

THE REGISTRATION OF EARTHQUAKES
AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

April 1, 1921, to September 30, 1921

BY

JAMES B. MACELWANE

BULLETIN OF THE SEISMOGRAPHIC STATIONS, VOL. 2, No. 2

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SYMBOLS AND NOTATIONS

1. *Character of the Earthquake*—

I. Perceptible. II. Moderately strong. III. Strong.

d (terrae motus domesticus)	Local shock (origin less than 100 kilometers distant).
v (terrae motus vicinus)	Near shock (origin from 100 to 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.) for the Lick Station; and for the Berkeley Station, the unreduced seismogram amplitude measured from the median line in millimeters.
A _E	E-W component of A.
A _N	N-S component of A.
A _V	Vertical component of A.

4. *Time*—

O (origin)	Time of shock at point of origin.
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THE BERKELEY STATION

CONSTANTS

Latitude and longitude of the center of the seismographic room:

$$\phi = 37^{\circ} 52' 15.''9 \text{ N. Lat.}$$

$$\lambda = 122^{\circ} 15' 36.''6 \text{ W. from Greenwich.}$$

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

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

Owing to lack of personnel the constants of the seismographs at the Berkeley Station were not determined during the period covered by this bulletin. Hence the amplitudes could not be reduced. The trace amplitudes in millimeters are given in the tables.

Grateful acknowledgment is hereby tendered to Mr. Lewis A. Bond for the measurement of all the seismograms from April 1 to May 1, 1921.

No.	Date	Character	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A _E	A _N	A _V	
				h m s	s	mm	mm	mm	
1	1921 1 April	I _u	eL F	12 39± 12 52					Registered on all three components. According to DeBilt, destructive earthquake in North Sumatra.
2	2 April	I _u	e F	2 45± 3 0					DeBilt reports from Penang Island.
3	10 April	I _r	eP _{EV} eP _N eS _E eS _{NV} M _E M _N F	13 44 32 13 44 35 13 47 22 13 47 25 13 53 17 13 53 56 15 17	11 9	1.2	1.3		S-P = 3 ^m 18 ^s . Δ = 1940 km. O = 13 ^h 40 ^m 26 ^s . Reported felt on Queen Charlotte Island.
4	12 April	I _r	eP _{ENV} eS _E ? F	7 33 10 7 36 18 8 08±					Amplitudes very small and phases poorly defined. Victoria reports near Queen Charlotte Island.
5	22 April	I _u	e F	7 04± 7 22±					
6	25 April	I	eL F	18 10± 18 27±					Registered on all three components.
7	1 May	I _r	eP _E eS _E eL _E M _E M _N F	5 44 35 5 49 20 5 51 05 5 55+ 5 56+ 6 56±	13 11	11	6.3		Δ = 3030 km. O = 5 ^h 38 ^m 35 ^s . Well registered on all components, but due to failure of the time-marking device to function consistently fuller data cannot be obtained.
8	12 May	I _r	e F	4 4 11 4 13±					
9	14 May	I _r	eE _N eL _{EN} M _{ENV} F	20 57 40 21 01 20 21 05 20 21 44±	18	.4	.3	.2	Reported felt in Salvador.
10	14 May	I _r	eP _N iP _{EV} M _{E1} M _N M _{E2} F	22 14 37 22 14 47 22 23 20 22 24 20 22 30 50 22 44±	16 16 13	.3	.2		Reported felt in Salvador.
11	21 May	I _u	e M _N F	22 53 19 22 59 20 23 41±	5		.6		According to DeBilt, the origin was in the Kurile Islands.

No.	Date	Character	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A _E	A _N	A _V	
				h m s	s	mm	mm	mm	
12	1921 28 May	I _r	e M _{EN} F	20 57 18 21 05 01 21 27±	12	.3	.2		Victoria: felt on Vancouver Island at 20 ^h 49 ^m .
13	12 June	II _v	eP _N eP _E i _{EN} i _N M _E F	3 24 37 3 24 39 3 24 56 3 25 01 3 25 12 3 40±	3 11	3.8	1.8		Reported felt at Santa Cruz and in the Salinas Valley, Calif. May be two shocks superposed.
14	17 June	I	eE eN i _N i _{EN} M _N M _E F	8 12 41 8 13 01 8 13 45 8 15 00 8 16 10 8 16 45 8 38±	4 8 7 7	.8	.7 .5		
15	17 June	I	eN eE M _N F	10 22 14 10 22 41 10 24 01 10 37±	8		.2		
16	25 June	I	eE eN M _{E1} M _{EN} M _{E2} F	2 09 34 2 11 02 2 13 14 2 14 52 2 19 2 2 46±	10 10 10	.4 .4 .4	.3		
17	28 June	I	eE _N F	14 23 04 14 46±					
18	12 July	I	eE i _E L _E F	20 04 28 20 04 38 20 10 42 20 24±					The records on the N-S and V components are masked by microseisms.
19	21 July	II _v	eP _N eP _V eE i _E i _N i _V i _V i _N i _V i _E i _N i _E M _N i _N M _E M _V F	20 17 20 20 17 24 20 17 36 20 17 48 20 17 49 20 17 50 20 17 58 20 18 03 20 18 06 20 18 10 20 18 15 20 18 17 20 18 25 20 18 33 20 18 44 20 19 06 20 30±	3 9 6		1 2 .5		Felt strongly at Eagle Lake north of Susanville, Calif. (See Bull. Seis. Soc. Am., Vol. II, pp. 192-194). The complexity of the record may be due to the superposition of waves from more than one shock. Several shocks were felt in quick succession.

THE LICK OBSERVATORY STATION

CONSTANTS

CONSTANTS OF THE STATION

Latitude and longitude of the center of the seismographic room:

$$\phi = 37^{\circ} 20' 24.5'' \text{ N. Lat.}$$

$$\lambda = 121^{\circ} 38' 34'' \text{ W. from Greenwich.}$$

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

Date	Apparatus	Component	V	T ₀	ε
30 April	Wiechert 160 Kg. H.	E	104	4.6	14
		N	75	5.8	25
	(changed)	V	56	5.8	60
31 May	160 Kg. H.	E	64	4.4	8
	80 Kg. V.	N V	75 48	4 3.2	15 20
1 July	160 Kg. H.	E	88	4	4
		N	98	3	5
	80 Kg. V.	V	46	3.1	10
29 July	160 Kg. H.	E	82	4	4
		N	76	3	5
	80 Kg. V.	V	55	3.2	5
31 Aug.	160 Kg. H.	E	136	3	5
		N	98	3.2	5
	80 Kg. V.	V	50	3.3	4

ACKNOWLEDGMENT

Our thanks are hereby rendered to Mr. Lewis A. Bond for the measurement of the seismograms from April 1 to May 1, 1921.

No.	Date	Char-acter	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A _E	A _N	A _V	
	1921			h m s	"	μ	μ	μ	
1	1 April	I _d	e F	2 40 41 2 40 52					Registered on the horizontal components only.
2	1 April	I _u	e F	12 39± 12 55±					Trace of main phase of a distant earthquake on the horizontal components only. Destructive in N. Sumatra.
3	9 April	I _d	i F	19 51 58 19 52 37					On horizontal components only.
4	10 April	I _r	e F	13 47 57 13 56±					Trace of a distant quake registered on horizontal components. Felt on Queen Charlotte Island.
5	12 April	I _r	e F	7 35± 7 57±					Very faint trace of a distant earthquake. Not registered on V. Victoria reports origin near Queen Charlotte Island.
6	14 April	I _d	i F	22 56 36 22 56 48					Weak local shock followed after about a minute by a very slight aftershock.
7	16 April	I _d	i F	0 13 27 0 13 38					Pronounced thickening of the pen trace on all three components.
8	18 April	I _d	i F	23 43 21 23 43 34					Slight shock registered on all components.
9	28 April	I	e F	3 45 31 3 48 28					Slight trace on all components.
10	1 May	I _r	eP _{EN} eS _E eS _N eL _N eL _E F	5 44 23 5 48 59 5 49 01 5 50 37 5 50 43 6 21±					Δ = 2900 km. O = 5 ^h 38 ^m 36 ^s . Not recorded on V. No definite maxima appear.
11	16 May	I	eE F	15 56 44 16 13±					Long-period waves of small amplitude.
12	17 May	I _u	eE M _E F	5 44 00 5 46 15 5 52±	19	60			A series of regular, semi-soidal waves.



No.	Date	Character	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A _E	A _N	A _V	
13	24 May 1921	I _d	eP _E	3 26 49	<0.5	26	70		
			i _E	3 26 59					
			M _N	3 27 01					
			M _E	3 27 08					
			F	3 28 25					
14	28 May	I _r	e _E	21 01 00					Victoria reports that this earthquake was felt on Vancouver Island at 20 ^h 49 ^m .
			F	21 19±					
15	12 June	II _v	iP _{ENV}	3 24 28	1&2.5	90	30		Felt strongly at Santa Cruz and in the Salinas Valley, Calif. (See Georgetown Dispatches). The phases cannot be distinguished. The record is possibly that of two quickly succeeding shocks superposed.
			i _{EN}	3 24 31					
			i _{ENV}	3 24 40					
			i _N	3 24 41					
			M _E	3 24 46					
			M _{N1}	3 24 48					
			M _V	3 24 50					
			M _{N2}	3 25 05					
F	3 28±								
16	25 June	I	e _E	2 11 10	7	3			
			M _E	2 14 11					
			F	2 25±					
17	21 July	I _v	iP _{EV}	20 18 08	2	11			Felt strongly at Eagle Lake north of Susanville, Lassen Co., Cal. (cf. Bull. Seis. Soc. Am., Vol. II, pp. 192-194). The vertical amplitude is very small and there is no record on E.
			M _E	20 18 12					
			F	20 19 40					
18	21 July	I _d	iP _{NV}	23 19 53	<0.1	6	4	2	
			i _E	23 19 58					
			M _{ENV}	23 19 59					
			F	23 22±					
19	25 July	II _d	iP _{ENV}	5 04 44	2.2	40	35		S-P=5*. Δ=46 km. Origin near Chittenden, Santa Cruz Co., Cal. (cf. Bull. Seism. Soc. Am., Vol. II, pp. 189-191).
			iS _{ENV}	5 04 49					
			M _{E1}	5 04 54					
			M _{E2}	5 04 58					
			M _N	5 04 59					
			F	5 08±					
20	1 Sept.	I _v	P _V	0 00 20					S-P=28*. Δ=250 km.
			P _N	0 00 30					
			S _V	0 00 48					
			L _N	0 00 57					
			L _V	0 01±					
			F	0 02±					

No.	Date	Character	Phase	Time G. M. C. T.	Period	Amplitude			Remarks
						A _E	A _N	A _V	
21	5 Sept. 1921	I _u	cL _E F	h m s					Not recorded on N or V. Preliminaries on E masked by microseisms.
				20 24 56					
22	8 Sept.	I _v	cP _E ? C _N S _E L _{EN} M _E F	19 25 25				40	
				19 26 04					
23	11 Sept.	I _u	e _E M _E F	4 22 55				20	
				4 40 33					
24	13 Sept.	I _u	cL _E F	3 07 03					Not registered on N or V. Only a few sinusoidal waves on E.
				3 09±					
25	14 Sept.	I _d	P _{ENV} S _{ENV} L _{ENV} F	23 14 47				<0.1	S-P=9*. Δ=80 km.
				23 14 56					
				23 14 58					
				23 16±					
26	19 Sept.	I _u	eL _E F	4 25 34				10	Nothing on N or on V.
				8 59±					