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THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

OCTOBER 1, 1913, TO MARCH 31, 1914

BY

E. F. DAVIS

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CONTENTS

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 (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
	1913			h m s	s	μ	μ	μ	
1	2 Oct.	I_u	e P_N	4 31 39					A few long flat waves on East-West component lasting from $4^h\,48^m\,30^s$ to $5^h\,08^m\,30^s$. Origin in Panama.
			e P_V?	4 32 18					
			e L_N?	4 46 34					
			M_V	4 52 23	21			4	
			M_N	4 52 34	24		4		
			F	5 48 30±					
2	7 Oct.	II_d	i LM	8 40 28	<¼	3	3		Registered on Vertical component by a thickening of the pen-trace accompanied by a shifting of the line. Reported felt in Berkeley.
			C	8 40 31					
			F	8 40 34					
3	8 Oct.	I_V	e P_{EN}	1 29 40	2		4		East-West record unsatisfactory. Damper out of order. Maximum acceleration of ground apparently occurs in first preliminary motion. Registered by North-South component of Omori tromometer but effect of friction is apparent.
			ev	1 29 46					
			e S_N	1 30 16	2		2		
			e L_N	1 30 43					
			e L_V	1 30 47					
			M_V	1 31 01	8			3	
			M_N	1 31 20	8		3		
			C	1 31 45					
			F	1 34±					
4	11 Oct.	I?	e	4 30 07					Simple sinusoidal waves from $4^h\,49^m$ to $5^h\,05^m$. No definite maximum on East-West record. Period of waves 20 seconds. Amplitude 2 microns.
			M_V	4 59 00	21			9	
			M_N	4 59 52	19		8		
			F	5 50±					
5	11 Oct.	I?	e	9 30 22					North-South only. Simple sinusoidal waves from $9^h\,44^m$ to $9^h\,52^m$.
			M	9 44 17	9		2		
			F	10 08±					
6	14 Oct.	I?	e P	8 21 11					The first part of the first preliminary tremors is well marked. The latter part of the record consists of a series of long flat waves in which no phases can be discerned. Recorded on all components. First few movements recorded by the North-South component of the Omori seismograph.
			F	8 38 30±					
7	20 Oct.	I_V	e	11 26 02					North-South only. Felt at San Luis Obispo, Paso Robles, and Santa Maria.
			M	11 26 50	4		7		
			F	11 29 30±					
8	25 Oct.	III_d	i P_{EN}	9 45 43.7					See discussion in text.
			e P_V	9 45 44.2					
			i LM_{EN}	9 45 47.3	¼–½	36	30		
			i LM_V	9 45 47.4	¼			16	
			C	9 45 55					
			F	9 47 10±					
9	26 Oct.	I?	e	23 02±					Barely perceptible long flat waves.
			F	23 23±					
10	31 Oct.	II_d	i P_{EN}	22 35 18.4	<¼	3	3		Vertical record consists of a sudden displacement followed by a thickening of the pen-trace. Registered by Omori, but preliminaries are not apparent in the record.
			i LM	22 35 20	<¼	17	39	4	
			C	22 35 22					
			F	22 35 46					
11	10 Nov.	I?	e_N	21 44 38					Trace of distant earthquake. Probable origin in Peru. Barely perceptible long flat waves on East-West. Simple sinusoidal waves on North-South from $21^h\,54^m$ to $22^h\,08^m$, period 18 sec., amplitude 3 microns; on Vertical from $21^h\,55^m$ to $22^h\,05^m$, period 24 sec., amplitude 4 microns.
			e_V	21 44 58					
			F	22 31±					
12	23 Nov.	I?	e	21 42 35					East-West only. Trace of distant earthquake. Barely perceptible long flat waves.
			F	22 00±					
13	25 Nov.	I_V	e	2 58 17					Lost in microseisms after $3^h\,01^m\,09^s$. Trace of near shock. Felt at Eureka and Fort Seward. Not recorded by the Vertical seismograph.
			F	3 01 09+					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
14	29 Nov.	I_d	e	9 59 25					Barely perceptible trace of a local earthquake. North-South only.
			F	9 59 50					
15	29 Nov.	I_d	e	10 01 10					Barely perceptible disturbance. Horizontal components only.
			F	10 01 50					
16	30 Nov.	I_d	e	9 16 33					North-South only. Barely perceptible.
			F	9 16 57					
17	6 Dec.	I_V	e_E	0 19 37					Not recorded by Vertical or by Omori.
			e_N	0 19 42					
			M_E	0 20 01	4	8			
			M_N	0 20 06	5		5		
			F	0 30 50					
18	14 Dec.	I_V?	e	23 51 50					Series of minute waves of short period. Probably dying energy of near shock. Not recorded by Vertical seismograph.
			F	23 54 33					
19	20 Dec.	I_V	e P_E	0 32 38					Cause of discrepancy unknown. Probably due to an error in parallax. Earthquake not recorded by Omori or by Vertical seismographs.
			e L_E	0 32 54					
			M_E	0 33 10	8	4			
			F_E	0 34 09±					
			e P_N	0 32 24					
			e L_N	0 32 39					
			M_N	indefinite					
			F_N	0 34 25±					
20	26 Dec.	I_V	e P_{EN}	12 34 09					Not recorded by Vertical seismograph.
			e L_E	12 34 24					
			e L_N	12 34 28					
			M_E	12 34 30	4	5			
			M_N	12 34 44	3		4		
			C	indefinite					
			F	12 37 03±					
	1914								
21	19 Jan.	I_V	e	7 43 07					This disturbance occurred in the midst of strong microseisms. It is undoubtedly an earthquake since the form of the waves is altogether unlike that of ordinary microseisms. Not recorded by the Vertical seismograph.
			M	7 43 35	3		4		
			F	7 44 37					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1914			h m s	s	μ	μ	μ	
22	20 Jan.	I?	e	12 17 35					Trace of a distant earthquake. Horizontal components only. Simple sinusoidal waves from $12^h\ 26^m\ 10^s$ to $12^h\ 30^m\ 10^s$. Period 30 sec. Amplitude 3 microns.
			F	12 39±					
23	24 Jan.	III_d	i P	3 32 48.5					Origin near San Bruno. See discussion in text.
			i LM	3 32 25.6	<½	235	69	29	
			M_{N_2}	3 32 54	½		123		
			M_{E_1}	3 32 55.3	½	248			
			C	3 33 05					
			F	3 33 46					
24	30 Jan.	I_u	e P_N	3 59 14					Barely perceptible record on East-West and Vertical. No definite maximum. A series of long flat sinusoidal waves from $4^h\ 17^m\ 45^s$ to $4^h\ 24^m\ 45^s$.
			e L_N	4 16 23					
			M_N		22		4		
			F	5 54±					
25	18 Feb.	I_V	e	18 16 00					Reno earthquake. See discussion in text. Well recorded by Vertical but time marks cannot be distinguished on account of over-scoring.
			M_E	18 16 26	2	4			
			M_{N_1}	18 16 33	2		7		
			M_{N_2}	18 17 32	6		9		
			F	18 18 35					
26	26 Feb.	I?	e	5 19 20					Barely perceptible on East-West. Not recorded by Vertical.
			M	5 20 25	4		4		
			F	5 22 02					
27	28 Feb.	I?	e	5 27 02					No definite maximum. A series of simple sinusoidal waves from $5^h\ 31^m\ 15^s$ to $5^h\ 34^m\ 40^s$. Barely perceptible record on East-West.
			M		13-14		3	4	
			F	5 41 32					
28	4 Mar.	I?	e	15 55					Beginning of record interrupted by changing of sheets. Barely perceptible on North-South and Vertical.
			M	16 02 58	22	3			
			F	16 37±					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1914			h m s	s	μ	μ	μ	
29	14 Mar.	I_V	e_N	7 42 28					Series of barely perceptible movements on Vertical from $7^h\ 42^m\ 24^s$ to $7^h\ 43^m\ 36^s$
			e_E	7 42 39					
			e L_E	7 42 42					
			e L_N	7 42 43					
			M_E	7 42 47	1	3			
			M_N	7 42 50	1		3		
			C	7 42 57					
			F	7 43 58					
30	18 Mar.	I?	e_E	4 37 00					Trace of a distant earthquake. Barely perceptible long flat waves on North-South. Not recorded by Vertical.
			M_E	4 47 15	25	3			
			F	5 10±					
31	20 Mar.	I?	e	21 47 14					Trace of a distant earthquake. Barely perceptible long flat waves on all components.
			F	21 58 14					
32	24 Mar.	I?	e	16 25 14					Trace of a distant earthquake. Barely perceptible long flat waves on all components.
			F	16 41 18					
33	28 Mar.	I_a	i P	13 35 23					Vertical record illegible through over-scoring. Faintly recorded by both components of Omori seismograph.
			i LM	13 35 23.6	$<\frac{1}{2}$	4	6	—	
			C	13 35 26					
			F	13 35 34					
34	30 Mar.	I_r	e_N	0 47 49					Vertical record is imperfect, showing only a few long flat waves of the maximum movement. Registered by East-West component of Omori seismograph.
			e_E	0 48 07					
			e S_E	0 53 10					
			e S_N	0 53 17					
			e L_E	0 57 03					
			e L_N	0 57 12					
			M_{N_1}	0 59 50	22		172		
			M_{E_1}	1 00 11	20	175			
			M_{E_2}	1 02 44	16	284			
			M_{N_2}	1 03 00	19		84		
			M_{E_3}	1 03 56	12	229			
			C	1 09 45					
			F	2 29±					

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
From October 1, 1913, to March 31, 1914.			
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 A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
1	2 Oct.	I_d	e P	4 32 23					North-South component only. Record poorly written. F lost in microseisms after $5^h 20^m$.
			e L?	4 50 23					
			M	4 46 32	17		15		
			F	5 20+					
2	3 Oct.	I_d	e P	0 52 02					Registered on Vertical and on North-South by a thickening of the pen-traces.
			e LM	0 52 06	$<\frac{1}{2}$	7			
			C	0 52 15					
			F	0 52 33					
3	3 Oct.	I_d	i P	15 02 01					Registered on Vertical and on North-South by a thickening of the pen-traces.
			i LM	15 02 04.5	$<\frac{1}{2}$	6			
			C	15 02 11					
			F	15 02 19					
4	3 Oct.	I_d	i P	15 08 40					Strong thickening of pen-traces on North-South and Vertical.
			i LM	15 08 43.5	$<\frac{1}{2}$	7			
			C	15 08 49					
			F	15 09 19					
5	4 Oct.	I_d	i P	1 01 19					Thickening of pen-traces on North-South and on Vertical.
			i LM	1 01 23.5	$<\frac{1}{2}$	5			
			C	indefinite					
			F	1 01 30					
6	4 Oct.	I_d	i P	1 35 41					Thickening of pen-traces on North-South and on Vertical.
			i LM	1 35 43	$<\frac{1}{2}$	8			
			C	indefinite					
			F	1 35 49					
7	5 Oct.	I_d	i P	1 08 48					Thickening and displacement of pen-traces on North-South and on Vertical.
			i L	1 08 52					
			i M	1 08 54	$<\frac{1}{2}$	8			
			C	indefinite					
			F	1 09 01					
8	5 Oct.	I_d	e	1 25 34					Thickening of pen-traces on horizontal components.
			F	1 25 48					
9	7 Oct.	I_d	e_E	19 43 20					North-South record imperfect. Not recorded by Vertical.
			M_E	19 43 40	$\frac{1}{2}$	4			
			F_E	19 44 20					
10	8 Oct.	I?	e_N	1 29 35					East-West record begins suddenly with maximum movement followed by waves of decreasing amplitude. Not recorded by Vertical.
			i M_E	1 29 35	$\frac{1}{2}$	4			
			M_N	1 31 08	8		18		
			F	1 40±					
11	11 Oct.	I_d	i P	0 11 06					Thickening of the pen-traces on North-South and on Vertical.
			i L	0 11 10					
			M	0 11 12	$<\frac{1}{2}$	6			
			C	0 11 13					
			F	0 11 18					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
12	11 Oct.	I?	e	4 43 44					Barely perceptible waves on East-West. Not recorded by Vertical. Simple sinusoidal waves from $4^h 57^m 50^s$ to $5^h 05^m 35^s$.
			M	5 00 24	15		9		
			F	5 22±					
13	11 Oct.	I_d	e	17 23 48					Thickening of pen-traces on North-South and on Vertical. On East-West a gradual increase in amplitude up to a maximum after which amplitude decreases rapidly.
			M	17 24 19	$<\frac{1}{2}$	6			
			F	17 24 25					
14	14 Oct.	I_d?	i P_N	8 21 15					Main waves not well marked and no definite maximum appears.
			e S_N?	8 31 47					
			F_N	9 37 30±					
15	20 Oct.	I?	e	11 25 48					Not recorded by Vertical.
			M_E	11 26 23	4	19			
			M_N	11 26 28	4		21		
			F	11 28 45					
16	25 Oct.*	II_d	i P_E	9 45 55.4					*See discussion in text. North-South record damaged before varnishing; no measurements possible.
			i P_V	9 45 55.7					
			i LM_E	9 46 06.7	$<\frac{1}{2}$	15			
			i LM_V	9 46 07.8	$<\frac{1}{2}$			4	
			C	9 46 18					
			F	9 46 48					
17	26 Oct.	I_d	e	3 22 27					Thickening of pen-traces on both horizontal components.
			F	3 22 49					
18	28 Oct.	I_d	i P	18 07 27.2					Thickening of pen-trace and shifting of line on North-South. Not recorded by Vertical.
			i LM	18 07 28.4	$<\frac{1}{2}$	5			
			C	18 07 30					
			F	18 07 32					
19	30 Oct.	I_d	i P	11 47 29					Registered on Vertical by a thickening and displacement of pen-trace.
			i LM	11 47 31	$<\frac{1}{2}$	8	6		
			C	11 47 33					
			F	11 47 37					
20	3 Nov.	I_d	e P	15 51 29					Thickening of pen-traces on North-South and on Vertical.
			i L	15 51 32	$<\frac{1}{2}$	5			
			M	15 51 34	$<\frac{1}{2}$	6			
			C	indefinite					
			F	15 51 40					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
21	10 Nov.	I?	e	21 50 33					Each maximum occurs in the midst of a group of sinusoidal waves. First group from 21^h 53^m 30^s to 22^h 03^m 30^s; second group, 22^h 08^m 30^s to 22^h 14^m 30^s. Not recorded by Vertical.
			M_{N_1}	21 55 33	19		6		
			M_{E_1}	21 55 53	18	5			
			M_{N_2}	22 09 33	15		3		
			M_{E_2}	22 10 38	13	4			
			F	22 31 30±					
22	10 Nov.	I_d	i M	22 30 59	<½	10			Sudden displacement of East-West pen. Thickening of pen-trace on North-South.
23	11 Nov.	I_d	i M	18 23 45	<½	5			Sudden displacement of East-West pen. Thickening of pen-trace on North-South.
24	11 Nov.	I_d	i M	20 45 27	<½	9			Sudden displacement of East-West pen. Thickening of pen-trace on North-South.
25	15 Nov.	I_d	i P	19 40 21.7					Thickening of pen-traces on North-South and on Vertical.
			e LM	19 40 25.8	<½	3			
			C	indefinite					
			F	19 40 31					
26	16 Nov.	I_d	i M	3 53 52					A sudden slight disturbance of pens in all components.
27	22 Nov.	I_d	i P	6 33 54.5					Thickening of pen-trace on Vertical.
			i LM	6 33 56.7	<½	7	7		
			C	indefinite					
			F	6 34 14					
28	29 Nov.	II_d	i P_{NV}	9 58 58.8					Not reported felt at Lick Observatory.
			i P_E	9 58 59.4					
			i L_N	9 59 00.7	<½		25		
			i LM_V	9 59 00.7	<½			6	
			i LM_E	9 59 01.2	<½	30			
			M_N	9 59 01.7	<½		28		
			C	9 59 05					
			F	9 59 48					
29	29 Nov.	II_d	i P_V	10 00 38.2					Felt at Mount Hamilton and San Jose. Much chattering of pens on paper.
			i P_{EN}	10 00 39					
			i LM_V	10 00 40	<½			21	
			i LM_{EN}	10 00 41	<½	77	91		
			C	10 00 47					
			F	10 01 36					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
30	30 Nov.	II_d	i P_N	9 16 06.3					
			i P_E	9 16 07.1					
			i P_V	9 16 07.7					
			i LM_N	9 16 08.2	<½		39		
			i LM_{EV}	9 16 09.5	<½	46		9	
			C	9 16 14					
			F	9 17 02					
31	1 Dec.	I_d	e	17 14 32					Marked thickening of pen-traces on all components.
			F	17 14 46					
32	2 Dec.	I_d	e P_E	0 39 35					Thickening of pen-traces on North-South and on Vertical.
			i LM_E	0 39 41	<½	4			
			C	indefinite					
			F	0 39 47					
33	2 Dec.	I_d	i P_E	0 57 28					Thickening of pen-traces on North-South and on Vertical.
			i LM_E	0 57 31	<½	4			
			C	indefinite					
			F	0 57 36					
34	6 Dec.	I_V	i P	0 19 25					North-South only. L not discernible.
			M	0 20 00	4 sec.		9		
			F	0 21 48					
35	11 Dec.	I_d	e	18 53 07					Marked thickening of pen traces on all components.
			F	18 53 15					
36	12 Dec.	I_d	e	0 13 27					Thickening of pen-traces on North-South and on Vertical.
			i LM_E	0 13 31	<½	4			
			C	0 13 33					
			F	0 13 37					
37	14 Dec.	I_V	e P_N	23 50 48					Not recorded by Vertical. East-West record shows thickening and shifting of the pen-trace. F lost in microseisms after 23^h 55^m 00^s.
			e L_N	indefinite					
			M_N	23 51 45	6		34		
			C	23 51 58					
			F	23 55 00+					
38	15 Dec.	I_d	e	21 22 17					Marked thickening of pen traces on all components.
			F	21 22 23					
39	16 Dec.	I_d	e	23 30 34					Marked thickening of pen-traces in all components.
			F	23 30 42					
40	20 Dec	I_V	i P_N	0 32 13					Effect of friction apparent in East-West record. Registered on Vertical by a thickening of pen-trace.
			e P_E	0 32 14					
			e L	indefinite					
			M_N	0 32 27	½–1		13		
			M_E	0 32 30	½–1	6			
			C	0 32 37					
			F	0 35 55±					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1913			h m s	s	μ	μ	μ	
41	20 Dec.	I_d	e	4 27 14					Thickening of pen-trace on Vertical. Minute waves of short period apparent on horizontal.
			F	4 27 49					
42	25 Dec.	I_d	e	2 35 34					Thickening of pen-traces on all components.
			F	2 55 40					
43	26 Dec.	I_V	e P_{EN}	12 33 52					Record poorly written on East-West due to excessive friction. Barely noticeable thickening of pen-trace on Vertical.
			e L_{EN}	12 34 24					
			M_{EN}	12 34 29	6	16	23		
			C	12 35 03					
			F	12 36 15±					
44	26 Dec.	I_d	e	19 23 12					Slight disturbance of pen on all components.
			F	19 23 21					
45	27 Dec.	I_d	e	0 17 02					Slight thickening of pen-traces on all components.
			F	0 17 04					
	1914								
46	4 Jan.	I_d	e P_E	0 56 24					Barely discernible on North-South and Vertical.
			i LM_E	0 56 26	$<\frac{1}{2}$	4			
			C	indefinite					
			F	0 56 28					
47	20 Jan.	I_d	e P_{EN}	0 59 43					*Greater than 22. Record limited on one side by safety stop. Barely perceptible on Vertical.
			i LM_E	0 59 45	$<\frac{1}{2}$	5			
			i LM_N	0 59 46	$<\frac{1}{2}$		22*		
			C	0 59 50					
			F	0 59 59					
48	21 Jan.	I_d	i LM_E	12 31 22	$<\frac{1}{2}$	9			Barely discernible on North-South and on Vertical.
			F	12 31 29					
49	24 Jan.	II_d	i P	3 32 54					See discussion in text.
			i L_{EN}	3 33 04					
			i LM_V	3 33 04	$<\frac{1}{2}$			6	
			M_{EN}	3 33 06	$<\frac{1}{2}$	24	16		
			C	3 33 30					
			F	3 35 01					
50	24 Jan.	I_d	i LM	10 08 17	$<\frac{1}{2}$	9	5		Thickening of pen-trace on Vertical.
			C	10 08 19					
			F	10 08 27					

*The horizontal seismograph was out of order from January 24 to January 30.

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1914			h m s	s	μ	μ	μ	
51	12 Feb.	I_d	i P	22 54 34.5					
			M_V	22 54 36	$<\frac{1}{2}$			2	
			i LM_{EN}	22 54 37	$<\frac{1}{2}$	6	6		
			C	22 54 38					
			F	22 54 41					
52	14 Feb.	I?	i M	3 33 45	$<\frac{1}{2}$	4	4		A series of minute waves which begin suddenly with a maximum. Not recorded by Vertical.
			F	3 35 02					
53	18 Feb.	I_V	e P_N	18 16 02					Reno earthquake. F lost in microseisms after $18^h\ 21^m\ 22^s$. East-West component poorly recorded due to instrumental defect. Not recorded by Vertical. *See discussion in text.
	*		e L_N	18 16 50					
			M_N	18 17 02	6		26		
			C	18 17 32					
			F	18 27 22+					
54	22 Feb.	I_d	i P	22 18 44					
			i LM	22 18 46.5	$<\frac{1}{2}$	4	9	3	
			C	22 18 50					
			F	22 18 03					
55	26 Feb.	I_r	e P_{EN}	5 09 44					F lost in strong microseisms after $5^h\ 32^m$. P somewhat confused by microseisms. Not recorded by Vertical.
			e S_{EN}	indefinite					
			i L_{EN}	5 19 16					
			M_E	5 19 19	7	22			
			M_N	5 20 10	6		28		
			C	5 21 47					
			F	5 32+					
56	28 Feb.	I?	e	5 26 43					Not recorded on East-West or on Vertical.
			M	5 28 51	5		4		
			F	5 39±					
57	3 Mar.	I_d	e	0 21 37.5					Thickening of pen-traces on North-South and on Vertical.
			M_E	0 21 40	$<\frac{1}{2}$	3			
			F	0 22 13					
58	8 Mar.	I_d	e	21 30 40.5					Thickening of pen-traces on North-South and on Vertical.
			M_E	21 30 48	$\frac{1}{2}$	8			
			F	21 30 57					
59	14 Mar.	I_d	i P	7 42 14					Marked thickening of pen-trace on North-South. Barely discernible trace on Vertical.
			i LM	7 42 22.9	$\frac{1}{2}$	9			
			C	7 42 30					
			F	7 42 49					
60	15 Mar.	I_d	e	8 20 33					Thickening of line on North-South and on Vertical.
			M_E	8 20 36	$<\frac{1}{2}$	4			
			F	8 21 05					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude A_E	Amplitude A_N	Amplitude A_V	Remarks
	1914			h m s	s	μ	μ	μ	
61	17 Mar.	I_d	e P	16 37 06.5					Barely noticeable disturbance on North-South and on Vertical.
			e LM_E	16 37 09.2	$<\frac{1}{2}$	4			
			C	16 37 17					
			F	16 37 32					
62	20 Mar.	I_d	e P	16 50 34.2					Registered on North-South and on Vertical by a thickening of the pen-traces.
			e LM	16 50 37.1	$<\frac{1}{2}$	4			
			C	16 50 44					
			F	16 50 50					
63	20 Mar.	I_d	e P	17 56 27					Marked thickening of pen-traces on North-South and on Vertical.
			i LM	17 56 30	$<\frac{1}{2}$	4			
			C	17 56 37					
			F	17 56 44					
64	20 Mar.	I_d	e	19 14 33					Thickening of pen-traces on all components.
			F	19 14 50					
65	20 Mar.	I_d	e	21 51 11					Thickening of pen-traces on all components.
			F	21 51 26					
66	21 Mar.	I_d	e	0 40 43					Thickening of pen-traces on all components.
			F	0 41 02					
67	21 Mar.	I_d	i P	21 43 29.8					Thickening and displacement of Vertical pen trace.
			i LM	21 43 31	$<\frac{1}{2}$	10	9		
			C	21 43 34					
			F	21 43 44					
68	23 Mar.	I_d	e	22 17 44.5					Thickening and displacement of Vertical pen-trace.
			M	22 18 03.5	$<\frac{1}{2}$	6	6		
			F	22 18 20					
69	24 Mar.	I_d	e	0 00 34					Thickening of all pen-traces. Records imperfect due to interruption by hour marks.
			F	0 01 10					
70	30 Mar.	I_r	e S?	0 52 42					East-West record imperfect due to binding of damper. Beginning of earthquake obscured by exceptionally strong microseisms. F lost in microseisms after 2^h 00^m. Not recorded by Vertical.
			e L	0 56 52					
			M_1	1 03 17	11		146		
			C	1 09 57					
			F	2 00+					

NOTE.—In addition to the earthquakes tabulated above, there are a number of minute disturbances on the records, the nature of which is somewhat uncertain. They are not recorded by the vertical component seismograph, and in many cases are recorded by only one component of the horizontal seismograph. It is possible, and in many cases seems quite probable, that these disturbances represent minute earthquakes. They were particularly numerous during the months of February and March.

DISCUSSION OF PARTICULAR SHOCKS

Local Earthquake of October 25, 1913

This earthquake was felt in Berkeley, where it had an intensity about equal to III of the Rossi-Forel scale. It was not reported as felt at Santa Clara or at the Lick Observatory.

Attempts to determine the epicenter of this earthquake gave somewhat unsatisfactory results, as it was found to be impossible to get good intersections of the epicenter circles. All that can be said as to the position of origin of this earthquake is that it lay to the northwest of Berkeley and very probably was on the San Andreas Rift.

San Bruno Earthquake of January 24, 1914*

This earthquake was well recorded at Berkeley and at Santa Clara. The record at the Lick Observatory Station was not perfect, but was good enough to permit a fairly accurate determination of the time of duration of the preliminary tremors.

At Berkeley the earthquake was generally felt and had an intensity of III to IV of the Rossi-Forel scale. Its intensity was not great enough, however, to start the Marvin seismograph. Some differences were noted in the reports of those who felt the earthquake at Berkeley. The majority of those reporting the earthquake stated that they felt two maximum movements separated by a short interval of time. Other careful observers stated that they felt only a single strong movement. Many observers reported that the movement seemed to be stronger in the North-South component while the seismographic records indicated that the East-West component of motion was the greater.

At San Francisco the intensity of the earthquake was considerably higher than at Berkeley, being IV to V of the Rossi-Forel scale. At the Lick Observatory the earthquake was not

* A brief note on this earthquake appeared in the Bulletin of the Seismological Society of America, vol. 4, no. 1, p. 25 (1914).

reported as being felt. At Santa Clara a slight shock was felt. At Clayton the earthquake was barely perceptible. At Livermore it was felt by only a few persons who were favorably situated. At San Gregorio the earthquake was more severe than it was in Berkeley, and apparently the intensity there was about as high as it was in San Francisco.

The times of duration of the preliminary tremors at the different stations were: Lick Observatory, 9.8 seconds; Santa Clara, 6.9 seconds; Berkeley, 4.1 seconds. Omori's formula for local shocks was used to determine the epicentral distances with the following results: Lick Observatory, 75.4 kilometers; Santa Clara, 55.5 kilometers; Berkeley, 36.3 kilometers.

The direction of the epicenter could not be determined at either the Lick or Berkeley stations on account of the quick periods of the first movements of the ground. At Santa Clara the epicenter was determined to lie to the northwest of the station.

Three circles were constructed with radii equal to the foregoing values of epicentral distance, and with their centers at the respective stations. These three circles intersected in the neighborhood of San Bruno, and the center of the resulting triangle lay very nearly on the San Andreas Rift at a point north of Montara Mountain and west of San Bruno.

Reno Earthquake of February 18, 1914

The records of this earthquake which were obtained at the Berkeley Station were rather unsatisfactory. The horizontal records showed an irregular trace consisting of short period vibrations of small amplitude superposed on vibrations of longer period and greater amplitude. The vertical record was illegible through over-scoring of the pen. The shock was recorded by both components of the Omori seismograph, but neither of these records were good. It was not possible to recognize the characteristic phases in any of these records, and no determination of the epicentral distance could be made.

At the Lick Observatory the North-South record showed the characteristic phases. The East-West record, however, was poor

and the instrument did not appear to be working properly. No vertical record was obtained at the Lick Observatory.

Newspaper reports indicate that the earthquake was severe enough at Reno to crack walls and break windows, and it is said that this is the most severe earthquake ever experienced during the history of the city. The territory affected by the shock extended from the Sierra Nevada on the west to Palisade, Nevada, on the east. The earthquake was reported by nine telegraph operators at different stations in the region of the crest of the Sierra Nevada. This is the first earthquake felt in the high mountains for a considerable time.