton *Daily Argus* January 10, 1857 p. , col. 1

A severe shock of an earthquake was felt in this city at about 8 o'clock, yesterday morning. It continued about fifteen seconds, and in many parts of the city was so violent as to produce a clattering of windows, swinging to and fro of hanging lamps, and causing a succession of quick movements which were anything but agreeable to those who experienced the feeling of dizziness which followed them. In the eastern portion of the city the shock was observed more distinctly. We learn of an instance in which a gentleman was thrown from his feet from the effects of the earthquake; and a number of instances in which people were compelled for the moment to suspend work. The shock was probably the most severe of any that has ever visited this city.

57. Stockton *Daily Argus* January 16, 1857 p. 2, col. 1

We learn from Mr. Canaday, who arrived in this city yesterday in charge of an express from Fort Tejon, that the earthquake which was felt in this city on the 9th inst., was remarkably severe at that place. A light shock was observed in the morning at about 6 o'clock [76] which was scarcely perceptible. At about $8\frac{1}{2}$ o'clock, a second shock occurred which lasted from three to five minutes, and resembled in sound the rumbling

[75] This analysis of tide-gauge records of the tsunami from the 1854 Ansei-Tokai and Ansei-Nankai earthquakes is in Bache (1855). Despite Trask's correction of the times to the same longitude, the wide scatter in the reported times made the results quite misleading—as was true for all such studies prior to the widespread distribution of time by telegraph (Bartky, 2000).

[76] In his statement to the *Republican*, Mr. Canaday gave this as 6;30.

of a train of cars. Nearly all of the buildings in the vicinity were seriously injured by the falling of chimneys, plastering, and walls. Several adobe buildings in course of erection and nearly completed were almost totally demolished. Fortunately, they were unoccupied, although the roofs were on and the work upon the interior nearly finished. Several narrow escapes occurred at the Fort. A man in the kitchen of one of the adobe buildings succeeded in making his escape from the door at the moment the walls fell in. Had he remained in the building a moment longer, his life would have been the forfeit. Dr. Tenbrock, at the Fort, was violently thrown from his feet.

At the government mill, which supplies the lumber for the Fort, situated about twenty miles beyond, the mules employed in hauling timber were thrown down, and the mill, for the time, was abandoned. Branches of trees were broken off, and large oaks fell to the ground.

At Reed's Ranch, a Mexican woman was killed by the falling of an adobe,—.Several large buildings in the neighborhood were very much injured. About a mile above the Fort, a little girl came near to losing her life by a limb which fell from the effects of the shock. Rev. Mr. Bateman, riding through the country about twenty miles distant from the Fort, states that in many places upon the road, the earth is upheaved, and exhibits the appearances of a very violent shock. He was informed by a vaquero that at a point still further in the mountains the roads have become almost impassable.

At Kern Lake, the water in the river was forced back, and rose over the banks about four feet. Mr. Canaday informs us that through information obtained along his route to this city, he is satisfied that the force of the shock was gradually less as it approached northward. At the Fort, no one was injured and no accident occurred, beyond the falling of houses and trees. Shocks were felt throughout the day at short intervals, which kept the people on the *qui vive*, expecting every moment more serious results. From the accounts detailed by Mr. Canaday, we are confident that the shock was more severely felt at Fort Tejon, than at any other point in the state. The damage done will require much time and expense to repair.

58. Stockton *Daily Argus* January 19, 1857 p. col. 2

Visalia, Jan. 9th, 1857

EDITOR ARGUS—Sir: This morning about sun-rise a slight shock of an earthquake was felt at this place. Fifteen minutes after 8 o'clock a very severe shock was felt which lasted for a number of minutes I have heard various estimates of its duration but all agree that it lasted between ten and twenty minutes.

At first, a slight rumbling of the earth, which lasted for about two minutes, when the earth began to heave and roll like the waves of the ocean—so much as to make it very difficult to remain on the feet. This continued for several minutes, when a deep rumbling sound was heard, as many describe it, like the sound of distant thunder, but [to] my ear sounded like the grating together of immense rocks. The rolling of the ground under us was seen as distinct as the waves on the ocean. I cannot describe it more definite than to compare the motion of the earth to the waves of the ocean after a storm.

The tree tops vibrated back and forth for several feet, The water in the streams was dashed from bank to bank, throwing it several feet out of its level. The vibrations were from North-East to South-West. I have seen gentlemen from White River, fifty miles South-East of this, also about the same distance North of this place, and they give about the same accounts that I have here given. I have also seen persons from near Tulare Lake, who say the shock was severely felt there, and three miles from the Lake they could distinctly hear the dashing of the waves.

Slight shocks have been felt during the day and evening. At fifteen minutes of 9 o'clock at night, a slight shock—at twenty five minutes after ten, a slight shock—followed in a few minutes by quite a severe one. No damage has been done as we can learn. Should I be able to gather any more particulars in reference to this matter, I will forward them by the first opportunity. Respectfully,

TULARE

59. Stockton *San Joaquin Republican* January 10, 1857 p. 2, col. 1

Many of our citizens experienced a severe shock of an earthquake yesterday, at about twenty minutes past eight o'clock A.M. By all we can learn, the commotion was very visible, lasting some minute or two. We have heard two or three gentlemen describe the sensation as being so violent as to cause a kind of sea-sickness. In our establishment, the shock was quite apparent. The lamps, which are suspended from the ceiling, swung to and fro for a distance of more than a foot. One of them was thrown against the wall so violently that its jingling was heard in every part of the office. One gentleman informs us that he felt a shock similar to the one mentioned above, about six o'clock, but being engaged out of doors at the hour first named, he did not feel it at that time. If his statement is correct, there must have been two separate shocks, at 6 and 8 o'clock. If this quaking was felt in San Francisco, proportionably more severe than here, as has usually been the case, we may expect to hear of some damage being done.

60. Stockton *San Joaquin Republican* January 11, 1857 p. 2, col. 2

We are informed by a gentleman who was on a hunting excursion on Friday morning last, that he witnessed a very singular phenomenon, which he describes about as follows: He was standing on the bank of one of the little lakes which are found in the tules, watching for ducks. All at once he heard a rustling in the water, resembling the noise that would be made by animals wading through a shoal. His attention being called to the peculiarity of the noise, he stood watching for a few moments, when a large swell came rolling and dashing violently against the shores, and in places running out over the plain to the distance of several hundred yards. The bank where our informant stood, was covered by the swell to the depth of two or three feet. The swell seemed to roll northward, as though the centrifugal motion of the earth had momentarily ceased. In a short time the waters settled back and again became placid. This phenomenon occurred in the morning about the time the earthquake was felt in this city.

61. Stockton *San Joaquin Republican* January 16, 1857 p. 2, col. 1

From Mr. Canaday, [77] who arrived in this city yesterday afternoon from Fort Tejon, we learn that the earthquake which occurred on the 8th inst., was felt in that vicinity with' great severity.

The first shock, which was very slight, and barely perceptible, occurred at $6\frac{1}{2}$ o'clock in the morning, and second at $8\frac{1}{2}$ o'clock, The second lasted from three to five minutes, throwing down some of the walls of unfinished adobe houses, and prostrating most of the chimneys in the vicinity of the Fort. Limbs of pine and other trees, many of them four feet in circumference, were broken off, about twenty miles to the southward of the Fort; chasms and fissures were also made in the earth, in the same vicinity. Mules and other animals were thrown to the ground with violence. A house on Reed's Ranch, six miles from the Fort, was leveled with the earth, and a Mexican woman, an inmate, killed by the fall. This is the only instance of any one known to have been either killed or injured.

Up to the time our informant left the Fort—Saturday morning—slight shocks were felt with more or less frequency. No indications of an earthquake were observed during the trip to this city.

62. Sacramento *Age* January 9, 1857 p. 2, col. 1

About twenty minutes past eight this morning, an earthquake was very sensibly felt throughout the city. The vibrations were from east to west and of sufficient violence to create general alarm, many persons rushing out into the streets. We have heard of one or two instances of hardware, crockery and light articles being thrown from the shelves. On J street the second story walls of a brick building were cracked and a chandelier thrown down and broken. Further than this we know of no actual damage, though there are many rumors of such being the case.

63. Sacramento *Age* January 10, 1857 p, col. 1

We have information of severe effects of the earthquake, along the line of the lower Stockton road. Below Benson's Ferry, [78] the waters of the Mokelumne river, much swelled by recent rains, were thrown over the banks, leaving the bed of the stream almost bare. Houses were shaken violently, destroying articles of glassware, and overturning furniture. Limbs were broken from trees, the trees in some instances settling down two or three feet into the ground. [79] The inhabitants of that section were terror stricken, whilst dumb brutes appeared to be paralyzed. We look with interest for further details of the occurrence and expect they will prove this to be the severest commotion experienced in the country since it has been inhabited by Americans.

[77] This article, being drawn from Mr. Canaday's statements, is not independent of (57), which is the more full account.

[78] This was about 500 meters west of the junction between the Consumnes and Mokelumne Rivers (Hoover *et al.*, 1966, p. 374) We have assumed that the rest of this report refers to the area between Stockton and Sacramento.

[79] Possibly an effect of liquefaction.

64. Sacramento *Daily Times* January 9, 1857 p. 3, col. 1

The shock of an earthquake was sensibly felt in this city at ten minutes past eight this morning. The waters in the Sacramento river heaved and swelled so as to make the hulks rocks at their moorings as though a squall had struck them. The statuary in the telegraph building swayed to and fro—the roof of the Catholic Church creaked as if in pain—the gas pipes in the Orleana sent forth jets of water—one of Cheap John's houses cracked a little, and other houses throughout the city, felt the shock very sensibly, but no real damage was done so far as we have heard.

65. Sacramento *Daily Union* January 10, 1857 p. col. 4

The vibrating motion incident to an earthquake was observed distinctly, though slightly, in this city about $2\frac{1}{4}$ A.M. yesterday—more sensibly at $10\frac{1}{4}$ A.M. and again, slightly (we are informed) at 10:20 P.M. The shock at $10\frac{1}{4}$ A.M. created some consternation in many localities, although in others it was wholly unnoticed. It was but of a few seconds duration, but sufficient in force to cause chandeliers to vibrate about a foot from the center, to create a rattling among the crockery and other wares of our dealers, to rock several of the hulks at the levee and impart to many a sense of motion produced by some general unseen cause. The clocks in the banking houses of Drexel, Sather & Church and D. 0. Mills & Co., and in the Magnolia and other places, were stopped; a seam about a quarter of an inch in width was opened in the plastering in a new brick building on J street, between 7th and 8th streets, and portions of the plaster thrown down upon the operatives at work in the room; and many persons being unable to appreciate the causes of their sensations at the movement imagined that they were attacked with vertigo, and in instances called for and applied restoratives. The motion seemed to be from east to west like successive undulations. The phenomenon has not been observed in this locality since 1851.

66. Sacramento *Daily Union* January 10, 1857 p, 2, col. 5

There can be no doubt but that a considerable shock of an earthquake was experienced in this city on Friday about 8 A.M. There were, as far as we can ascertain, three distinct vibrations, which seemed to proceed in a direction from south-east to northwest. The shock was perceived by a large number of our citizens, and so evident was it, that its nature was instantly recognized, as some even rushed out of their houses. We have heard of clocks being stopped, doors and lamps set swinging, and it is reported that the walls of the Catholic.Church have been cracked.

67. Sacramento *Daily Union* January 12, 1857

The different accounts given of the shock of the earth felt on Friday morning last, January 9th cannot but be of interest to the reader, although some of them, we must confess, appear to be tempered by the temperament of individuals. An excessively nervous man would, of course, feel the shock much more distinctly than one less so; whilst others possessing an extremely fertile imagination, will have seen wonderful things, which in all probability a matter of fact man would have been unconscious of. We, however, give the different stories, leaving them to stand upon their own foundation. [80]

[80]We have reprinted only one account, for which the original is not available.

The *American* of yesterday remarks: A gentleman from Mokelumne Hill informs us that it was severely felt in that region, and seemed to shake the hills for miles around. Reports were numerous of the caving in of several tunnels and the burial of a number of men, but he could not obtain the particulars. [81]

68. State Year Book, 1857 (Langley and Mathews, 1857, p. 36)

The undulatory motion was very sensibly felt at Sacramento City. The Orleans Hotel seemed to rock to and fro, the chandeliers in the halls took on the same motion, while the water in an artificial pond in the yard was observed to oscillate with considerable force from side to side.

69. Marysville *Herald* January 13, 1857 p, 2, col. 2

On the night of Thursday and the morning of Friday last, several shocks of an earthquake were felt in San Francisco, Sacramento, Stockton and also slightly in this city.

70. Sacramento *California Farmer and Journal of Useful Sciences* January 9, 1857 p. 4

A severe shock was felt at Sacramento this morning, at eight o'clock and five minutes. We were writing at the time, and the sensation was so strange as to startle us. The building (a fire-proof brick) rocked like a ship affected by a ground-swell, swaying to and fro. The pendants upon a candelabra rattled together, and pictures upon the wall swung and moved the same as on board ship. The movement lasted two to three minutes, and was in three distinct, heavy rolls, although continuous. The shock caused a like sensation to sea sickness, in some persons. The vessels at the Levee were moved the same as by the rolling of the sea, although there was a perfect calm. No damage has been announced to the hour of our going to press.

71. San Francisco *California Farmer and Journal of Useful Sciences* January 16, 1857 p. 5, col. 1

The earthquake was felt very sensibly at San Jose, and in all Santa Clara Valley, and its effects upon the artesian wells was most singular. The well at the beautiful cottage of Col. A. J. Grayson rose some twelve inches above the usual flow, and then fell suddenly as much. below—rose and fell several times and then resumed its usual current. The first well sunk, near Smith and Winchell's, which had flowed but slowly of late, ceased altogether. Another, at Guild & Brown's, was stopped. Several others rose and fell. The great well in the city suddenly ceased its flow and now barely runs. We have heard of other strange pranks, both on earth and in the water. We shall note further these results,

[81] The last phrase suggests that the reporter could not confirm this account. It is not confirmed elsewhere, and is contradicted in (50) and (51). We have therefore chosen to reject it as false.

72. Sacramento *Daily Union* January 12, 1857 p. 1, col. 7

Several shocks of an earthquake were felt last evening and this morning in this city. [82] The greatest vibration occurred a little before eight o'clock this morning. There is a great diversity of opinion among our citizens as to the extent of the motion of the earth produced by the affair at the time last mentioned. Many people were ignorant that we had again been visited by an earthquake; others felt the shock very slightly; and other still were much frightened at the extent of the vibration. A gentleman who resides in Happy Valley, [83] the southern portion of the city, informs me that most of the people in his vicinity left their houses in alarm, and that he was nearly thrown from his chair. The shock was the most severe in the lower part of the city, and the crockery and other wares in some of the stores down town were considerably shaken up, although. I heard of no damage being done. In the upper part of the city and on the different hills the inhabitants were hardly conscious that anything unusual had occurred. The vibration was from east to west. The occurrence to-day was slight in comparison to that which took place in February last,

73. Reminiscence of Mr. Bell, c. 1905 (As retold by geologist Harry R. Johnson, in a letter to H. O. Wood, May 22, 1944; text here taken from Wood, 1955, p. 63)

A year or so before the 1906 San Francisco earthquake I learned that a Mr. Bell had experienced the 1857 disturbance whilst herding cattle in the Carriso Plains, I visited Bell in Bakersfield and he informed me that at the time of the earthquake he and a couple of other men working with him thought at first that the disturbance was due to a stampede among the cattle. According to Bell the earthquake occurred in the early morning hours, before daybreak, and when it became light enough he and his helpers started a search for their cattle, which of course had been badly frightened. Bell noticed considerable dust in the air along the foot of the Temblor Range and assumed it to have been raised by his stock on the run. It is possible of course that this may have been due to fine material thrown into the air along the rift at the moment of displacement.

The outstanding statement made by Bell to me was that an old fashioned round sheep corral, apparently located directly upon the rift near the southeastern end of Carriso Plains, was dislocated in such a way that it made a rude S-shaped figure, which would imply a movement horizontally of several feet.

I was very doubtful as to the accuracy of Bell's statement at the time he made it, but a year or so later, after the 1906 earthquake, I saw plenty of evidence along the San Andreas rift south of San Francisco of a sort which convinced me that the statements by Mr. Bell were to be trusted.

[82] San Francisco: this is a portion of a letter from the San Francisco correspondent of the Union, dated 3:30 P.M., January 9, 1857.

[83] According to the map on page 20 of Soulé *et al.* (1855) this was the area along 2nd Street, between Mission and Howard.

74. Portion of a letter from Ellen Pratt McGary to Ellen Spencer Clawson, San Bernardino, January 9, 1857 (Ellsworth 1974, p. 35)

Friday morning 9th

We have just had quite a severe shock of an earthquake. We are hardly done shaking from the effects of it. What frightful sensations it gives one to feel the earth shaking under ones feet, not knowing one second what will happen next, expecting every moment to see the houses fall or perhaps the earth open and swallow you up. If you ever saw pale faces you would have seen them this morning. it made me think of a great ship rocking on the sea, it lasted more than a minute, the trees shook as if in a strong wind, the water in the well splashed against the sides, the walls of the houses creaked, and folks staggered as if they were a "little bit tight," but there was not material damage done I believe and I realy do hope such shocks may not be frequent

75. Santa Cruz *Pacific Sentinel* January 17, 1857 p. 2, col. 5

On the morning of the 9th there were three earthquake shocks. The first was felt about 4 A.M., and was quite severe, causing buildings to tremble considerably and accompanied with a noise resembling a heavy wind. A second was felt a few minutes before 7, and was not as severe as the first or third. The third took place about 7-1/2, and was so severe that clocks were stopped, cradles and chairs set in rapid motion, and the undulatory motion of the earth caused many to feel dizzy, a cracking and shaking of buildings, waving and bowing of trees as if by a heavy wind. I am not fully satisfied as to the direction of the wave. [84]

76. Santa Cruz *Pacific Sentinel* January 24, 1857 2, col. 2

A shock of an earthquake was very seriously felt on Tuesday morning last, it was not so severe as that of the 9th inst., though our store keepers say it caused a general rattling among their crockery ware.

3 Acknowledgments

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References

Agnew, D. C., and K. Sieh (1978), A documentary study of the felt effects of the great California earthquake of 1857, *Bull. Seismol. Soc. Amer.*, **68**, 1717–1729.

Antisell, T. (1856), Geological Report., in *Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi*

[84]This account is part of "Meteorological Observations for Santa Cruz, made by Rev. A. Higbie". Presumably this was a private weather record, since it is not listed in Darter (1942).

River to the Pacific Ocean, Volume VII, 33rd Congress, 2nd Sess., Senate Exec. Doc. 78, Washington D.C.

Arnold, R., and H. R. Johnson (1908), The so-called volcano in the Santa Monica Mountains, near Los Angeles, California, *Science*, **27**, 553–554.

Arrington, L. J. (1958), *Great Basin Kingdom; an Economic History of the Latter-Day Saints, 1830-1900.*, Harvard University Press, Cambridge.

Bache, A. D. (1855), Notice of earthquake waves on the western coast of the United States, on the 23d and 25th December, 1854, *Report of the Superintendent of the Coast Survey*, pp. 342–346.

Bancroft, H. H. (1886), *The History of California*, The History Company, San Francisco.

Bancroft, H. H. (1888), *The History of California*, The History Company, San Francisco.

Bartky, I. R. (2000), *Selling the True Time: Nineteenth-century Timekeeping in America*, Stanford University Press, Stanford, California.

Beattie, G. W. (1929), Diary of a ferryman and trader at Fort Yuma: 1855-1857, *South. Calif. Hist. Soc. Q.*, **14**, 88–128, P 213–242.

Beattie, G. W., and H. P. Beattie (1939), *Heritage of the Valley: San Bernardino's First Century*, San Pasqual Press, Pasadena.

Beck, W. A., and Y. D. Haase (1974), *Historical Atlas of California*, University of Oklahoma Press, Norman.

Bouchon, M., and K. Aki (1980), Simulation of long-period, near-field motion for the great California earthquake of 1857, *Bull. Seismol. Soc. Amer.*, **70**, 1669–1682.

Boyd, W. H. (1972), *A California Middle Border: The Kern River Country, 1772-1880*, Havilah Press, Richardson, Texas.

Boyd, W. H., and G. J. Rogers (1955), *San Joaquin Vignettes: The Reminiscences of Captain John Barker*, Kern County Historical Society, Bakersfield.

Brewer, W. H. (1966), *Up and Down California in 1860-1864: The Journal of William H. Brewer*, University of California Press, Berkeley.

Butler, R., and H. Kanamori (1980), Long-period ground motion from a great earthquake, *Bull. Seismol. Soc. Amer.*, **70**, 943–961.

Conkling, R. P., and M. B. Conkling (1947), *The Butterfield Overland Mail: 1857-1869*, Arthur H. Clark Company, Glendale.

Cowan, R. E. (1933), Alexander S. Taylor, 1817-1876, first bibliographer of the Golden State, *Calif. Hist. Soc. Quart.*, **12**, 18–24.

Crocheron, A. J. (1885), California Memories, *The Contributor*, **6**, 282–286, 339–342, 370–374.

Cullimore, C. C. (1941), *Old Adobes of Forgotten Fort Tejon*, Kern County Historical Society, Bakersfield.

Darter, L. J. (1942), List of Climatological Records in the National Archives, *U.S. Nat. Archiv. Spec. List*, **1**.

Eisman, D. B. (1972), Dust from antelope, *Calif. Geol.*, **25**, 171–173.

Engelhardt, Z. (1923), *Santa Barbara Mission*, James H. Barry Company, San Francisco.

Evernden, J. F., W. M. Kohler, and G. D. Clow (1981), Seismic intensities of earthquakes of conterminous United States: their prediction and interpretation, *U.S. Geolog. Surv. Prof. Pap.*, **1223**.

Geiger, M. (1965), *Mission Santa Barbara: 1782-1965*, Franciscan Fathers of California, Santa Barbara.

Grant, L. B., and A. Donnellan (1994), 1855 and 1991 surveys of the San Andreas fault: implications for fault mechanics, *Bull. Seismol. Soc. Amer.*, **84**, 241–246.

Grant, L. B., and K. Sieh (1993), Stratigraphic evidence for 7 meters of dextral slip on the San Andreas fault during the 1857 earthquake in the Carrizo plain, *Bull. Seismol. Soc. Amer.*, **83**, 619–635.

Gudde, E. G. (1975), *California Gold Camps*, University of California Press, Berkeley.

Harris, R. A., and R. W. Simpson (1996), In the shadow of 1857: the effect of the great Fort Tejon earthquake on subsequent earthquakes in southern California, *Geophys. Res. Lett.*, **23**, 229–232.

Holden, E. S. (1898), A catalogue of earthquakes on the Pacific Coast: 1769 to 1897, *Smithson. Misc. Coll*, **1087**.

Hoover, M. B., H. E. Rensch, E. G. Rensch, and W. N. Abeloe (1966), *Historic Spots in California, 3rd ed.*, Stanford University Press, Stanford.

Hutton, W. R. (1956), *California, 1847-1852*, Huntington Library, San Marino.

Ives, J. C. (1861), *Report upon the Colorado River of the West*, 36th Congress, 1st Session, House Exec. Doc. 90, Washington, D. C.

King, W. F. (1971), El Monte, an American town in southern California: 1851-1866, *South. Calif. Hist. Soc. Q.*, **53**, 317–332.

Langley, H. G., and S. A. Mathews (1857), *The State Register and Year Book of Facts*, Langley and Mathews, San Francisco.

Lawson, A. C. (1908), *The California Earthquake of April 18, 1906: Report of the State Earthquake Investigation Commission*, Carnegie Institution, Washington D.C.

Lienkaemper, J. J. (2001), 1857 slip on the San Andreas fault southeast of Cholame, California, *Bull. Seismol. Soc. Amer.*, **91**, 1659–1672.

Lienkaemper, J. J., and T. A. Sturm (1989), Reconstruction of a channel offset in 1857 (questionable) by the San Andreas fault near Cholame, California, *Bull. Seismol. Soc. Amer.*, **79**, 901–909.

Martindale, D., and J. P. Evans (2002), Historigraphical analysis of the 1857 Fort Tejon earthquake, San Andreas Fault, California: Preliminary results (abs.), *Trans. Amer. Geophys. Union*, pp. S12C–05.

McFarland, J. C. (1949), Don Benito Wilson, *South. Calif. Hist. Soc. Quart.*, **31**, 273–290.

McGarr, A. (1965), Excitation of seisches in channels by seismic waves, *J. Geophys. Res.*, **70**, 847–854.

Meadows, D. (1966), *Historic Place Names in Orange County*, Paisano Press, Balboa Island.

Meisling, K. E., and K. E. Sieh (1980), Disturbance of trees by the 1857 Fort Tejon earthquake, California, *J. Geophys. Res.*, **85**, 3225–3238.

Meltzner, A. J., and D. J. Wald (1999), Foreshocks and aftershocks of the great 1857 California earthquake, *Bull. Seismol. Soc. Amer.*, **89**, 1109–1120.

Mitchell, H. C. (1927), First and second order triangulation in California, *U.S. Coast Geod. Surv. Spec. Publ.*, **202**.

Ogden, A. (1941), *The California Sea Otter Trade, 1784-1848*, University of California Press, Berkeley.

Pollitz, F. F., and I. S. Sacks (1992), Modeling of postseismic relaxation following the great 1857 earthquake, Southern California, *Bull. Seismol. Soc. Amer.*, **82**, 454–480.

Raup, H. F. (1940), San Bernardino, California: settlement and growth of a pass-site city, *Univ. Calif. Berkeley, Publ. Geogr.*, **8**, 1–62.

Runnerstrom, E. E., L. B. Grant, J. R. Arrowsmith, D. D. Rhodes, and E. M. Stone (2002), Displacement across the Cholame segment of the San Andreas fault between 1855 and 1893 from cadastral surveys, *Bull. Seismol. Soc. Amer.*, **92**, 2659–2669.

Sanders, C. O. (1993), Interaction of the San Jacinto and San Andreas fault zones, Southern California: triggered earthquake migration and coupled recurrence intervals, *Science*, **260**, 973–976.

Sharp, R. V. (1972), Map showing recently active breaks along the San Jacinto fault zone between the San Bernardino area and Borrego Valley, California, *U.S. Geol. Surv. Misc. Geol. Invest. I-675*.

Sieh, K., C. Cheatum, L. Dingus, W. Johnson, and G. McMurty (1973), Geological investigations of portions of the San Jacinto fault zone, San Bernardino Valley, California, *Univ. Calif. Riverside Campus Museum Contrib.*, **3**.

Sieh, K. E. (1978a), Central California foreshocks of the great 1857 earthquake, *Bull. Seismol. Soc. Amer.*, **68**, 1731–1749.

Sieh, K. E. (1978b), Slip along the San Andreas Fault associated with the great 1857 earthquake, *Bull. Seismol. Soc. Amer.*, **68**, 1421–1447.

Smith, B. R., and D. T. Sandwell (2006), A model of the earthquake cycle along the San Andreas Fault System for the past 1000 years, *J. Geophys. Res.*, **111**, B01,405, doi:10.1029/2005JB003703.

Smith, H. (1846), *The Poetical Works of Horace Smith*, Henry Colburn, London.

Soulé, F., J. H. Gihon, and J. Nisbet (1855), *The Annals of San Francisco*, D. Appleton and Company, New York.

Sykes, G. (1937), *The Colorado Delta*, American Geographical Society, New York.

Trask, J. B. (1858), On the direction and velocity of the earthquake in California, January 9, 1857, *Am. J. Sci., Ser. 2*, **25**, 146–148.

Trask, J. B. (1864), Earthquakes in California from 1800 to 1864, *Proc. Calif. Acad. Sci.*, **3**, 130–151.

Troxell, H. C. (1942), Floods of March 1938 in Southern California, *U.S. Geol. Surv. Water Supply Pap.*, **844**.

Waring, G. A. (1965), Thermal springs of the United States and other countries of the world, *U.S. Geol. Surv. Prof. Pap.*, **492**.

Whipple, A. W., and J. C. Ives (1856), Explorations for a Railway Route, near the Thirty-Fifth Parallel of North Latitude, from the Mississippi River to the Pacific Ocean, in *Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, Volume III*, 33rd Congress, 2nd Sess., Senate Exec. Doc. 78, Washington D.C.

Whitehead, R. S. (1976), Santa Barbara's volcanoes, *Santa Barbara Hist. Soc. Noticias*, **22 (2)**, 8–18.

Whiting, J. S., and R. J. Whiting (1960), *Forts of the State of California*, privately printed, Seattle.

Williamson, R. S. (1856), Explorations In California for Railroad Routes, to Connect with the Routes near the 35th and 32nd Parallels of North Latitude, in *Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, Volume V*, 33rd Congress, 2nd Sess., Senate Exec. Doc. 78, Washington D.C.

Wood, H. O. (1955), The 1857 earthquake in California, *Bull. Seismol. Soc. Am.*, **45**, 47–67.

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