UNIVERSITY OF CALIFORNIA PUBLICATIONS

BULLETIN OF THE

SEISMOGRAPHIC STATIONS

No. 6, pp. 117-133 April 10, 1914

THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

APRIL 1 TO SEPTEMBER 30, 1913

BY

E. F. DAVIS

UNIVERSITY OF CALIFORNIA PRESS

BERKELEY

UNIVERSITY OF CALIFORNIA PUBLICATIONS
BULLETIN OF THE
SEISMOGRAPHIC STATIONS
No. 6, pp. 117-133 April 10, 1914

THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION AND AT THE LICK OBSERVATORY STATION FROM APRIL 1 TO SEPTEMBER 30, 1913

BY
E. F. DAVIS

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

THE MARVIN STRONG-MOTION SEISMOGRAPH

The Marvin strong-motion seismograph, which has been in process of construction for some time, was completed during the month of April. The essential features and modifications of this instrument have been described elsewhere.*

A method of oil damping is employed on this instrument. The device which is in use at the present time is somewhat imperfect, and it is not possible to secure a very high damping ratio. The writing pens are so designed that there is little danger of their being dismantled during a severe earthquake, but there is a considerable amount of friction—much more than would be permissible in a seismograph designed to record more feeble earthquakes.

It has not been possible to make a practical test of this instrument up to the present time (November 28, 1913). Since its completion no earthquake has occurred having sufficient intensity at Berkeley to set it into action.

---

* Bull. Seis. Soc. Am., vol. III, no. 4, 1913, p. 195.

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	25 Apr.	I?	e	18 25 19					Barely perceptible long flat waves on East-West.
			M	18 41 49	18-20		3	6	
			F	19 27±					
2	30 Apr.	I?	e	11 41 36					Barely perceptible movement on East-West. Not recorded by vertical seismograph.
			M_N	11 48 06	9		6		
			F	12 47±					
3	8 May	I?	i P	18 46 36					Peculiar seismogram. First few movements are well recorded; then follows a series of long flat waves in which no phases are discernible. No definite maximum on East-West component. Not recorded by vertical.
			M_N	18 57 58	8		8		
			F	19 43±					
4	16 May	I_d	i P	7 48 31					Slight disturbance. No well defined maximum. No phases discernible. Thickening of pen trace on North-South component. Not recorded by vertical.
			F	7 49 18					
*	18 May								*At certain periods during this day there were rather strong microseisms. It is possible that one series of these movements occurring after $13^h\,05^m$ may represent an earthquake—but it does not appear probable.
5	30 May	I?	e	12 17 42±					Dying energy of a distant earthquake. See discussion in text.
			M		18	16	—	—	
			F	13 29±					
6	4 June	I?	e	10 22 06					Not recorded by vertical seismograph. Barely perceptible long flat waves on horizontal component records. No definite maxima.
			M		30	2	2		
			F	11 06 30					
7	14 June	I?	e	7 01 06					A few barely perceptible long flat waves on East-West component. Not recorded by vertical seismograph.
			M_N	7 04 06	7		3		
			F	7 12+					

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	
8	14 June	I?	e	8 43 03					Not recorded by vertical seismograph.
			M_E	8 58 43	10	6			
			M_N	8 59 23	8		9		
			F	9 37+					
9	14 June	I?	e	10 14±					No definite maximum on East-West component. Not recorded by vertical instrument.
			M_N	10 31 38	18-20		4		
			F	10 55±					
10	22 June	I_T	e P	13 58 08					Not recorded by vertical seismograph. No phases discernible on record of East-West component.
			e S?	14 04 30					
			e L?	14 07 58					
			M_{N_1}	14 10 53	11		23		
			M_{N_2}	14 14 00	9		19		
			M_E	14 14 38	16	19			
			F	15 46 30±					
11	26 June	I_U	e P_{EN}	5 09 00					All phases on East-West component are of smaller amplitude than similar phases on North-South component. Record on vertical is exceptionally good. Last part of chief phase in all components consists of separate groups of waves. See discussion in text.
			e P_V	5 09 02					
			e S_E	5 18 46					
			e S_N	5 18 49					
			e S_V	5 19 00					
			e L_N	5 29 18					
			e L_E	5 29 47					
			M_{N_1}	5 31 13	11		29		
			M_{V_1}	5 33 07	26			29	
			M_E	5 35 09	10	11			
			M_{V_2}	5 39 27	17			31	
			M_{N_2}	5 40 38	18		35		
			C	6 01 22					
			F	8 11±					
12	8 July	I?	e	22 48 40					No definite maximum. Long flat waves. Barely perceptible movement on North-South. Not recorded by vertical.
			M	indefinite	26	2			
			F	23 03 40					
13	9 July	I?	e	0 08 41					Barely perceptible movement on East-West record.
			M_N	0 13 54	7		6		
			M_V	0 14 39	9			5	
			F	0 33+					
14	22 July	I?	e	7 14					Trace of distant earthquake. Barely perceptible movement on North-South and East-West records. Not recorded by vertical seismograph.
			F	7 38					

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	
15	28 July	I?	e	6 00 33					Barely perceptible waves on North-South and vertical record. Period about 25 sec. Not apparent on East-West record.
			F	6 43+					
16	1 Aug.	I?	e	17 21					Barely perceptible waves. North-South component only.
			F	18 05					
17	5 Aug.	I?	e	2 00					Barely perceptible on East-West and vertical records. No definite maximum on North-South component, but a series of simple sinusoidal waves from $2^h 02^m$ to $2^h 12^m$.
			M_N		11		2		
			F	2 33					
18	6/7 Aug.	I_U	e P_N	22 25 58					Vertical record poor. Barely visible waves on East-west record. Newspapers report an earthquake in Peru.
			i S_N	22 35 11					
			e L	indefinite					
			M_V	22 52 59	21			11	
			M_N	22 53 43	18		26		
			F	0 15+					
19	15 Aug.	I?	e	19 30 30					Barely perceptible on East-West record, Vertical record illegible on account of overscoring. Sinusoidal waves on North-South from $19^h 41^m 30^s$ to $19^h 46^m 30^s$.
			M_N		8		2		
			F	19 54 30					
20	3 Sept.	I?	e_N	21 15 01					Barely perceptible on East-West record. Simple sinusoidal waves on North-South from $21^h 33^m$ to $21^h 42^m$. Vertical record is the best but the times are uncertain on this record.
			M_N		22		2		
			M_V		26			10	
			F_N	22 14±					
21	26 Sept.	I?	e	9 26 48					Barely perceptible waves on East-West. Not recorded by vertical seismograph.
			M_N	9 31 12	8		3		
			F	9 46±					

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 April 1 to May 17, 1913—			
Wiechert Seismograph N-S component	5.5	80	8:1
Weichert Seismograph E-W component	3.5	80	8:1
Wiechert Seismograph Vertical component	3.5	80	8:1
From May 17 to June 20, 1913—			
Wiechert Seismograph N-S component	5.0	80	8:1
Wiechert Seismograph E-W component	4.5	80	8:1
Wiechert Seismograph Vertical component	3.5	80	8:1
From June 20 to July 19, 1913—			
Wiechert Seismograph N-S component	6.5	80	4:1
Wiechert Seismograph E-W component	5.5	80	2:1
Wiechert Seismograph Vertical component	2.5	80	2:1
From July 19 to September 30, 1913—			
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	
	1913			h m s	s	μ	μ	μ	
1	1 Apr.	I_a	e_V	20 01 39					Thickening of pen traces on horizontal records.
			i LM_V	20 01 44	$<\frac{1}{2}$			8	
			C_V	indefinite					
			F_V	20 01 54					
2	2 Apr.	I_a	e_V	21 47 57					Thickening of pen traces on horizontal records.
			M_V	21 48 03	$<\frac{1}{2}$			4	
			F_V	21 48 08					
3	4 Apr.	I_a	e	22 29 46					Thickening of pen traces on East-West and vertical records.
			F	22 29 58					
4	6 Apr.	I_a	i LM	4 25 36	$<\frac{1}{2}$			8	Vertical only.
			C	4 25 39					
			F	4 25 42					
5	8 Apr.	I_a	e	15 33 59					Thickening of pen traces on East-West and vertical components.
			F	15 34 11					
6	11 Apr.	I_a	i P_V	15 53 03.4					
			e P_{EN}	15 53 03.7					
			i L_V	15 53 07.1					
			M_{EN}	15 53 07.3	$<\frac{1}{2}$	3	3		
			M_V	15 53 09.5	$<\frac{1}{2}$			7	
			C	15 53 11					
			F	15 53 26					
7	18 Apr.	I_a	i M	18 16 21	$<\frac{1}{2}$	5	4	2	Sudden displacement of pen traces on all components.
8	22 Apr.	I_a	e_V	0 48 07					Barely noticeable thickening of pen trace on North-South record.
			i M_E	0 48 11	$<\frac{1}{2}$	3			
			M_V	0 48 12	$<\frac{1}{2}$			3	
			F	0 48 19					
9	25 Apr.	I?	e	18 45 26					Vertical only. Barely perceptible trace of a distant earthquake.
			F	19 22 26					
10	26 Apr.	I_a	i P_{EV}	15 52 24					Two distinct maxima in horizontal records.
			M_{EN}	15 52 25.5	$<\frac{1}{2}$	3	4		
			M_{ENV}	15 52 28	$<\frac{1}{2}$	3	3	6	
			C	indefinite					
			F	15 52 33					
11	27 Apr.	I_a	e	0 04 50					
			M	0 04 54	$<\frac{1}{2}$	4	5	4	
			F	0 05 00					

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	30 Apr.	I?	e	11 50 52					Vertical only. Barely perceptible trace of a distant earthquake.
			F	12 05 42					
13	1 May	I_a	e	19 53 09					Thickening of pen traces on all components.
			F	19 53 16					
14	1 May	I_a	e	19 53 54					Thickening of pen traces on all components.
			F	19 54 02					
15	3 May	I_a	e	19 36 38					Thickening of pen traces on all components.
			F	19 36 44					
16	5 May	I_a	e_V	5 40 38					Horizontal records begin with the maxima.
			i LM	5 40 41	$<\frac{1}{2}$	6	5	4	
			C	5 40 42					
			F	5 40 48					
17	7 May	I_a	e_V	16 22 44					
			i LM_{EN}	16 22 50	$<\frac{1}{2}$	3	3		
			e LM_V	16 22 52	$<\frac{1}{2}$			4	
			F	16 22 57					
18	16 May	I_a	i	0 49 01					A slight displacement of writing pens on all components.
19	16 May	II_a	i P_V	7 48 04.1					
			i P_{EN}	7 48 05					
			i LM_V	7 48 06.3	$\frac{1}{2}$–1			8	*Limited on one side by safety stop.
			i LM_{EN}	7 48 06.7	$\frac{1}{2}$–1	08	*79		
			C	7 48 13					
			F	7 48 42					
20	24 May	I_a	e	16 21 30					Marked thickening of all pen traces.
			F	16 21 42					
21	29 May	I_a	e	16 18 38					Marked thickening of pen traces on horizontal components, vertical record being changed at instant of shock.
			F	16 18 47					
22	30 May	I?	e	12 17 04					Energy of earthquake not sufficient to give a characteristic record. Simple sinusoidal waves from $12^h 37^m$ to $12^h 46^m$. See discussion in text.
			e L_N	12 23 44					
			M_N	12 36 44	18		9		
			M_V	12 — —	18			3	
			M_E	12 38 34	17	13			
			F	13 29±					
23	30 May	I_a	e	22 47 43					Thickening of pen traces on horizontal.
			i LM	22 47 46	$<\frac{1}{2}$			5	
			C	22 47 47					
			F	22 47 52					

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	
24	1 June	I_a	e	1 13 37					Thickening of pen traces on horizontal components.
			F	1 13 41					
25	7 June	I_a	i P	0 57 33					No phases discernible on North-South record. A marked thickening of pen trace.
			i LM	0 57 36	$<\frac{1}{2}$	3		5	
			C	0 57 37					
			F	0 57 49					
26	7 June	I_a	i P_V	22 05 37					Thickening of pen traces on horizontal records.
			i LM_V	22 05 43	$<\frac{1}{2}$			4	
			C_V	22 05 47					
			F_V	22 05 53					
27	9 June	I_a	i P	12 38 30					All components
			i LM	12 38 32	$<\frac{1}{2}$	11	9	2	
			C	12 38 36					
			F	12 38 56					
28	14 June	I?	e_N	8 43 22					No phases discernible. Not recorded by vertical seismograph. A few waves on East-West record at time of M_{N_1} and M_{N_2}.
			M_{N_1}	8 55 52	6		20		
			M_{N_2}	8 59 10	10		16		
			F	9 20±					
29	14 June	I?	e	10 19 47					North-South only. A series of simple sinusoidal waves begin at $10^h 26^m$ and continue to $10^h 36^m$. There is no definite maximum.
			M	10 — —	18		3		
			F	10 47 57					
30	15 June	I_a	e	17 12 41					Marked thickening of all pen traces.
			F	17 12 55					
31	16 June	I_a	e	16 33 23					Marked thickening of all pen traces.
			F	16 33 34					
32	16 June	I_a	e P_N	18 20 08					Registered on East-West and vertical components by a thickening of the pen traces.
			i LM_N	18 20 11	$<\frac{1}{2}$		4		
			F_N	18 20 16					
33	22 June	II_r	e P_{EN}	13 58 24					Not recorded by vertical seismograph.
			e S_{EN}	14 04 39					
			e L_N	14 08 05					
			e L_E	14 08 09					
			M_{N_1}	14 11 24	11		25		
			M_E	14 14 32	9	24			
			M_{N_2}	14 14 38	9		27		
			M_{N_3}	14 18 07	8		31		
			F	16 10±					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A_E	A_N	A_V	
	1913			h m s	s	μ	μ	μ	
34	22 June	I_d	e	19 54 08					Marked thickening of all pen traces.
			F	19 54 16					
35	26 June	II_d	e P_N	5 08 59	6		34		No trace of movement on vertical record except for a sudden shift of pen at $5^h\ 09^m\ 19^s$.
			i P_E	5 09 00	5	37			
			e S_N	5 18 58	6		34		
			e S_E	5 19 00	6	26			
			e L_{EN}	5 29 52					
			M_{E_1}	5 30 44	12	15			See discussion in text.
			M_{N_1}	5 34 50	10		50		
			M_{N_2}	5 37 27	10		60		
			M_{E_2}	5 38 51	9	25			
			M_{N_3}	5 43 33	7		54		
			C	indefinite					
			F	8 12 30±					
36	9 July	I?	e	0 08 46					No phases discernible. Not recorded by vertical seismograph.
			M_E	0 13 28	9	4			
			M_N	0 15 10	8		23		
			F	0 37±					
37	23 July	I_d	i P	22 44 34					Thickening of pen traces on horizontal.
			i LM	22 44 37	<½			6	
			C	22 44 30					
			F	22 44 58					
38	25 July	I?	e	12 52 22					North-South only.
			M	13 04 42	19		3		
			F	13 17+					
39	30 July	I_d	e	19 43 22					Thickening of pen traces on horizontal components. Indicated on vertical by a displacement of pen at $19^h\ 43^m\ 34^s$.
			F	19 43 37					
40	1 Aug.	I?	e	17 29 09					No well defined maximum but a series of simple sinusoidal waves with periods and amplitudes as indicated. Not recorded by vertical.
			M	17 — —	20-30	3	3		
			F	17 52 30±					
41	3 Aug.	I_d	e	8 04 05					Not recorded by vertical. Marked thickening of horizontal pen traces.
			F	8 04 25					
42	5 Aug.	I?	e_N	1 58±					Trace of a distant shock. No phases discernible.
			M_N	2 03 25					
			F_N	2 39±					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A_E	A_N	A_V	
	1913			h m s	s	μ	μ	μ	
43	6 Aug.	I_d	e P_N	22 25 57					Time of beginning of chief phase not certain. Earthquake in Peru.
			e P_E	22 26 02					
			e S_{EN}	22 35 02					
			M_N	22 53 26	18		36		
			M_E	22 56 53	18	55			
			C	indefinite					
			F	0 39±					
44	10 Aug.	I_d	e	8 07 07					Thickening of pen traces on all components.
			F	8 07 19					
45	15 Aug.	I?	e	19 26 45					North-South component only. No definite maximum. Sinusoidal waves from 19^h42^m to 19^h52^m.
			M	19 — —	10		2		
			F	20 11±					
46	16 Aug.	I_d	e	8 39 25					Thickening of pen traces on all components.
			F	8 39 27					
47	16 Aug.	I_d	e	23 11 52					Thickening of pen traces on all components.
			F	23 12 01					
48	17 Aug.	I_d	e	0 28 27					Thickening of pen traces on all components.
			F	0 28 48					
49	26 Aug.	I_d	e	19 10 10					Thickening of pen traces on all components.
			F	19 10 32					
50	2 Sept.	I_d	e	16 23 20					Thickening of pen traces on all components.
			F	16 23 35					
51	4 Sept.	I_d	e	0 52 17					Marked thickening of pen trace on East-West. Faint on North-South. No record on vertical.
			F	0 52 43					
52	4 Sept.	I_d	e	0 57 01					Thickening of pen traces on all components.
			F	0 57 14					
53	4 Sept.	I_d	e	2 14 56					Thickening of pen traces on all components.
			F	2 15 09					
54	6 Sept.	I_d	e	1 40 58					Registered on East-West component by thickening of pen trace. No record on vertical.
			M_V	1 41 02		<½		3	
			F	1 41 29					
55	7 Sept.	I_d	e	0 26 46					Thickening of pen trace on East-West record. Sudden shift of pen on vertical at $0^h\ 26^m\ 52^h$.
			F	0 27 16					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A_E	A_N	A_V	
	1913			h m s	s	μ	μ	μ	
56	8 Sept.	I_d	e P_E	15 48 14					Not recorded by North-South component. Registered on vertical by thickening of pen trace.
			e L_E	15 48 19					
			e M_E	15 48 21	$<\frac{1}{2}$	4			
			C	15 48 23					
			F	15 48 34					
57	9 Sept.	II_d	i P	6 18 20					Recorded on East-West component and on vertical by a thickening of the pen traces. Felt by several persons. See discussion in text.
			M	6 18 23	$<\frac{1}{2}$	1	63		
			F	6 18 26					
58	18 Sept.	I_d	e	21 16 50					Poorly recorded. Energy of shock small and epicentral distance large.
			M_{EN}	21 17 07	3	2	2		
			F	21 18 30					
59	22 Sept.	I_d	e	21 13 51					Marked thickening of pen traces on all components.
			F	21 14 01					
60	22 Sept.	I_d	e	22 16 43					Thickening of pen traces on all components.
			F	22 16 54					
61	23 Sept.	I_d	i LM_E	18 32 30	$<\frac{1}{2}$	4			Thickening of pen traces on vertical and North-South records.
			F	18 32 33					
62	23 Sept.	I_d	e	19 49 11					Thickening of pen trace on East-West component. Displacement of pen trace on vertical. Not recorded by North-South component.
			F	19 49 18					
63	23 Sept.	I_d	e	19 53 42					Thickening of pen traces on all components.
			F	19 53 54					
64	24 Sept.	I_d	e	0 53 47					Thickening of pen traces on North-South and vertical components.
			M_E	0 53 52	$<\frac{1}{2}$	11			
			F	0 53 54					
65	24 Sept.	I_d	i P_E	1 02 09					Thickening of pen traces on vertical and North-South components.
			i LM_E	1 02 15	$<\frac{1}{2}$	9			
			C	1 02 20					
			F	1 02 33					
66	24 Sept.	I_d	i P_E	1 34 35					Registered on vertical and on North-South components by a thickening of the pen traces.
			i LM_E	1 34 39	$<\frac{1}{2}$	12			
			C	1 34 43					
			F	1 34 49					

No.	Date	Charac.	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A_E	A_N	A_V	
	1913			h m s	s	μ	μ	μ	
67	24 Sept.	I_d	i P_E	1 38 41					Registered on vertical and on North-South components by a thickening of the pen traces.
			i LM_E	1 38 42	$<\frac{1}{2}$	6			
			C	indefinite					
			F	1 38 49					
68	26 Sept.	I?	e	9 26 08					Dying energy of a distant earthquake. Registered by North-South component only.
			M	9 29 35	9		8		
			F	9 55+					
69	26 Sept.	II_d	i P	13 13 24					All components. Felt by a number of persons.
			i LM	13 13 25.5	$<\frac{1}{2}$	37	48	11	
			C	13 13 31					
			F	13 13 53					
70	26 Sept.	I_d	i P	18 34 22					Not reported felt.
			i LM	18 34 24	$<\frac{1}{2}$	14	29	4	
			C	18 34 26					
			F	18 34 51					
71	28 Sept.	I_d	i P_E	8 16 02					Thickening of pen traces on vertical and North-South components.
			e LM_E	8 16 05	$<\frac{1}{2}$	6			
			C	8 16 12					
			F	8 16 47					

DISCUSSION OF PARTICULAR EARTHQUAKES

Earthquake of May 30, 1913

The records of this earthquake, which were obtained at Berkeley, are imperfect. The time-marking devices on the horizontal instruments were both working improperly, and while the vertical time-marker is on a separate circuit, no record of the shock was obtained on this instrument. As a result the times given in the tabulation are somewhat uncertain.

The record on the North-South component was somewhat obscured in places by the dragging of the time marker, but considerable parts of the record are apparent. The form of curve written by both horizontal seismographs is very nearly that of a simple curve of sines. There are, however, certain noticeable variations from the simple curve. The record shows a remarkable similarity between successive wave-forms.

At the Lick Observatory the records are not characteristic. Microseisms were running on the North-South component so that the time of beginning of motion was obscured. The time of beginning of the chief phase on the North-South component appears to be fairly definite.

Earthquake of June 26, 1913

At Berkeley this earthquake was well recorded by all three instruments, the record on the vertical component being exceptionally good. The first shift of the pens was West and South and the vertical record indicates that the first impulse was due to a dilational wave.

The chief phase is somewhat irregular. The records show several groups of waves of large amplitude separated by intervals of smaller movement. All the phases on the East-West record are of smaller amplitude than the corresponding phases on the North-South component.

At the Lick Observatory the horizontal records were extremely well written. No record was given by the vertical seismograph at this station. This is peculiar in view of the fact that a most

excellent vertical record was obtained at Berkeley. Here, as at Berkeley, the first shift of the horizontal pens was to the west and south.

One peculiarity of the records here is the large amplitude of the waves of the first and second phases. It seems probable that this is due in part to the effect of resonance. The damping ratios were quite low at the time this earthquake was recorded.

As at Berkeley, the motion throughout the seismogram is irregular, consisting of separate groups of waves. In general the phases of the East-West record are of smaller amplitude than corresponding portions of the North-South record. One or two exceptions to this statement may be noted.

Earthquake of September 9, 1913

This earthquake was felt by several persons at Mount Hamilton. It was not registered at Berkeley. No sign of a disturbance at this time could be found on the Berkeley records, though a careful search of them was made.

At Mount Hamilton, the North-South component record is somewhat peculiar. No phases are apparent. The seismogram appears to consist of a series of movements beginning with a small amplitude and gradually increasing up to a maximum. The maximum is followed by a rapid decrease of amplitude. The periods were very short so that the different oscillations of the pen cannot be distinguished from each other. In spite of the large amplitude in the North-South component the vertical and East-West records show only a thickening of the pen traces at the time of the earthquake.