UNIVERSITY OF CALIFORNIA PUBLICATIONS

BULLETIN OF THE

SEISMOGRAPHIC STATIONS

No. 10, pp. 189-211 March 20, 1916

THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

APRIL 1, 1915, TO SEPTEMBER 30, 1915

BY

E. F. DAVIS

UNIVERSITY OF CALIFORNIA PRESS

BERKELEY

UNIVERSITY OF CALIFORNIA PUBLICATIONS

BULLETIN OF THE

SEISMOGRAPHIC STATIONS

No. 10, pp. 189-211 March 20, 1916

THE REGISTRATION OF EARTHQUAKES AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

APRIL 1, 1915, TO SEPTEMBER 30, 1915

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 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	2 Apr.	I_{V-r}	e	0 17 53					Barely noticeable trace on both horizontal components. Not visible on vertical record. Periods 6 sec., amplitude 2 microns.
			F	0 28 29					
2	5 Apr.	I_V	e	21 39 57					No phases discernible. Series of minute waves on vertical record. Recorded by both components of Omori tromometer. *Monthly Weather Review* mentions an earthquake at 21h 45m which was felt at Bridgeport, Coulterville, and Coleville near the Sierra scarp.
			M_E	21 40 29	2	7			
			M_N	21 40 32	2		7		
			F	21 42 16					
3	5 Apr.	I_V	e P_E	23 11 11					Series of minute waves on vertical record and on records of Omori tromometer. *Monthly Weather Review* states that an earthquake was felt on April 5 at 23h 11m at Bridgeport, Camino, Coleville, Coulterville, Markleeville, Norfork, Sonora and Towle.
			e P_N	23 11 12					
			e L_E	23 11 39					
			e L_N	23 11 40					
			M_N	23 11 46	2		6		
			M_E	23 11 50	1	7			
			C	indefinite					
			F	23 15±					
4	6 Apr.	I_V	e P_E	16 28 25					Recorded by vertical seismograph but record was illegible through overscoring. Recorded by both components of Omori tromometer. *Monthly Weather Review* states a shock was felt at Coyote, Spreckels and Watsonville on April 6, at 16-27m.
			e P_N	16 28 27					
			e L_{EN}	16 28 40					
			M_E	16 28 44	2½	11			
			M_N	16 28 47	2		11		
			C	16 28 54					
			F	16 31 07					
5	10 Apr.	I_{V-r}	e_E	0 47 48					Sinusoidal waves, with periods and amplitudes given, run on East-West record from 0h 49m 50s to 0h 50m 46s and on North-South record from 0h 49m 24s to 0h 56m 21s. Barely perceptible disturbance on vertical record.
			e_N	0 47 51					
			M_E		8	3			
			M_N		8		8		
			F	1 09±					

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	
6	12 Apr.	I_d	i P_E	22 10 30.3					First record of this type obtained at Berkeley. Registered on vertical record by a thickening of the pen trace.
			i P_N	22 10 30.5					
			i LM_E	22 10 31.1	<½	2			
			i LM_N	22 10 31.7	<½		7		
			C	22 10 33					
			F	22 10 37					
7	17 Apr.	I_{d-V}	e_N	6 27 36					Series of minute jerky waves in which no phases are visible. No trace of movement on vertical record or on record of Omori tromometer. *Monthly Weather Review* states that an earthquake was felt at Markleeville and Sonora on April 17, at 6h 20m.
			e_E	6 27 37					
			M_N	6 27 39	1		3		
			M_E	6 27 41	1½	4			
			F	6 28 16					
*	22 Apr.								Newspapers reported a shock at 18h 26m felt at Tacoma, Washington. This earthquake is said to have been strong enough to cause hundreds of persons to run out of doors. No trace of it appears on the records at Berkeley or at Lick Observatory.
8	1 May	I_a	e P_E	5 09 58					Excellent vertical record. Harvard gives origin questionably in Kurile Islands. See discussion in text.
			e P_V	5 09 59					
			e P_N	5 10 06					
			e S_V	5 18 00					
			e S_E	5 18 01					
			e S_N	5 18 03					
			e L_{EN}	5 24 41					
			e L_V	5 24 42					
			M_V	5 28 50	24			19	
			M_N	5 30 05	10		4		
			M_E	5 30 15	20	15			
			C	indefinite					
			F	8 09±					

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	
9	6 May	III_V	e P_N	12 09 59					Vertical record very poor. Recorded by both components of Omori tromometer but no phases discernible in their records. Resonance effect of continued impulses started the Marvin and a few waves of the main phase were recorded by this instrument.
			e P_E	12 10 01					
			e P_V	12 10 03					
			e S_E	12 10 43					
			e S_V	12 10 53					
			e S_N	12 10 55					
			e L_E	12 11 56					
			e L_N	12 12 00					
			e L_V	indefinite					
			M_E	12 13 59	$11\frac{1}{2}$	425			
			M_{N_1}	12 14 14	8		350		
			M_{N_2}	12 15 33	8		360		
			C	indefinite					*Monthly Weather Review* states that an earthquake was felt at Eureka, Branscomb, Fort Bragg and Shively on May 6 at $12^h\ 10^m$.
			F	13 25±					
10	29 May	I_V	e P_{EN}	6 46 59					Slight disturbance on vertical record at time of the maxima on horizontal components. Imperfect records on the Omori tromometer.
			e S_N	6 47 33					
			e L_N	6 47 58					
			M_E	6 48 11	2	25			
			M_N	6 48 17	$3\frac{1}{4}$		60		
			C	6 49 20					
			F	6 55 40±					Felt at Fresno, Porterville, Merced and Bakersfield. Intensity was V R.F. in Bakersfield, according to statement in the *Bulletin of the Seismological Society.*
11	29 May	I_V	e_N	8 31 03					Series of minute jerky waves on horizontal components. Not recorded by vertical seismograph.
			e_E	8 31 05					
			M_N	8 32 05	2		6		
			M_E	8 32 59	2	5			
			F	8 36 30±					
12	1 June	I_u	e P_V?	14 53 01					Trace of record on North-South component. No phases discernible.
			e_E	14 54 38					
			e S_E	15 02 40					
			e L_V?	15 12 17					
			M_V	15 17 22	10			4	
			M_E	15 17 31	15	90			
			F	16 05±					
13	5 June	I_V	e_E	21 10 33					Records all show a series of minute jerky waves in which no phases are discernible.
			e_V	21 10 36					
			e_N	21 11 15					
			M_E	21 11 35	2	3			
			M_N	21 11 37	2		9		
			M_V	21 12 08	$8\frac{1}{2}$			7	
			F	21 19 03					

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	
14	6 June	II_d	i P_E	17 50 45.4					First shift of ground at Berkeley to South and West. Recorded by both components of Omori tromometer.
			i P_V	17 50 45.6					
			i P_N	17 50 46.2					
			e L_V	17 50 48.5					
			i LM_E	17 50 48.6	$<\frac{1}{2}$	67			
			i LM_N	17 50 49.0	$<\frac{1}{2}$		60		Felt in Oakland, San Francisco, and Sausalito. *Monthly Weather Review* states it was felt in Coyote.
			M_V	17 50 50	$<\frac{1}{2}$			21	
			C	17 51 06					
			F	17 52 24					
15	6 June	I_u?	i P_{NV}	21 41 03					See discussion in text.
			i P_E	21 41 04					
			M_N	21 41 47	6		10		
			M_V	21 41 50	5			27	
			i S_N?	21 50 42					
			F	23 22±					
16	10 June	I_V	e P_V	16 11 47.2					Time markers on horizontal seismographs not working properly. Intervals L–P were 14.3 sec. on the East-West record and 14.2 sec. on the North-South record.
			e L_V	16 12 01.4					
			M_V	16 12 08	2			4	
			M_{EN}		$\frac{1}{2}$	9	8		
			C	indefinite					
			F	16 13 43					
17	23 June	I_d	i P_{EN}	1 02 36.2					Not registered by vertical seismograph.
			i LM_{EN}	1 02 37.1	$<\frac{1}{2}$	7	11		
			C	1 02 39					
			F	1 02 49					
18	23 June	I_V	e_N	1 22 08					Barely perceptible on records of East-west and vertical components.
			M_N	1 23 02	2		3		
			F	1 25 22					
19	23 June	I_V	e P_V	4 00 50					No phases discernible on record of vertical component. Origin in Imperial Valley. See discussion in text.
			e P_E	4 00 52					
			e P_N	4 00 53					
			i S_E	4 02 17					
			e S_N	4 02 21					
			e L_{EN}	4 02 43					
			M_N	4 02 49	3		1		
			M_E	4 02 53	6	2			
			C	4 05 41					
			F	4 24 44					
20	23 June	I_V	e P_N	4 57 32					No phases discernible on record of vertical component. Origin in Imperial Valley. See discussion in text.
			e_E	4 57 59					
			e_V	4 58 17					
			e S_N	4 58 56					
			e L_N	4 59 22					
			M_N	4 59 33	3		4		
			M_E	5 00 36	11	66			
			C	5 03 04					
			F	5 27 30±					

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	
21	27 June	I_v	e_{EN}	0 25 51					No phases discernible. East-West component shows a series of minute jerky waves without definite maximum. Not recorded by vertical seismograph.
			M_N	0 27 30	2		5		
			F	0 29 03					
22	28 June	I_v	e_{EN}	6 18 23					A series of minute jerky waves on East-West without definite maximum. Not recorded by vertical seismograh.
			M_N	6 18 32	2½		5		
			F	6 19 44					
23	19 July	I_{d-v}	e	23 10 42					Records of all three components were very weak. They consist in part of minute waves and in part of a mere thickening of the pen traces. They represent the dying energy of a weak local shock. See No. 58 in the list of Lick Observatory Station.
			F	23 11 13					
24	31 July	I_u	e P_N	1 40 40					No trace of disturbance on vertical record.
			e P_E	1 40 45					
			e S_N	1 48 09					
			e S_E	1 48 14					
			e L_N	1 55 45					
			e L_E	1 55 55					
			M_E	1 58 42	21	126			
			M_N	1 59 05	13		28		
			C	indefinite					
			F	3 08±					
25	3 Aug.	I_{r-u}	e	13 29 22					Simple sinusoidal waves on East-West component from $13^h\,56^m$ to $14^h\,38^m$. Barely perceptible on North-South record. No visible disturbance on the record of the vertical component.
			M_E		19	2			
			F	14 53±					
26	6 Aug.	I?	e_N	13 22 56					Trace of distant shock, in which no phases were discernible. Sinusoidal waves on East-West record from $13^h\,45^m\,05^s$ to $13^h\,49^m\,25^s$ and on North-South record from $13^h\,41^m\,20^s$ to $13^h\,49^m\,25^s$ with the periods and amplitudes given in the table. A barely perceptible trace on the vertical record.
			e_E	13 31 46					
			M_E		10	3			
			M_N		10		4		
			F	14 48±					
27	16 Aug.	I?	e_E	1 13 09					Barely perceptible trace on North-South component. No disturbance on vertical.
			e_N	1 15 14					
			M_E	1 21 00	19	5			
			F	1 44±					
28	6 Sept.	I?	e_N	17 46 00					Barely perceptible on East-West and vertical component records. Long flat sinusoidal waves on North-South record from $17^h\,57^m\,40^s$ to $18^h\,02^m\,20s$.
			M_N	18 00 13	9		4		
			F	18 50±					
29	7 Sept	III_r	e P_E	1 27 57					Origin in Central America. See discussion in text. Regular waves began at about $1^h\,39^m\,00^s$.
			e P_{NV}	1 28 00					
			i S_N	1 33 47					
			i S_E	1 33 53					
			e S_V	1 33 59					
			e L_E	1 38 17					
			e L_N	1 38 18					
			e L_V	indefinite					
			M_{N_1}	1 40 43	29		430		
			M_{N_2}	1 41 41	26		400		
			M_E	1 42 57	20	>800			
			M_V	1 42 59	20			385	
			C	1 45 26					
			F	3 30±					
30	7 Sept.	I?	e	13 00 31					Barely perceptible trace on records of East-West and vertical components. Driving clock on North-South instrument stopped before this earthquake.
			F	13 31 15±					

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 A_E	Amplitude A_N	Amplitude A_V	Remarks
	1915			h m s	s	μ	μ	μ	
1	2 Apr.	I_d	e	0 06 52					Marked thickening of pen traces on horizontal component records.
			F	0 07 05					
2	2 Apr.	I_d	e	0 15 10					Marked thickening of pen traces on horizontal component records.
			F	0 15 19					
3	5 Apr.	I_v	e P_{EN}	21 39 49.5					Slight disturbance of vertical pen. See No. 2 under Berkeley Station.
			i LM_E	21 40 19	$<\frac{1}{2}$	9			
			i L_N	21 40 19					
			M_N	21 40 20	1		21		
			C	21 40 30					
			F	21 41 12±					
4	5 Apr.	II_v	i P_N	23 11 05					Slight disturbance of pen on record of vertical component. See No. 3 under Berkeley Station.
			e P_E	23 11 06					
			e L_{EN}	23 11 35					
			M_E	23 11 37	$\frac{1}{2}$	20			
			M_N	23 11 39	$1\frac{1}{2}$		32		
			C	23 12 12					
			F	23 13 00±					
5	6 Apr.	II_d	i P_V	16 28 11+					Series of minute waves on record of vertical component, ending at $16^h 29^m 47^s$. See No. 4 under Berkeley Station.
			i P_N	16 28 12.0					
			i P_E	16 28 12.6					
			i L_{EN}	16 28 18.1					
			M_E	16 28 26	$4\frac{1}{2}$	29			
			M_N	16 28 27	$4\frac{1}{2}$		31		
			C	16 28 50					
			F	16 29 57					
6	10 Apr.	I_v	e_N	0 47 51					Barely perceptible waves on East-West component. Not recorded by the vertical seismograph
			M_N	0 47 56	1		5		
			F	0 48 26					
7	13 Apr.	I_d	e	1 52 05					Barely noticeable disturbance on the records of the two horizontal components consisting of minute waves of short period.
			F	1 52 35					
8	15 Apr.	I_d	e	23 55 08					Thickening of pen traces on horizontal components.
			F	23 55 19					
9	17 Apr.	I_d	i P	6 27 37					Well-written record of slight local earthquake. Record is so confused by minute mark that no measurements are possible.
			F	6 28 30					

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	22 Apr.								No trace of Tacoma earthquake of this date. See Berkeley list.
10	6 May	III_V	i P_N	12 10 14					No trace of any disturbance on the record of the vertical component. See No. 9 in list of shocks at Berkeley Station.
			i P_E	12 10 15					
			e S_E?	12 11 12					
			e S_N	indefinite					
			e L_E	indefinite					
			i L_N	12 11 58					
			M_N	12 14 42	9		434		
			M_E	12 15 30	9½	158			
			C	12 18 09					
			F	13 29±					
11	7 May	I_d	e	1 06 44					Thickening of pen traces on the records of the horizontal components.
			F	1 06 55					
12	15 May	I_d	e	5 48 56					Records of horizontal components show a series of minute waves of short period. Barely perceptible disturbance on vertical.
			M_E	5 49 04					
			M_N	5 49 06					
			F	5 50 11					
13	21 May	I_d	e	0 46 03					Strong thickening of pen traces on horizontal records. Strongest on North-South record. No perceptible movement on record of vertical component.
			M_N	0 46 05	<½		4		
			F	0 46 12					
14	21/22 May	I_d	e	23 51 14					Strong thickening of pen traces on records of all components.
			F	0 04 22					
15	22 May	I_d	e	0 04 26					Strong thickening of pen traces on records of all components.
			F	0 04 36					
16	23 May	I_d	i P	21 53 07.5					Thickening of pen traces and disturbance of line on record of vertical component.
			i LM	21 53 08.1	<½	3	?		
			C	21 53 11					
			F	21 53 15					
17	24 May	I_d	e	20 22 17					Thickening of pen traces on horizontal records.
			F	20 23 24					
18	24 May	I_d	e	23 27 42					Thickening of pen traces on records of horizontal components.
			F	23 27 50					

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	
19	25 May	I_d	e	0 13 55					Thickening of pen traces on records of horizontal components.
			F	0 14 00					
20	25 May	I_d	e	19 05 15					Thickening of pen traces on horizontal records.
			F	19 05 22					
21	26 May	I_d	e	0 39 00					Thickening of pen trace on vertical component.
			F	0 39 10					
22	27 May	I_d	e	17 29 19					Strong thickening of pen traces on records of all components.
			F	17 29 31					
23	28 May	I_d	e	16 46 06					Strong thickening of pen traces on records of all components.
			F	16 46 17					
24	28 May	I_d	e	18 46 58					Strong thickening of pen traces on records of both horizontal components.
			F	18 47 10					
25	28 May	I_d	e	19 14 03					Thickening of pen traces on records of horizontal components.
			F	19 14 12					
26	29 May	I_V	e P_N	7 46 51					Recorded by vertical component instrument but record was imperfect. See No. 10 under Berkeley Station.
			e P_E?	7 46 56					
			e L_E	7 47 31					
			e L_N	7 47 32					
			M_E	7 47 31		3	46		
			M_N	7 47 49		2		79	
			C	indefinite					
			F	7 52 45					
27	29 May	I_V	e P_N	8 30 52					East-West record rather poor. Not recorded by vertical seismograph.
			e L_N	8 31 32					
			M_N	8 31 39		1½		15	
			M_E	8 31 45		1½	14		
			C	indefinite					
			F	8 35 25					
28	31 May	I_d	i P_{EN}	15 28 15.9					
			i P_V	15 28 16.1					
			i LM_{EN}	15 28 18.1		<½	20	15	
			i LM_V	15 28 18.4		<½			4
			C	15 28 21					
			F	15 28 26					
29	2 June	I_d	e	21 56 30					Strong thickening of pen traces on records of both horizontal components.
			F	21 56 44					

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	
30	3 June	I_d	e	19 33 51					Thickening of pen traces on records of both horizontal components.
			F	19 34 02					
31	3 June	I_d	e	23 44 17					Strong thickening of pen traces on records of both horizontal components.
			F	23 44 29					
32	4 June	I_d	e P_E	21 44 38					Marked thickening of pen trace on record of North-South component. Not registered by vertical seismograph.
			i LM_E	21 44 41	$<\frac{1}{2}$	6			
			C	21 44 45					
			F	21 44 47					
33	4 June	I_d	e	23 21 54					Strong thickening of pen traces on records of both horizontal components.
			F	23 21 06					
34	5 June	I_d	e	17 44 39					Thickening of pen traces on both horizontal records.
			F	17 44 50					
35	5 June	I_d	e	18 39 23					Thickening of pen traces on both horizontal records.
			F	18 39 35					
36	6 June	I_d?	i P	17 49 55					Strong thickening of pen traces with displacements of line on records of all components.
			F	17 50 20					
37	9 June	I_d	e	22 08 53					Thickening of pen traces on both horizontal components.
			F	22 09 09					
38	9 June	I_d	e	0 35 27					Thickening of pen traces on records of both horizontal components.
			F	0 35 38					
39	10 June	II_d	i P_{NV}	16 11 37.6					
			i P_E	16 11 38.6					
			i L_E	16 11 44.2					
			i L_N	16 11 44.6					
			i L_V	indefinite					
			M_{EN}	16 11 49	$\frac{1}{2}$	36	27		
			M_V	16 11 54	$2\frac{1}{2}$			6	
			C	16 12 03					
			F	16 13 00±					
40	16 June	I_d	e	0 58 19					Thickening of pen traces and displacement of lines on records of both horizontal components.
			F	0 58 30					

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	
41	23 June	I_v	e	1 22 21					Record of North-South component imperfect on account of binding of the damper. Record of East-West component shows a barely perceptible disturbance. Not registered by vertical seismograph.
			F	1 23 40					
42	23 June	I_v	e_N	4 01 08					Imperial Valley earthquake. See discussion in text. East-West record imperfect on account of binding of dampers. Not recorded by vertical seismograph.
			e L_N	4 02 16					
			M_N	4 02 25	4		26		
			C	4 04 50					
			F	4 08 40					
43	23 June	I_v	e_N	4 58 30					Imperial Valley earthquake. See discussion in text. East-West record imperfect. Not recorded by vertical seismograph.
			e L_N	4 58 58					
			M_N	4 59 45	6		50		
			C	5 01 37					
			F	5 08 30					
44	26 June	I_d	e	12 25 35					Series of minute waves on records of both horizontal components in which no phases are discernible. Barely perceptible disturbance on record of vertical component.
			M_{EN}	12 25 49	1	7	7		
			F	12 27 10					
45	27 June	I_d	e	0 22 24					On North-South component a series of minute waves. On East-West component a strong thickening of pen trace. On vertical component a barely perceptible disturbance.
			M	0 22 47	2		3		
			F	0 23 07					
46	30 June	I_d	e	7 48 32					Strong thickening of pen traces on records of both horizontal components.
			F	7 48 38					
47	1 July	I_d	e	0 24 13					Thickening of pen traces on records of both horizontal components.
			F	0 24 25					

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	
48	2 July	I_d	e	0 04 24					Strong thickening of pen traces on records of both horizontal components.
			F	0 04 35					
49	2 July	I_d	e	0 18 34					Strong thickening of pen traces on records of both horizontal components.
			F	0 18 43					
50	2 July	I_d	e_N	0 41 20					No phases discernible on record of North-South component. Strong thickening of pen trace on record of East-West component. Not registered by vertical seismograph.
			i LM_N	0 41 23	$<\frac{1}{2}$		4		
			F	0 41 33					
51	8 July	I_d	e	21 17 45					Strong thickening of pen traces on records of both horizontal components.
			F	21 18 00					
52	14 July	I_d	e	20 26 47					Marked thickening of pen traces on records of both horizontal components.
			F	20 26 56					
53	15 July	I_d	e	0 55 48					Strong thickening of pen traces on records of ponents.
			F	0 56 09					
54	15 July	I_d	e	1 17 10					Marked thickening of pen traces on records of both horizontal components.
			F	1 17 25					
55	16 July	I_d	e	0 55 51					Strong thickening of pen traces on records of both horizontal components.
			F	0 56 09					
56	16 July	I_d	e	0 57 20					Strong thickening of pen traces on records of both horizontal components.
			F	0 57 31					
57	17 July	I_d	e	0 07 26					Strong thickening of pen traces on records of both horizontal components.
			F	0 07 37					

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	
58	19 July	III_d	i P_{EN}	23 10 19.5					This earthquake began with a rumbling sound without motion of the ground at first. As the sound grew stronger the ground began to move and both the sound and the earth movement reached their maximum intensity at the same time.
			i P_V	23 10 21.9					
			i LM_{EN}	23 10 21.5	$\frac{1}{2}$	138	67		
			i LM_V	23 10 23.4	$\frac{1}{2}$			22	
			C	23 10 26					
			F	23 11 01					
59	31 July	I_d	e P_N?	1 41 38					A few long flat waves on record of East-West component at about the time of maximum. Not recorded by vertical seismograph.
			e S_N	1 48 38					
			e L_N	1 56 43					
			M_N	1 58 33	21		17		
			C	2 00 13					
			F	2 19±					
60	4 Aug.	I_d	e	0 16 40					Strong thickening of pen trace on record of North-South component. Faint records written by East-West and vertical seismographs.
			F	0 16 53					
61	6 Aug.	I_d	e P_E	6 31 40					Barely perceptible on record of vertical component. Clock not marking properly so *minute* given may be incorrect. Second is correct.
			e P_N	6 31 41					
			e L_{EN}	6 31 46					
			M_N	6 31 48	$\frac{1}{2}$		9		
			M_E	6 31 49	$\frac{1}{2}$	12			
			C	indefinite					
			F	6 34 04					
62	6 Aug.	I_{v-r}	e	13 44 49					North-South component only. Simple sinusoidal waves from $13^h\,47^m\,55^s$ to $13^h\,49^m\,05^s$. Minute given may be incorrect.
			M		9		3		
			F	13 55±					
63	7 Aug.	I_d	e	19 31 47					Strong thickening of pen traces on records of both horizontal components.
			F	19 31 55					
64	19 Aug.	I_d	e	23 41 16					Thickening of pen traces and shifting of lines on records of both horizontal components.
			F	23 41 28					
65	19 Aug.	I_d	e	23 41 37					Thickening of pen traces and shifting of lines on records of both horizontal components.
			F	23 42 01					

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	
66	21 Aug.	I_d	e_N	23 48 25					No phases discernible. Horizontal components only.
			e_E	23 48 27					
			M_N	23 48 30	$\leq\frac{1}{2}$		4		
			M_E	23 48 32	$\leq\frac{1}{2}$	4			
			F	23 48 35					
67	23 Aug.	I_d	e	22 16 03					Strong thickening of pen traces on records of both horizontal components.
			F	22 16 14					
68	27 Aug.	I_d	e	22 57 49					Strong thickening of pen traces on records of both horizontal components.
			F	22 57 55					
69	31 Aug.	I_d	e	22 38 29					Thickening of pen traces on records of both horizontal components.
			F	22 38 41					
70	2 Sept.	I_d	e	1 51 11					Strong thickening of pen traces on records of both horizontal components.
			F	1 51 22					
71	7 Sept.	I_r	e P_{EN}	1 28 00					No trace of movement on vertical. See discussion in text.
			e S_N	1 33 47					
			e L_{EN}	1 38 15					
			M_N	1 40 27	30		134		
			M_E	1 41 27	19	173			
			C	1 49 30					
			F	2 49±					
72	8 Sept.	I_V	e	12 45 52					A train of waves of short period and amplitude on record of North-South component. Barely perceptible on record of East-West component. Not recorded by vertical seismograph.
			M_N	12 46 31	$3\frac{1}{2}$		4		
			F	12 47 21					
73	14 Sept.	I_d	e	1 43 51					Strong thickening of pen traces on records of both horizontal components.
			F	1 44 04					
74	14 Sept.	I_d	e	23 26 23					Marked thickening of pen traces on records of both horizontal components.
			F	23 26 30					

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	
75	17 Sept.	I_d	e	0 08 02					Strong thickening of pen traces on records of both horizontal components.
			F	0 08 23					
76	17 Sept.	I_d	e	0 15 15					Thickening of pen traces on record of both horizontal components.
			F	0 15 25					
77	17 Sept.	I_d	e	0 39 04					Strong thickening of pen traces on records of both horizontal components.
			F	0 39 22					
78	23 Sept.	I_d	e	15 46 14					Strong thickening of pen traces on records of both horizontal components.
			F	15 46 25					
79	24 Sept.	I_d	e	0 27 51					Strong thickening of pen traces on records of both horizontal components.
			F	0 28 03					

DISCUSSION OF PARTICULAR SHOCKS

Teleseism of May 1, 1915

This earthquake was well recorded by the more sensitive instruments at the Berkeley station, and it also gave a trace on the East-West component of the Omori tromometer.

The records on the sensitive seismographs are unusually good for an earthquake of this type, all the phases being clearly discernible on the seismograms of the three components. The fact that a complete record was obtained by the vertical seismograph is notable, since good vertical records of teleseisms are exceptional.

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

Near Shock of May 6, 1915

This strong earthquake gave excellent records on the two Bosch-Omori seismographs at Berkeley. It was recorded on both components of the Omori tromometer, but no phases are discernible in these records. The vertical component seismogram is imperfect. The continued impulses of the earthquake movement were able, by their resonance effect, to operate the starting device of the Marvin strong-motion seismograph, and partial records were obtained by this instrument.

At the Lick Observatory a good record was obtained by the North-South component of the Wiechert horizontal instrument, and a rather poor record appeared on the East-West component. The record of the vertical seismograph shows no trace of the movement.

All the seismograms at both stations are of the characteristic type for strong near shocks. The preliminaries consist of short-period jerky waves of small amplitude, which give way later to the long regular waves of the chief phase.

Distant Earthquake of June 6, 1915

The seismograms of this earthquake which were obtained at Berkeley were rather peculiar, and the character of the seismogram of each component is different from that of the other two components.

The East-West component seismogram begins suddenly with a series of short-period waves of small amplitude which gradually merge into waves of longer period but still of small amplitude. In this record no phases are discernible and there is no well-defined maximum.

The North-South component seismogram begins sharply with a maximum shortly after the first impulse. This is followed by a series of barely perceptible waves which continue until $21^h\ 50^m\ 42^s$, when a sudden strong movement apparently marks the arrival of the waves of the second phase. After this there follows a long series of faint waves in which no further phases or maxima are discernible.

On the record of the vertical component no phases are discernible. The movement begins abruptly with a maximum near the start. This is followed by a series of faint waves which continue until $23^h\ 22^m$ and in which no phases are apparent.

Imperial Valley Earthquakes of June 23,[1] 1915

At Berkeley, fairly good seismograms were obtained on the sensitive Bosch-Omori and Wiechert instruments. Slight movements were apparent on the records of both components of the Omori tromometer, but the records of this instrument are not intelligible.

On the records of the Bosch-Omori horizontal component instruments, the first preliminaries of both earthquakes (Nos. 19 and 20) are very slight, consisting of barely perceptible waves of short period and small amplitude. The second preliminaries are a little stronger, the amplitudes being larger and the periods a trifle longer.

The chief phases of the seismograms are different on the records of the two horizontal components. During the main phase of both earthquakes the record of the East-West component shows waves of small amplitude and short period, while the records of the North-South component show waves of somewhat longer period and of greater amplitude.

[1] These earthquakes occurred on June 22, 1915, at $8^h\ 00^m$ P.M. and at $8^h\ 57^m$ P.M. (Pacific Standard time).

The records of the vertical components obtained at Berkeley are fairly well written but show no discernible phases.

At the Lick Observatory, the preliminary motion of these earthquakes (Nos. 42 and 43) was only partly recorded. The East-West component seismograms are imperfect, due to the binding of the damper on that component. No trace of the disturbances is apparent on the record of the vertical component.

The reports of witnesses indicated that there were two strong shocks about an hour apart, with a weaker earthquake in between, but no trace of this intermediate earthquake is visible on the records either at Berkeley or at the Lick Observatory.

These earthquakes were studied in the field by Mr. Carl H. Beal[2] of Stanford University. His study of the distribution of intensity shows that the epicentral area lay in the Imperial Valley near the International Boundary. The central part of the area enclosed by the highest isoseismal line (IX Rossi-Forel) is near the town of Heber, and this isoseismal barely includes the towns of El Centro and Calexico. Mr. Beal concludes that these earthquakes were probably due to slips on the southern continuation of the San Jacinto Fault.

Central American Earthquake of September 7, 1915

At Berkeley, this earthquake (No. 29) began gradually. All three components of the seismogram show a gradual beginning, but fairly definite readings of the time of beginning of the different phases can be made. The interval S–P is determinable with a fair degree of accuracy on all three components. The beginning of the chief phase is well marked except on the record of the vertical component, where it cannot be determined.

About half a minute after the main phase began, the movement of the ground became quite regular and the writing pens on all three components moved from side to side in long strokes which were entirely free from minor superposed vibrations. This phase continued for about six or seven minutes and the movements then became more irregular.

[2] Carl Beal, The Earthquake in the Imperial Valley, California, June 22, 1915, Bull. Seis. Soc. Am. 5 (1915), 130–149.

The maximum displacement is shown by the record of the East-West component. In this component the movement of the ground exceeded 800 microns. At this time the writing pen of the East-West seismograph went off the paper and remained off for nearly a minute. This is the greatest amplitude recorded by the Bosch-Omori instruments since the Mexican earthquake of June 7, 1911, when an earth-movement of 875 microns was recorded by the North-South component instrument.

The waves of the chief phase were recorded by both components of the Omori tromometer, the record being strongest on the East-West component.

At the Lick Observatory (No. 71) the North-South component was well recorded but the record of the East-West seismograph was not satisfactory, due to excessive friction in that instrument. The vertical record shows no trace of motion at this time.

As at Berkeley, the maximum displacement of the ground is in the East-West component, but the record is everywhere of less amplitude than the one obtained at Berkeley.