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BULLETIN OF THE

SEISMOGRAPHIC STATIONS

No. 11, pp. 213-242 November 6, 1916

THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

OCTOBER 1, 1915, TO MARCH 31, 1916

BY

E. F. DAVIS

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Symbols and Notation

1. *Character of the Earthquake*—

I. Perceptible	II. Moderately strong.	III. Strong.
d (terrae motus domesticus)	Local shock (origin nearby, perceptible at the station).	
v (terrae motus vicinus)	Near shock (origin less than 1,000 kilometers distant).	
r (terrae motus remotus)	Distant shock (origin from 1,000 to 5,000 kilometers distant).	
u (terrae motus ultimus)	Very distant shock or teleseism (origin more than 5,000 kilometers distant).	

2. *Phases of the Seismogram*—

P (undae primae)	First phase, or first preliminary tremors.
PR_n	Waves n-times reflected at the earth's surface.
S (undae secundae)	Second phase, or second preliminary tremors.
SR_n	Waves n-times reflected at the earth's surface.
PS	Waves changed from longitudinal to transverse oscillation, or vice versa, through reflection at the earth's surface.
L (undae longae)	Long waves, chief phase, or principal part.
M (undae maximae)	Greatest motion in the chief phase.
C (coda)	Tail or end portion.
F (finis)	End of discernible movement.

3. *Nature of the Motion*—

i (impetus)	Sudden beginning of the motion.
e (emersio)	Gradual beginning of the motion.
T (period)	Time of one complete oscillation.
A	Amplitude of the motion, measured from the median line in microns ($\mu = 1/1000$ mm.).
A_E	E-W component of A.
A_N	N-S component of A.
A_V	Vertical component of A.

THE BERKELEY STATION

CONSTANTS

Latitude and longitude of the center of the seismographic room:

$\phi = 37° 52' 15''.9$ N. Lat.
$\lambda = 122° 15' 36''.6$ W. from Greenwich.

Time. All determinations are reduced to Greenwich mean civil time.

Altitude, 85.4 meters (280 feet) above mean sea-level.

Constants of the Seismographs

	Period	Magnif.	Damping
Bosch-Omori Seismograph N-S component	15s	80	8–1
Bosch-Omori Seismograph E-W component	15s	80	8–1
Weichert Seismograph Vert. component	6s	80	8–1
Omori Tromometer N-S component	2s	60	.....
Omori Tromometer E-W component	2.5s	60	.....
Marvin Strong-motion Seismograph—			
E-W component	6.5s	5.8	1.3–1
N-S component	6.5s	5.1	1.4–1

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
1	1 Oct.	III_d	i P_E	15 26 16.1					Error in parallax on horizontal component instruments. Vertical record limited on one side by safety stop. See discussion in text.
			i P_N	15 26 18.6					
			i P_V	15 26 19.9					
	-		i LM_E	15 26 21.3	¼	26			
			i LM_N	15 26 23.7	¼		32		
			i LM_V	15 26 25.5	1			>51	
			C	15 26 31					
			F	15 29 23					
2	2 Oct.	I_d	e	9 16 42					No definite maximum An aftershock of the earthquake of October 1. Reported felt at Purisima.
			F	9 17 10					
3	2 Oct.	I_V	e P_{EN}	23 41 17					Not registered by vertical, as driving clock had stopped before earthquake. A foreshock of the strong earthquake (No. 5 in this list). Discussed in text.
			e S	indefinite					
			e L_{EN}	23 42 05					
			M_N	23 42 54	8		50		
			M_E	23 42 56	6	61			
			C	23 44 45					
			F	0 00 45					
4	(3) Oct.	II_V	e P_E	1 49 23					Vertical driving clock stopped. A foreshock of No. 5. Discussed in text.
			e P_N	1 49 33					
			e S_E	1 50 01					
			e S_N	indefinite					
			e L_E	1 50 33					
			e L_N	1 50 38					
			M_N	1 51 13	11		282		
			M_E	1 51 15	10½	460			
			C	1 53 55					
			F	2 41±					
5	3 Oct.	III_V	i P	6 54 31.					M_E and M_N measured on Omori tromometer record. Pen off paper at time M_E. Vertical seismograph not running but throw of pen on paper was 725μ. Origin in Nevada. See discussion in text.
			i S	6 55 34.					
			i L	6 55 51.					
			M_E	6 56 08	1½	>870			
			M_N	6 57 00	2		515		
			C	6 58 00					
			F	9 51±					
6	3 Oct.	I_V	e	10 07 45					A few barely perceptible waves on East-West component. Possibly an aftershock of No. 5.
			F	10 12 05					
7	4 Oct.	I_V	e	14 57 06					No definite maximum on East-West component. Record consists of weak irregular waves of short period and small amplitude. Barely perceptible on East-West component.
			F	15 01 22					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
8	5 Oct.	I_r	i P_N	13 58 23					No definite maximum on East-West component. F lost in microseisms after 15h 01m. Driving clock on vertical out of order.
			e P_E	13 58 32					
			e S	indefinite					
			e L_N	14 07 41					
			e L_E	14 07 44					
			M_N	14 07 48	8		14		
			C	indefinite					
			F	15 01+					
9	6 Oct.	I_V	e	5 32 28					Weak irregular waves without definite maximum on North-South. On East-West was just barely visible.
			F	5 36 38					
10	8 Oct.	III_d	i PM	5 25 41.8	4/10	827	563		See discussion in text.
			i L_V	not separable					
			M_V	5 25 45	4/10			162	
			C	indefinite					
			F	5 30±					
11	8 Oct.	I_d	e	5 29 48					Marked thickening of pen traces. An aftershock of No. 10.
			F	5 29 57					
12	8 Oct.	III_d	i PM_V	5 35 26.2	<½			32	East-West instrument dismantled by No. 10. North-South pen thrown off by this earthquake. An aftershock of No. 10.
			i P_N	5 35 26.7					
			C	indefinite					
			F	5 38 01					
13	8 Oct.	I_d	i P	5 44 06.0					An aftershock of No. 10.
			i LM_N	5 44 06.8	¼		4		
			F	5 44 10					
14	8 Oct.	III_d	i PM_V	5 52 01.6	<½			5	An aftershock of No. 10. See discussion in text.
			i P_{EN}	5 52 01.6					
			i L_N	5 52 02.4					
			i LM_E	5 52 02.5	<½	26			
			M_N	5 52 03	<½		59		
			C	5 52 06					
			F	5 52 23					
15	8 Oct.	I_d	e	5 55 55					Strong thickening of pen trace. North-South only. An aftershock of No. 10.
			F	5 56 00					
16	8 Oct.	III_d	i PM_V	6 31 30.1	<½			3	Error in parallax on North-South component. An aftershock of No. 10. See discussion in text.
			i P_E	6 31 30.5	<½		30		
			i P_N	6 31 31.8	<½	15			
			i LM_E	6 31 31.5					
			i LM_N	6 31 32.2					
			C	6 31 35					
			F	6 31 56					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
17	8 Oct.	I_d	e	6 50 07					Thickening of pen trace on North-South. An aftershock of No. 10.
			F	6 50 11					
18	8 Oct.	I_d	e	7 54 40					Thickening of pen trace on North-South component. An aftershock of No. 10.
			F	7 54 49					
19	8 Oct.	I_d	e	7 56 19					Thickening of pen traces on horizontal components. An aftershock of No. 10.
			F	7 56 24					
20	8 Oct.	I_d	e P_V	9 47 23.2					Strong thickening of pen trace on vertical component. An aftershock of No. 10.
			e P_{NE}	9 47 23.4					
			i LM_N	9 47 24.3	$<\frac{1}{2}$		6		
			e L_E	9 47 24.4					
			M_E	9 47 24.6	$<\frac{1}{2}$	5			
			C	9 47 26					
			F	9 47 56					
21	8 Oct.	I_d	e	9 59 09					Thickening of pen trace on North-South component. An aftershock of No. 10.
			F	9 59 13					
22	8 Oct.	I_d	e	10 57 42					Strong thickening of pen trace on North-South component. An aftershock of No. 10.
			F	10 57 43					
23	8 Oct.	I_d	i PM	17 16 49.4	$\frac{1}{4}$		3		North-South component only. Begins with a maximum and amplitude gradually decreases to zero. An aftershock of No. 10.
			F	17 16 55					
24	8 Oct.	I_d	i PM	22 44 15	$\frac{1}{4}$	4			East-West component only. Begins with a maximum movement. Amplitude gradually decreases to end of record. End portion interrupted by the beginning of the next earthquake. An aftershock of No. 10.
			F	not determinable					
25	8 Oct.	I_d	i P	22 44 23	$\frac{1}{4}$	4			East-West component only. Record begins with a maximum and amplitude gradually decreases thereafter. An aftershock of No. 10.
			F	22 44 33					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
26	10 Oct.	I_v	e	5 22 53					Short period waves of small amplitude, representing the dying energy of a near shock. Phases not separable. Registered on all components.
			F	5 26 54					
27	11 Oct.	I_r	e_N	19 43 56					Beginning and ending of this seismogram are obscured by strong microseisms. A few barely perceptible waves on the records of the East-West and vertical components. Regular waves on North-South component from $12^h\ 00^m$ to $12^h\ 14^m$. Period 12 to 17 sec., amplitude variable.
			e S_N	19 49 21					
			e L_N	19 58 06					
			M_N	20 03 50	16		5		
			C	indefinite					
			F	20 41+					
28	12 Oct.	I_d	i P_E	1 29 51.2					In tail portion of these records there is a sudden strong thickening of the pen traces. It is possible that this abrupt disturbance represents a second slight earthquake occurring almost immediately after the other. An aftershock of No. 10.
			i P_V	1 29 51.3					
			i P_N	1 29 51.4					
			i LM_E	1 29 52.1	$<\frac{1}{2}$	6			
			i LM_N	1 29 52.2	$<\frac{1}{2}$		11		
			L_V	indefinite					
			M_V	1 29 53	$<\frac{1}{2}$			4	
			C	1 29 55					
			F	1 30 41					
29	12 Oct.	I_{v-r}	e	2 24±					Beginning and ending of seismogram obscured by strong microseisms. No trace on vertical. A few barely perceptible waves on East-West component at the time of maximum.
			M_N	2 29 56	20		4		
			F	2 43±					
30	15 Oct.	I_v	e	20 22 28					A series of minute jerky waves, showing no definite maximum and in which no phases are separable. *Monthly Weather Review* reports a shock at $20^h\ 21^m$ at Fallon, Gerlach, and Winnemucca, Nevada.
			F	20 28 11					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
31	18 Oct.	I_V	e_N	1 13 03					Irregular jerky waves of short period and small amplitude. No definite maximum and no phases separable. On all components but barely perceptible on East-West.
			F	1 18 43					
32	20 Oct.	I_V	e	2 35 04					Irregular jerky waves in which no maximum is discernible and no phases separable. Beginning and ending obscured by microseisms. Horizontal component only. *Monthly Weather Review* reports a shock at 2^h 34^m at Fallon, Nevada.
			F	2 38 04					
33	22 Oct.	III_d	i P_E	6 18 32.8					An aftershock of No. 10. Not registered by vertical instrument, as the writing pen of that seismograph had been thrown off by an irregularity of the paper joint two hours before this shock.
			i P_N	6 18 33.2					
			i LM_E	6 18 33.8	$<\frac{1}{2}$	34			
			i LM_N	6 18 34.3	$<\frac{1}{2}$		60		
			C	6 18 39					
			F	6 19 54					
34	1 Nov.	I_u	e P_E	7 35 27					A fair record was written by the vertical seismograph but it was rendered illegible through overscoring caused by temperature variations. Harvard states origin is in island of Yezzo.
			e P_N	7 35 28					
			e S_N	7 44 22					
			e S_E	7 44 25					
			e L_N	7 53 33					
			e L_E	7 54 08					
			M_N	8 00 48	$9\frac{1}{2}$		59		
			M_E	8 00 49	9	10			
			C	indefinite					
			F	11 15±					
35	18 Nov.	I_{V-r}	e	4 32 28					Beginning and ending are obscured by strong microseisms. Horizontal components only. Regular waves begin 4^h 35^m 10^s and continue until 4^h 43^m 03^s. In these there are two groups of simple sinusoidal waves. The first begins at 4^h 35^m 08^s and continues to 4^h 38^m 03^s. Period is 10 seconds and amplitude 4 microns. The second group begins at 4^h 39^m 07^s and continues to 4^h 41^m 35^s. Period $8\frac{1}{2}$ seconds and amplitude 4 microns.
			F	4 46±					
36	20 Nov.	I_{r-u}	e	15 31 30					A few long flat waves with period and amplitude indicated.
			F	15 50 30	15	1	2-3		
37	21 Nov.	III_r	e P_N	0 15 45					e S not discernible on horizontal components. Maximum recorded shift on East-West was 630μ when pen went off paper at 0^h 18^m 32^s, East-West pen returned at 0^h 24^m 12^s. Pen on North-South left paper at 0^h 21^m 12^s and returned at 0^h 23^m 47^s. See discussion in text.
			e P_{EV}	0 15 47					
			e S_V	0 16 54					
			e L_N	0 17 44					
			e L_E	0 17 49					
			e L_V?	0 18 07					
			M_E	0 18 33	$18\frac{1}{2}$	825			
			M_N	uncertain			>630		
			M_V	0 19 17	13			125	
			C	0 23 47					
			F	2 20±					
38	12 Dec.	I_{V-r}	e	21 29 00					Beginning and ending obscured by strong microseisms. Very weak record on East-West component.
			M_N	21 31 30	$10\frac{1}{2}$		4		
			F	21 37 10					
39	27 Dec.	I_V	i P	7 23 35.0					"Tangled waves" on North-South record. Well registered by both components of Omori tromometer. *Monthly Weather Review* reports this shock felt at Lonoak, Salinas, San Jose, Santa Cruz, Soledad, Spreckels and Watsonville. Felt at Lick Observatory (No. 18).
			i L_E	7 23 49.6					
			e L_{NV}	7 23 51.7					
			M_E	7 23 54	2	39			
			M_N	7 23 55	3		20		
			M_V	7 23 56	$1\frac{1}{2}$			16	
			C	7 24 22					
			F	7 28 15					
40	29 Dec.	I_r	e	22 04 15					Trace of a distant earthquake.
			F	28 18±					
41	31 Dec.	III_V	e P	12 21 03					North-South pen left paper at time of the maximum.
			e L_V	12 21 57					
			e L_{EN}	12 21 59					
			M_N	12 23 00	22		<70		
			M_E	12 23 29	$10\frac{3}{4}$	79			
			M_V	12 23 52	$9\frac{1}{2}$			128	
			C	indefinite					
			F	14 01±					
42	31 Dec.	I_V?	i P	23 06 07					Peculiar record. Sudden beginning followed by a train of weak waves of small amplitude and period. At time indicated by S(?) there is a strong increase in amplitude followed by weak waves to time of ending.
			S_E	23 15 08					
			S_N	23 15 10					
			S_V	23 15 23					
			F	23 41±					

No	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1916			h m s	s	μ	μ	μ	
43	(1) Jan.	III_u	e P_N?	13 33 03					Record somewhat confused by microseisms. e P_N and F are uncertain on this account. Pen off paper at M_{E_1}. Absolutely no trace of movement on vertical record.
			e P_E	13 33 42					
			e S_E	13 44 06					
			e S_N	13 44 09					
			e L_E	14 01 10					
			M_N	14 04 04	20		69		
			M_{E_1}	14 05 18	18	>690			
			M_{E_2}	14 11 30	19½	222			
			C	indefinite					
			F	8 41±					
44	13 Jan.	I_r	e P	6 43 18					Regular waves from 7h 11m 15s to 7h 27m 15s. Period 16 to 18 seconds. Amplitude variable. A few barely perceptible long flat waves on North-South record. No disturbance on vertical.
			M_E	7 16 53	18	17			
			F	8 06±					
45	13 Jan.	I_r	e P_{EN}	20 39 18					North-South component weak. On it the amplitudes are several times smaller than they are on the record of the East-West component. Not registered by vertical seismograph. eL_E is indefinite.
			e S_E	20 45 38					
			e S_N	20 45 46					
			e L_N	20 53 28					
			M_N	21 02 48	38		8		
			M_E	21 19 15	19	122			
			C	indefinite					
			F	22 41±					
46	19 Jan.	I_{r-u}	e	19 19 30±					Barely perceptible long flat waves on North-South. On East-West record simple sinusoidal waves begin 19h 39m 30s and continue until 19h 50m 30s. Period is 20 seconds and amplitude is 3 microns.
			F	20 36 30±					
47	24 Jan.	I_{r-u}	e	7 40 33					Sinusoidal waves from 7h 53m 30s to 8h 03m 30s. Period 18 seconds, amplitude 6 microns. Registered by North-South and vertical seismographs. East-West instrument was out of order.
			F	8 14 30±					

No.	Date	Charac.	Phase	Time G.M.C.T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1916			h m s	s	μ	μ	μ	
48	26 Jan.	I_{V-r}	e	12 55 40					Beginning and ending obscured by microseisms. Simple sinusoidal waves from 13h 00m 00s to 13h 04m 50s with period of 10 seconds and amplitude equal to 2 microns. Vertical shows no sign of any disturbance. East-West seismograph undergoing repairs.
			F	13 35±					
49	31 Jan.	I_{r-u}	e P	18 09 00					Registered by all three components. No phases separable.
			M	18 35 36					
			F	19 12±					
50	31 Jan.	I_{r-u}	e	20 47 30±					Barely perceptible trace of a distant earthquake on East-West component.
			F	22 16 30±					
51	1 Feb.	I_u	e P	7 49 11					Horizontal components only. After the time of S there follows a group of waves which merge gradually with the waves of the main phase. The waves of the main phase consist of a series of long flat waves with an average period of 16 to 18 seconds and amplitude ranging from 1 micron to 3 microns.
			e S	7 59 34					
			e L	indefinite					
			C	9 12 46					
			F	10 21±					
52	3 Feb.	I_V	e P_N	5 03 04					Driving clock on vertical seismograph out of order. *Monthly Weather Review* reports earthquake in Nevada at 5h 00m. This shock was felt at Amos, Elko, Eureka, Fallon, Gerlach, Rebel Creek, Tuscarora, Winnemucca, and Paradise Valley.
			e P_E	5 03 08					
			e L_{NE}	5 04 01					
			M_N	5 04 25	3½		14		
			M_E	5 05 39	7	37			
			C	5 06 58					
			F	5 19±					
53	4 Feb.	I_V	e P_N	20 32 21					F lost in microseisms after time indicated. The *Monthly Weather Review* reports a shock felt at Hollister, California, at this time, with an intensity IV to V.
			e P_{EV}	20 32 22					
			e L_V	indefinite					
			e L_N	20 32 27					
			e L_E	20 32 39					
			M_E	20 32 48	1	8			
			M_N	20 32 53	2		5		
			M_V	20 32 55	1			4	
			C	20 33 01					
			F	20 36 09+					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1916			h m s	s	μ	μ	μ	
54	6-7 Feb.	I_u	e P	21 59 42					No definite maximum on North-South record.
			e S_N?	22 06 07					
			e S_V	22 06 24					
			e S_E	22 06 26					
			e L_N	indefinite					
			e L_V	22 12 12					
			e L_E	22 12 33					
			M_V	22 16 52					
			M_E	22 17 01					
			C	22 30 42					
			F	0 26 40±					
55	15 Feb.	I_r?	e	11 41 40					No phases separable. Seismogram begins with waves of short period and small amplitude which last a couple of minutes. After this amplitude decreases to a barely perceptible amount. At $11^h\ 49^m\ 06^s$ waves of long period begin. These continue to $3^h\ 59^m$.
			M_E	11 50 11	16½	10			
			M_N	11 50 28	18		6		
			F	12 32±					
56	20 Feb.	I_{r-u}	e	17 54 40					Simple sinusoidal waves begin $18^h\ 05^m\ 22^s$ and continue until $18^h\ 10^m\ 27^s$. On North-South component period is equal to 9 seconds and amplitude is 6 microns. On East-West component the period is the same but the amplitude is 18 microns.
			e L?	18 02 37					
			C	indefinite					
			F	19 27±					
57	27 Feb.	I_r	e P_N	20 29 07					Good record on vertical component but it was rendered illegible by reason of overscoring caused by temperature variations.
			i P_E	20 29 08					
			e S_N	20 35 31					
			e S_E	20 35 35					
			e L_N	20 40 43					
			e L_E	20 41 02					
			M_{E_1}	20 48 35	19	194			
			M_{N_1}	20 49 43	18		99		
			M_{E_2}	20 50 47	18	281			
			M_{N_2}	20 51 53	20		84		
			C	20 56 07					
			F	23 37±					
58	4 Mar.	I_{r-u}	e_E	8 14 23					Barely perceptible long flat waves. Period 18 seconds, amplitude 1½ microns. Not visible on North-South or vertical components.
			F_E	8 20 13					
59	12 Mar.	I_{r-u}	e	7 45 23	38	2	2		Long flat waves with period and amplitude indicated.
			F	8 07 23					
60	16 Mar.	I?	e	22 44 18					Barely perceptible trace. North-South only.
			M	22 49 28	14		3		
			F	23 13 30±					
61	31 Mar.	I?	e	11 13 55					Sinusoidal waves $11^h\ 18^m\ 15^s$ to $3^h\ 26^m\ 55^s$. Period and amplitude indicated. No trace of disturbance on vertical record.
			M_E	11 19 09	10	15			
			M_N	11 19 45	9		9		
			F	12 13 45					

THE LICK OBSERVATORY STATION

CONSTANTS

Constants of the Station

Latitude and longitude of the center of the seismographic room:

$\phi = 37° 20' 24''.5$ N. Lat.
$\lambda = 121° 38' 34''$ W. from Greenwich.

Time. All determinations are reduced to Greenwich mean civil time.

Altitude, 1281.7 meters (4202.25 feet) above mean sea level.

Constants of the Seismographs

	Period	Magnif.	Damping
Wiechert Seismograph N-S component	8.0	80	4:1
Wiechert Seismograph E-W component	7.0	80	5:1
Wiechert Seismograph Vertical component	2.5	80	2:1

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A_E	A_N	A_V	
	1915			h m s	s	μ	μ	μ	
1	1 Oct.	II_d	e P_N	15 26 26.6					Driving clock on vertical seismograph out of order. See discussion in text.
			e P_E	15 26 27.6					
			e L_{EN}	15 26 35.7					
			M_E	15 26 37	$\lesssim\frac{1}{2}$	27			
			M_N	15 26 39	$\lesssim\frac{1}{2}$		29		
			C	15 26 53					
			F	15 28 03					
2	2 Oct.	I_V	e_N	23 41 19					A foreshock of the strong shock listed as No. 4. See discussion in the text. Barely perceptible record on vertical.
			e_E	23 41 23					
			i L_{EN}	23 42 13					
			M_E	23 42 15	$4\frac{1}{2}$	49			
			M_N	23 42 58	6		80		
			C	23 43 16					
			F	23 52 09					
3	3 Oct.	II_V	e_N	1 49 33					A foreshock of No. 4. See discussion in text. Preliminary tremors not registered by vertical seismograph.
			e_E	1 49 39					
			i L_E	1 50 28					
			i L_N	1 50 30					
			i L_V	1 50 32					
			M_E	1 50 32	3	580			
			M_V	1 50 39	$3\frac{1}{2}$			388	
			M_N	1 50 44	$5\frac{1}{2}$		690		
			C	1 53 46					
			F	2 04 16					
4	3 Oct.	III_V	i P	6 54 27					Pen off paper during part M_V. Pen left paper on East-West drum at the time of iL_E. See discussion in text.
			i S_N	6 55 17					
			i S_E	6 55 20					
			i S_V	6 55 21					
			i L_E	6 55 36	6	616			
			i L_N	6 55 37					
			i L_V	6 55 38					
			M_V	6 55 42	$2\frac{1}{2}$			520	
			M_E	6 55 44	6	>760			
			C	indefinite					
			F	11 15±					
5	8 Oct.	I_d	e P_{EN}	5 25 54.2					Registered on vertical by a few waves of small amplitude in which no phases are discernible. See discussion in text.
			e L_N	5 26 03 8					
			e L_E	5 26 04.2					
			M_E	5 26 10	$\frac{1}{2}$	16			
			M_N	5 26 16	1		24		
			C	indefinite					
			F	5 28 39					
6	8 Oct.	I_d	e	5 35 51					Barely perceptible disturbance on both horizontal components but not on vertical record.
			F	5 36 18					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
7	20 Oct.	I_V	e P	2 34 04					No disturbance on vertical record. See No. 32 in list of shocks at Berkeley.
			e L	2 35 05					
			M_E	2 35 09	1	6			
			M_N	2 35 12	2		9		
			C	indefinite					
			F	2 38 09					
8	29 Oct.	I_d	e P	23 53 08					Barely perceptible on records of East-West and vertical components.
			e L	23 53 11					
			M_N	23 53 13	$<\frac{1}{2}$		11		
			C	23 53 20					
			F	23 53 46					
9	1 Nov.	I_u	e P_N	7 35 31					Not visible on any records except that of the North-South component.
			e S_N	7 44 34					
			e L_N	7 54 41					
			M_N	8 02 32	$9\frac{1}{2}$		63		
			C	indefinite					
			F	11 00±					
10	1 Nov.	I_d	e	21 09 40					Strong thickening of pen traces on both horizontal records.
			F	21 09 53					
11	17 Nov.	I_d	e	23 03 03					Strong thickening of pen traces on horizontal records.
			F	23 03 13					
12	19 Nov.	I_d	i P	19 49 58.5					Strong thickening of pen trace on East-West record.
			i LM_N	19 50 02.3	$<\frac{1}{2}$		7		
			C	indefinite					
			F	19 50 12					
13	21 Nov.	III_r		0 16					This earthquake gave partial records on all three components. None of the records were legible, as the instruments were out of order at this time. See discussion in text.
14	5 Dec.	I_V	e	2 30 45					Short-period jerky waves of small amplitude in which no phases are discernible. North-South component only.
			M_N	2 31 18	2		3		
			F	2 33 35					
15	12 Dec.	I_{V-r}	e	21 25 23					A few waves visible on North-South component. Beginning and ending obscured by microseisms.
			M	21 32 33	8		3		
			F	21 40 23					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
16	15 Dec.	I_d	i P	18 45 41.6					Recorded on all components but vertical record was illegible through overscoring.
			i LM	18 45 43.3	$<\frac{1}{2}$	10	16		
			C	18 45 47					
			F	18 45 57					
17	16 Dec.	I_d	e	23 20 08					Strong thickening of pen traces on all components.
			F	23 20 21					
18	27 Dec.	III_d	i P_N	7 23 24.9					Registered by vertical but record was imperfect. See No. 39 in list of shocks at Berkeley. Time correction uncertain. Intensity III at Mount Hamilton.
			i P_E	7 23 25.4					
			i L_N	7 23 30.9					
			i LM_E	7 23 31.0	$1\frac{1}{2}$	144			
			M_N	7 23 40	3		100		
			C	indefinite					
			F	7 26 14±					
19	31 Dec.	III_V	e P	12 21 22					Registered on North-South component only. Others were out of order.
			e L	12 22 19					
			M	12 54 50	9		482		
			C	12 29 41					
			F	12 40 21					
	1916								
20	1 Jan.	I_d	e	0 24 03					Strong thickening of pen traces on horizontal components.
			F	0 24 13					
21	13 Jan.	I_{r-u}	e	6 37±					Barely perceptible waves on North-South component only.
			F	7 36±					
22	13 Jan.	I_u	e P	20 39 22					Good record on North-South. Barely perceptible on East-West. No visible disturbance on vertical record.
			e S	20 46 02					
			e L	20 53 07					
			M_N	21 02 57	36		8		
			C	indefinite					
			F	23 15±					
23	26 Jan.	I_{r-u}	e	12 46 30					Trace of a distant earthquake. Registered only on North-South component.
			M	13 01 00	12		3		
			F	13 24±					
24	3 Feb.	I_V	e	5 03 47					Sudden shift of pen trace on vertical at the time of the maximum.
			e L_N	5 04 07					
			M_N	5 04 18	3		24		
			M_E	5 04 21	$2\frac{1}{2}$	31			
			C	indefinite					
			F	5 05 56					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1916			h m s	s	μ	μ	μ	
25	4 Feb.	I_d	e	5 45 55					Series of minute waves in which there is no definite maximum and in which no phases are separable. A trifle stronger on East-West record than on North-South. Barely perceptible on vertical.
			F	5 46 35					
26	4 Feb.	II_d	i P_N	20 32 15.9					Not reported felt at Lick Observatory. See No. 53 in list of Berkeley earthquakes.
			i P_E	20 32 17.0					
			i L_N	20 32 23.8					
			i L_E	20 32 24.4					
			M_V	20 32 22	1			5	
			M_N	20 32 33	4		31		
			M_E	20 32 40	1½	22			
			C	20 32 57					
			F	20 33 23					
27	15 Feb.	I_r	e	11 42 58					North-South component only.
			M	11 51 32	15		3		
			F	12 10±					
28	19 Feb.	I_d	e	8 01 56					Strong thickening of pen traces on the records of both horizontal components.
			F	8 02 06					
29	20 Feb.	I_{r-u}	e	18 10 00					A few long flat waves on North-South component.
			F	18 16 05					
30	27 Feb.	I_{r-u}	i P	20 19 14					Not registered by vertical seismograph. Only a few waves on East-West record.
			e S	20 35 46					
			e L	indefinite					
			M_N	20 46 49	10		22		
			C	indefinite					
			F	21 14±					
31	1 Mar.	I_d	e	0 21 22					Strong thickening of pen traces on both horizontal components.
			F	0 21 32					
32	1 Mar.	I_d	e	0 29 02					Thickening of pen traces on horizontal components.
			F	0 29 07					
33	10 Mar.	I_d	e	20 41 19					Strong thickening of pen traces on horizontal records.
			F	20 41 30					
34	14 Mar.	I_d	e	23 41 48					Marked thickening of pen traces on records of all three components.
			F	23 41 59					
35	16 Mar.	I_d	e	0 39 40					Strong thickening of pen trace on North-South record. Barely perceptible disturbance on the records of the East-West and vertical components.
			F	0 39 51					
36	29 Mar.	I_{d-v}	e	4 37 16					Series of minute waves on both horizontal components.
			F	4 38 00					
37	31 Mar.	I_r	e P	13 14 23					Record on North-South component considerably stronger than on East-West component. No trace of disturbance on vertical.
			e L	13 16 59					
			M_E	13 19 34	9	3			
			M_{N_1}	13 20 12	7½		12		
			M_{N_2}	13 21 07	8		15		
			C	indefinite					
			F	13 42±					

DISCUSSION OF PARTICULAR SHOCKS

The Local Earthquake of October 1, 1915

The seismograms obtained at Berkeley show a considerable amount of "tangling of the lines," this effect being especially noticeable on the records of the East-West component. The movement of the writing pen on the vertical component was limited on one side by the safety stop, so that the complete vertical amplitude was not determinable. The movement of the ground at Berkeley was sufficiently strong to start the Marvin strong-motion seismograph. On acount of the small amplitude of movement, however, no satisfactory record was obtained by this instrument.

The direction of the first shift of the ground at Berkeley cannot be determined from the records of the East-West and vertical components. On the seismogram written by the North-South instrument it is clearly toward the south. Since the point of origin lay to the south of this station, the earthquake must have begun with a wave of contraction.

At Berkeley the earthquake was felt by the greater proportion of the inhabitants. The earth movement was accompanied by a rapid quivering of buildings, during which observers noted sudden strong jerks, the reported number of which varied from one to three. The intensity in Berkeley was between III and IV of the Rossi-Forel scale.

The origin of this earthquake was estimated to lie at a distance of forty-four miles from Mount Hamilton and twenty-seven miles from the Berkeley Station. Through the kindness of Mr. A. J. Newlin of Santa Clara University, the writer was permitted to examine the records obtained at that station. They show that the distance of the epicenter from Santa Clara was thirty miles. Circles drawn with these epicentral distances as radii and the proper stations as centers, will give intersections on the San Andreas Rift a little northwest of Redwood City.

The *Monthly Weather Review* reported this earthquake felt at the following places with the intensities indicated: Petaluma, IV–V; San Francisco, III; Oakland, II; Livermore, II; San Jose, II. As noted above, the intensity in Berkeley was III to IV. At Purisima, this earthquake is said to have had an intensity as great as that of the 1906 earthquake, at that place (VIII).

The earthquake registered on October 2, at $9^h\,16^m\,42^s$, was felt at Crystal Springs Lake, Burlingame, Redwood City, and Purisima. It appears to have been an aftershock of the earthquake described above.

The Violent Nevada Earthquake of October 3, 1915[1]

This earthquake was felt over a large part of the area of the United States, west of the Rocky Mountains. As indicated below, the energy involved in this disturbance, measured by the area affected, was probably greater than that involved in the San Francisco earthquake of 1906. The region of origin was in Pleasant Valley, Nevada, which was studied in the field by Professor J. Claude Jones of the University of Nevada. His report upon the earthquake has already been published.[2]

The principal earthquake was preceded by a considerable number of foreshocks. Two of these were exceptionally severe and were felt throughout the greater part of the State of Nevada. The first of these stronger foreshocks occurred on October 2, 1915, at $23^h\,41^m$.[3] The second occurred at $1^h\,49^m$ on October 3, 1915.[3]

The second strong foreshock was considerably more intense than the first one and was felt over a larger area. It was distinctly perceptible at Grass Valley, in California, a distance of about two hundred miles.

Both of these strong foreshocks were registered by all the seismographic stations in the Western United States. Fair records were obtained at Berkeley[4] and at the Lick Observatory.[5]

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[1] Stated in Pacific Standard time, this earthquake occurred at $10^h\,54^m$ P.M. on October 2, 1915.

[2] J. Claude Jones, The Pleasant Valley, Nevada, Earthquake of October 2, 1915, Bull. Seis. Soc. Am., vol. 5 (1915), p. 190.

[3] Stated in Pacific Standard time, the date of both would be October 2, 1915, and the times of occurrence would be $3^h\,41^m$ P.M. and $5^h\,49^m$ P.M.

[4] Shocks numbered 3 and 4 in the Berkeley list.

[5] Shocks numbered 2 and 3 in the list of Lick Observatory.

The first impulse of the principal shock arrived at the Berkeley Station at $6^h\ 54^m\ 31^s$. The first shift of the ground at Berkeley was toward the southwest—away from the point of origin. The periods of vibration during the first preliminary tremors were unusually long, being as much as ten to fifteen seconds. During the preliminary tremors, the Bosch-Omori horizontal component seismographs were dismantled. After a few long strokes the writing pens of these instruments left the paper and remained off during the last portion of the preliminary tremors and during the main phase. The writing pen on the East-West instrument returned to the paper after about ten minutes and registered the end phases of the earthquake.

The Marvin strong-motion seismograph was started during the main phase of the earthquake and partial records were obtained by that instrument. Complete records were written by the Omori tromometer and the measurements given in the tabulation above were taken from that instrument.

The time of duration of the earthquake at Berkeley was unusually long—nearly *three hours*. When the seismograms were first examined, it was thought that a distant earthquake had occurred at about the same time as this strong near shock and that the record resulting was due to a combination of both disturbances. However, no other strong earthquake is known to have occurred at this time. The unusual duration of motion is due to the continuous arrival of energy from the group of strong aftershocks which followed the main earthquake.

At the Lick Observatory the East-West instrument and the vertical instrument gave complete records of the earthquake. The North-South instrument was dismantled at the beginning of the main phase. Here, as at Berkeley, the first shift of the ground was away from the origin.

The area affected by this earthquake, as shown by Professor Jones, was at least as large as that affected by the San Francisco earthquake of 1906. It is known to have been felt as far east as Salt Lake City. One newspaper report states that it was felt in San Francisco. The shock was felt throughout the greater part of California east of the Coast Ranges. It was reported felt as far south as San Diego and as far North as Seattle. In

view of these facts, though the information at hand does not justify an absolute statement, it is highly probable that the area affected by this earthquake was considerably greater than that affected by the earthquake of 1906.

This is rather interesting when one considers the relative length of the fault-trace in the two earthquakes. The work of Professor Jones shows that in the Nevada earthquake a vertical scarp was formed which could be traced for a distance of between twenty and thirty miles. On this scarp the displacement was fifteen feet at the maximum, and had no horizontal component. In the San Francisco earthquake, the movement on the fault was for the most part horizontal, being twenty-one feet at the maximum, and the break could be traced over a length of one hundred and ninety miles.

The Central California Earthquake of October 8,[6] 1915, and Its Aftershocks[7]

This group of earthquakes comprised two moderately severe shocks, two of slight intensity and a considerable number of instrumental earthquakes. The first shock of the group was the principal disturbance, the others representing its aftershocks.

At Berkeley the first earthquake began abruptly with a quick lurch of the ground. There was absolutely no preliminary movement perceptible to human beings. This is borne out by the instrumental records, on which it is not possible to separate any preliminary tremors.

The force of the first impulse threw the writing pens of the Bosch-Omori seismographs off the drums, so that no records of this first shock were written by these instruments. Excellent records were obtained, however, by the Omori tromometer and the Wiechert vertical seismograph. A partial record was written by the Marvin seismograph.

The maximum movement of the ground in the horizontal components was practically coincident with the first impulse. The

[6] In Pacific Standard time, the date would be October 7.

[7] See also E. F. Davis, The Earthquakes of October 7, 1915, in Central California, Bull. Seis. Soc. Am., vol. 5 (1915), p. 230.

vertical component record shows a maximum about three seconds later. Perceptible movement of the ground was accompanied by a rumbling sound which was distinctly heard by a large proportion of the residents of Berkeley. Several observers reported that the shock began with a sound like that of a boiler explosion. At Berkeley the earthquake had an intensity of about VI of the Rossi-Forel scale. In the Piedmont district, south of Berkeley and at the western base of the Contra Costa Hills, the intensity was considerably higher, reaching about VIII of the Rossi-Forel scale. In San Francisco, the earthquake was felt distinctly, though its intensity was not high. A slight preliminary tremor was noticed by observers there.

This earthquake gave fair records at the Lick Observatory on the two horizontal components. On the vertical record it is represented by a few irregular waves of small amplitude in which no phases are discernible. It is not reported as felt by those living on Mount Hamilton.

The second earthquake of the group was instrumental only and was extremely weak, not being registered by the Omori tromometer.

The third earthquake had an intensity of from III to IV in Berkeley. It was accompanied by a distinct rumbling sound. Like the first shock, it was too strong for satisfactory registration by the sensitive Bosch-Omori instruments. Excellent records were written by the Wiechert vertical seismograph and by the Omori tromometer.

At Lick Observatory the third earthquake is represented by a barely perceptible disturbance on the horizontal records. No trace of it is visible on the record of the vertical component.

The fourth earthquake was instrumental only.

The fifth earthquake of the group was felt by many people in Berkeley, where the intensity ranged from between II and III of the Rossi-Forel scale. The movement of the ground during this earthquake was accompanied by a rumbling sound.

The sixth earthquake was instrumental only.

The seventh earthquake was felt in Berekley, where it had an intensity between II and III. It was preceded by a sound

resembling a faint muffled explosion and the earthquake movement was accompanied by a slight rumbling sound.

All of the remaining earthquakes of this group were instrumental only, save for the eighteenth. This was felt in Berkeley and in Oakland. In Berkeley its intensity was between III and IV.

The following tabulation gives the time of occurrence of the various earthquakes of this group, together with their numbers in the lists of the Berkeley Station and of the Lick Observatory:

Number in the group	Time of Occurrence Greenwich Mean Civil Time	Number in the Berkeley list	Number in Mt. Hamilton list
1	October 8 5h 25m 41s8	10	5
2	5 29 48	11	
3	5 35 26.2	12	6
4	5 44 06	13	
5	5 52 01.6	14	
6	5 55 55	15	
7	6 31 30.1	16	
8	6 50 07	17	
9	7 54 40	18	
10	7 56 19	19	
11	9 47 23.2	20	
12	9 59 09	21	
13	10 57 42	22	
14	17 16 49.4	23	
15	22 44 15	24	
16	22 44 23	25	
17	October 12 1 29 51.2	28	
18	October 22 6 18 32.8	33	

An exact determination of the distance of the origin of these earthquakes from Berkeley cannot be made since the ordinary distance formulas do not hold for such short distances. The interval of the first preliminary tremors varied from zero up to about eight-tenths of a second. This variation in preliminary tremors indicates clearly that all the shocks did not originate at exactly the same point on the active fault. While the exact distance of origin cannot be determined, it is certain that it was small, probably in all cases being less than five miles.

There are two faults in the region of San Francisco Bay which have been active during recent years. These are the San

Andreas Rift and the Haywards Rift. The distance from Berkeley to the nearest point on the San Andreas Rift is approximately twenty miles. An earthquake originating at this distance from Berkeley should show a duration of preliminary motion from two and one-half seconds to three seconds. There can be no doubt that earthquakes with an interval of preliminary motion less than a second could not have originated on the San Andreas Rift. Their probable origin would be the Haywards Rift near Berkeley.

Measurements of the records obtained at the Lick Observatory indicate that the epicentral distance from that station was about forty-seven miles. Good records of the first two strong earthquakes were obtained at Santa Clara. Through the courtesy of Mr. Albert J. Newlin the writer examined these seismograms, and his measurements showed that the probable distance of the epicenters of these earthquakes was thirty-five miles from Santa Clara. Two circles drawn with these distances as radii and the proper stations as centers gave an intersection near Oakland. This fact, in connection with the nearness to the Berkeley station, would indicate that the origin of these earthquakes lay on the Haywards Rift between four and five miles south of the Berkeley Station. This determination is confirmed by the high intensity in Piedmont.

These earthquakes are of considerable interest on account of the fact that they are the first shocks, with the exceptions noted below, known to have originated on the northern end of the Haywards Rift since the installation of the present seismographic station at Berkeley. Slips which give rise to local shocks of moderate intensity are common on the *southern* end of this rift. The strong earthquake of July 1, 1911, had its origin on the southern end of this fault.

Like the strong earthquake of July 1, 1911, the first earthquake of October 7, 1915, was not preceded by any foreshocks. Careful search of the records during the preceding days failed to show any preliminary disturbances. Possible exceptions to this statement may be found in the occurrence of a couple of slight earthquakes some months before. On the morning of April 12, 1915, and on June 22, 1915, very weak earthquakes

were registered at Berkeley. The duration of their preliminary tremors was in both cases less than one second. As far as the writer is aware, this slight earthquake of April 12, 1915, was the first one of its type ever registered at Berkeley.

Earthquake in Lower California on November 21, 1915

This earthquake gave good records on all the sensitive instruments at Berkeley. The East-West component of the Omori tromometer gave a complete seismogram, but the North-South component did not register the first preliminary tremors on account of the effect of friction.

Movement of the ground at Berkeley began gradually. The first preliminary tremors consisted of two sorts of waves. The first type had long periods, ranging from ten to fifteen seconds, and amplitudes ranging from 2 microns up to 6 microns. Superposed on these were minute vibrations of quick period and small amplitude.

The main phase began rather gradually and on the record of the vertical component it was not possible to determine the time of its beginning. The time given in the tabulation above is the time of beginning of the regular waves. For twenty to thirty seconds after the beginning of the main phase, the movements of the pens were somewhat irregular. After this they became regular and the portions of the main phase which were afterwards registered consisted of beautifully written long slow strokes of the writing pens. In tracing some of these lines the pens went off the paper. The North-South pen was off the paper a little over a minute and a half during the main phase, while the writing pen on the East-West instrument was off during almost all of the main phase, returning at the beginning of the tail portion of the seismogram. The regular waves continued for about six and one-half minutes when there was an abrupt change in the record. The balance of the seismogram consisted of separated groups of small waves.

Newspapers reported a violent earthquake in Lower California at this time and one dispatch stated that the earthquake was accompanied by an outburst of a cloud of steam in the moun-

tains south of the International Boundary. This latter was taken to be an indication of a volcanic eruption. The record obtained at Berkeley shows a considerable amplitude of vibration, and this character, in connection with the distance of the origin, indicates that the focus of this disturbance was not shallow, as is usually the rule with volcanic earthquakes. The descriptions of the distribution of intensity in Southern California, and the fact that excellent records of this earthquake were written all over the country, all point to the same conclusion. No further outbreaks of the supposed volcano have occurred. Therefore, though the evidence at hand is rather meager, the writer believes it almost certain that this is an earthquake of the tectonic class. The steam cloud may possibly have been due to the mechanical effect of the earthquake on one of the hot springs or mud volcanoes which occur in that region.

Earthquake near Eureka, California, on December 31, 1915

This earthquake gave excellent records on the three sensitive instruments at the Berkeley Station. It gave fairly good records on the two components of the Omori tromometer. The continued impulses were finally able to operate the starting device of the Marvin strong-motion seismograph and a partial record was obtained on that instrument.

The seismograms written on the three sensitive instruments were of the usual type for strong near shocks. Movement began very gradually and the preliminaries consisted of rather flat waves of a period approximately equal to ten seconds and amplitude equal to about 9 microns. Superposed on these were very minute waves having a period about one second and amplitude in the neighborhood of one or two microns. These minute superposed vibrations continued throughout the whole time of duration of the preliminary tremors.

During the first ten or fifteen seconds of the main phase the vibrations were somewhat complicated, but after that time they became very regular and the pens moved back and forth in long regular strokes. This regular phase gradually decreased in

amplitude and became more irregular as it died away into the end portion of the seismogram.

At the Lick Observatory the North-South component showed the only satisfactory record of this earthquake. The East-West record was not complete and the vertical record showed no disturbance of any sort.

The record here was somewhat similar to that obtained at Berkeley. Movement of the ground began with a series of short period vibrations of small amplitude. These were ended by the arrival of the larger waves of the main phase. The regular vibrations began about one minute after the arrival of the first impulse of the main phase. The regular waves at this station were separated into groups which began with waves of small amplitude and increased to a maximum, after which the amplitude gradually decreased. Four of these groups make up the regular waves.

The origin of this earthquake was somewhere near Eureka, California, but no reports of any destruction were received.

Teleseism of January 1, 1915

This earthquake gave excellent records on the horizontal component Bosch-Omori seismographs. A fairly strong trace appeared on the record of the East-West component written by the Omori tromometer, while a barely perceptible disturbance was apparent on the North-South component of that instrument. The record of the Wiechert vertical seismograph gave no trace of this earthquake.

Of the two horizontal components, the movements in the East-West direction were considerably greater in amplitude. The writing pen on the East-West seismograph was carried off the paper twice during the main phase.

On the North-South component the beginnings of the first preliminary tremors are obscured by microseisms. The beginning of the main phase cannot be recognized. The time of beginning of the second preliminaries, however, is sharply marked on this component. The movements of the pen during the chief phase approach simple sinusoidal curves. There is a

marked tendency for the waves to occur in groups separated by periods of movement of smaller amplitude.

On the record of the East-West component all the phases are easily separated. The main phase of this seismogram consists of two well-defined groups of waves. The first group begins with the main phase at $14^h\ 01^m\ 10^s$. With each successive stroke of the pen the amplitude increases up to a maximum at $14^h\ 05^m\ 18^s$, the periods being nearly constant. When the maximum is reached the amplitudes decrease in the same regular manner as that in which they increased, until a minimum is reached at $14^h\ 10^m\ 06^s$. The amplitude at the minimum is about 95 microns with a period of about 17 seconds. After this the amplitudes increase again in the same regular way until the second maximum is reached at $14^h\ 11^m\ 30^s$, when they decrease somewhat irregularly until at $14^h\ 14^m\ 36^s$ the amplitude is nearly zero.

In the tail portion of this seismogram a similar tendency to grouping of waves is strongly marked.

No trace of this earthquake was discernible on the records of the Lick Observatory.