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THE REGISTRATION OF EARTHQUAKES
AT THE BERKELEY STATION

AND

AT THE LICK OBSERVATORY STATION

FROM

APRIL 1, 1918, TO SEPTEMBER 30, 1918

BY

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SYMBOLS AND NOTATION

1. Character of the Earthquake—

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

- d (terrae motus domesticus) Local shock (origin 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.
 o (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.

4. Time—

- O (origin) Time of shock at point of origin.

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.

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 Vertical 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 | | | Remarks |
|-----|-----------------------|------------------|------------------------------|---------------------|--------|-----------|-------|-------|--|
| | | | | | | A_E | A_N | A_V | |
| 1 | 1918 10 Apr. | I _u | O | 2 03 48 | s | μ | μ | μ | $\Delta = 7500$ km. No definite maximum. |
| | | | e P _{NV} | 2 14 43 | | | | | |
| | | | e S _N | 2 23 38 | | | | | |
| | | | F | 3 26± | | | | | |
| 2 | 15 Apr. | I? | e | 8 33 50 | | | | | Trace of a distant earthquake. <i>F</i> lost in microseisms about 8 ^h 50 ^m . |
| | | | F | 8 50+ | | | | | |
| 3 | 17 Apr. | II _v | e P _N | 6 43 43 | | | | | Monthly Weather Review reports an earthquake felt at Eureka at 6 ^h 49 ^m . |
| | | | e P _{EV} | 6 43 44 | | | | | |
| | | | e L _N | 6 45 01 | | | | | |
| | | | M _N | 6 45 24 | | | | | |
| | | | M _V | 6 45 30 | | | | | |
| | | | M _E | 6 47 20 | | | | | |
| | | | C | 6 48 03 | | | | | |
| F | 7 17± | | | | | | | | |
| 4 | 21 ₂₂ Apr. | III _v | i P _N | 22 33 55.6 | 5 | | | 220 | Origin near San Jacinto. See discussion in text. |
| | | | e P _E | 22 33 55.8 | | | | | |
| | | | i P _V | 22 33 56.0 | | | | | |
| | | | e S _V | 22 35 18.6 | | | | | |
| | | | i S _E | 22 35 18.8 | | | | | |
| | | | i S _N | 22 35 20.6 | | | | | |
| | | | e L _N | 22 35 34.8 | | | | | |
| | | | e L _{M_V} | 22 35 35.7 | | | | | |
| | | | e L _E | 22 35 39.1 | | | | | |
| | | | M _E | 22 36 11 | | | | | |
| | | | M _N | 11 36 32 | | | | | |
| | | | C | 22 51 23 | | | | | |
| | | | F | 0 50 30 | | | | | |
| 5 | 27 Apr. | I _v | e | 7 40 55 | | | | | Trace of a near shock. |
| | | | F | 7 51 30± | | | | | |
| 6 | 1 May | I _v | e | 4 35 43 | | | | | A series of irregular vibrations on all components; the trace of a near earthquake. Monthly Weather Review reports an earthquake felt in Imperial Valley and in southwestern Arizona at 4 ^h 32 ^m . |
| | | | F | 4 48± | | | | | |
| 7 | 6 May | I? | e | 4 59± | | | | | No phases discernible North-south out of order. |
| | | | M _E | 5 06 53 | | | | | |
| | | | F | 5 18± | | | | | |
| 8 | 11 May | I? | e | 21 52± | | | | | Trace of a distant earthquake. |
| | | | F | 22 41± | | | | | |
| 9 | 16 May | I? | e | 21 16± | | | | | Trace of a distant earthquake. |
| | | | F | 22 10± | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-------------------|----------------|----------------|-------------------|---------------------|--------|-----------|-------|-------|--|
| | | | | | | A_E | A_N | A_V | |
| 10 | 1918 20 May | I _u | O | 14 36 05 | s | μ | μ | μ | $\Delta = 9280$ km. Not registered by vertical seismograph. |
| | | | e P _E | 14 48 31 | | | | | |
| | | | e S _{EN} | 14 58 55 | | | | | |
| | | | e L | indefinite | | | | | |
| | | | M _E | 15 19 29 | | | | | |
| | | | M _N | 15 19 43 | | | | | |
| 11 | 20 May | I _u | C | indefinite | 28 | 55 | 19 | | $\Delta = 9040$ km. No definite maximum on north-south component. Not registered by vertical seismograph. |
| | | | F | 16 40± | | | | | |
| | | | O | 17 55 09 | | | | | |
| | | | i P _E | 18 07 23 | | | | | |
| 12 | 22 May | I? | i P _N | 18 07 24 | 25 | 15 | | | Trace of a distant earthquake on horizontal components. |
| | | | e S _E | 18 17 36 | | | | | |
| | | | i S _N | 18 17 37 | | | | | |
| | | | e L | indefinite | | | | | |
| | | | M _E | 18 48 43 | | | | | |
| | | | C | indefinite | | | | | |
| | | | F | 20 00± | | | | | |
| | | | e | 6 44 05 | | | | | |
| | | | F | 7 22± | | | | | |
| | | | 13 | 23 May | | | | | |
| i P _{EN} | 12 00 54 | | | | | | | | |
| e S _N | 12 03 46 | | | | | | | | |
| e S _E | 12 03 52 | | | | | | | | |
| e L _{EN} | 12 04 48 | | | | | | | | |
| M _N | 12 05 35 | | | | | | | | |
| M _E | 12 05 45 | | | | | | | | |
| C | 12 16 00 | | | | | | | | |
| F | 14 10± | | | | | | | | |
| 14 | 25 May | I? | | | e | 19 40 45 | | | |
| | | | F | 20 35± | | | | | |
| 15 | 3 June | I? | e | 0 51± | | | | | Barely perceptible trace of a distant earthquake on horizontal components. |
| | | | F | 1 16± | | | | | |
| 16 | 4 June | I? | e | 4 45± | | | | | Barely perceptible trace of a distant earthquake on horizontal components. |
| | | | F | 5 06± | | | | | |
| 17 | 4 June | I? | e | 17 33 25 | | | | | Trace of a distant earthquake on horizontal components. |
| | | | F | 18 51± | | | | | |
| 18 | 6 June | I _v | e | 22 34 10 | | | | | A series of irregular vibrations of small amplitude on horizontal components; trace of a near earthquake whose origin is in Southern California. |
| | | | F | 22 38 00 | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-----|----------------|----------------|-------------------|---------------------|--------|----------------|----------------|----------------|---|
| | | | | | | A _E | A _N | A _V | |
| 19 | 1918 7 June | I _a | O | h m s 21 26 53 | s | μ | μ | μ | Δ = 3020 km. Time uncertain within a few seconds. |
| | | | e P _N | 21 32 51 | | | | | |
| | | | e P _E | 21 32 55 | | | | | |
| | | | e S _N | 21 37 35 | | | | | |
| | | | e S _E | 21 37 38 | | | | | |
| | | | e L _N | 21 39 59 | | | | | |
| | | | M _E | 21 44 14 | | | | | |
| | | | M _N | 21 44 47 | | | | | |
| | | | C | indefinite | | | | | |
| | | | F | 22 51± | | | | | |
| 20 | 11 June | I? | e | 13 04± | | | | | May not be an earthquake. |
| | | | F | 13 24± | | | | | |
| 21 | 12 June | I _v | e | 4 25 55 | | | | | No phases discernible. |
| | | | M _{E1} | 4 28 30 | | | | | |
| | | | M _N | 4 28 33 | | | | | |
| | | | M _{E2} | 4 29 55 | | | | | |
| | | | F | 5 09± | | | | | |
| 22 | 14 June | I? | e | 21 58± | | | | | Horizontal components only. Character uncertain; may only be unusually strong microseisms. |
| | | | F | 22 21± | | | | | |
| 23 | 21 June | I? | e | 4 23± | | | | | Trace of a distant earthquake on horizontal components. |
| | | | F | 4 52± | | | | | |
| 24 | 29 June | I _v | e P _{NV} | 16 15 51 | 2 | 10 | 8 | 6 | Felt at Salinas and Spreckels. |
| | | | e P _E | 16 15 52 | | | | | |
| | | | e L _{EV} | 16 16 07 | | | | | |
| | | | e L _N | 16 16 09 | | | | | |
| | | | M _{EN} | 16 16 12 | | | | | |
| | | | M _V | 16 16 13 | | | | | |
| | | | C | 16 16 50 | | | | | |
| | | | F | 16 23± | | | | | |
| 25 | 1 July | I? | e | 6 42 30 | | | | | Trace of a distant earthquake on horizontal components. |
| | | | F | 7 16± | | | | | |
| 26 | 3 July | I _a | O | 6 58 34 | 21 | | | | Δ = 7320 km. Determination of P and S somewhat uncertain. Sinusoidal waves from 7 ^h 37 ^m 55 ^s to 7 ^h 48 ^m 05 ^s . Partial records on east-west and vertical components. |
| | | | e P _N | 7 09 19 | | | | | |
| | | | e S _N | 7 18 04 | | | | | |
| | | | e L _N | indefinite | | | | | |
| | | | M _N | 7 40 31 | | | | | |
| | | | F | 9 40± | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|--------------------|----------------|------------------|--------------------|---------------------|--------|----------------|----------------|----------------|---|
| | | | | | | A _E | A _N | A _V | |
| 27 | 1918 8 July | I _a | O? | h m s 10 28 31 | s | μ | μ | μ | Δ = 8800 km. (?) No definite maximum on east-west or vertical component. |
| | | | e P _V | 10 40 33 | | | | | |
| | | | e P _N ? | 10 41 29 | | | | | |
| | | | e P _E ? | 10 41 33 | | | | | |
| | | | e S _{NV} | 10 50 33 | | | | | |
| | | | e S _E | 10 50 41 | | | | | |
| | | | e L | indefinite | | | | | |
| | | | M _N | 11 32 43 | | | | | |
| | | | F | 12 51 30± | | | | | |
| | | | 28 | 15 July | | | | | |
| i P _{EN} | 0 24 00.6 | | | | | | | | |
| e S _V | 0 24 53.2 | | | | | | | | |
| e L _N ? | 0 25 00 | | | | | | | | |
| e L _E ? | 0 25 01 | | | | | | | | |
| e L _V | 0 25 06.5 | | | | | | | | |
| M _{V1} | 0 25 33 | | | | | | | | |
| M _N | 0 26 33 | | | | | | | | |
| M _{V2} | 0 27 04 | | | | | | | | |
| M _E | 0 27 05 | | | | | | | | |
| C | indefinite | | | | | | | | |
| F | 1 32± | | | | | | | | |
| 29 | 21 July | I _a ? | e | 6 33± | | | | | Record of a distant earthquake. Phases not determinable. |
| | | | F | 8 12± | | | | | |
| 30 | 23 July | I? | e | 14 03± | | | | | Barely perceptible trace of a distant earthquake on all components. |
| | | | F | 14 30± | | | | | |
| 31 | 24 July | I? | e | 11 30± | | | | | Faint trace of a distant earthquake on all components. |
| | | | F | 12 04± | | | | | |
| 32 | 31 July | I? | e | 14 49± | | | | | Trace of a distant earthquake; visible on all components. |
| | | | F | 15 37± | | | | | |
| 33 | 8 Aug. | I? | e | 10 09± | | | | | Trace of a distant earthquake; visible on all components. |
| | | | F | 11 30± | | | | | |
| 34 | 15 Aug. | I _a | O? | 12 19 23 | 27 | | | | Δ = 9960 (?) km. P _N , S _N , S _V are indefinite because of microseisms. Sinusoidal waves from 13 ^h 06 ^m 20 ^s to 13 ^h 48 ^m 30 ^s . These come in groups which begin with vibrations of moderate amplitude, increase gradually to a maximum and then die away. |
| | | | e P _V | 12 32 23 | | | | | |
| | | | e S _E | 12 43 19 | | | | | |
| | | | M _N | 13 08 43 | | | | | |
| | | | M _V | 13 08 53 | | | | | |
| | | | M _{E1} | 13 09 23 | | | | | |
| | | | M _{E2} | 13 33 51 | | | | | |
| | | | C | 13 48 33 | | | | | |
| | | | F | 15 27± | | | | | |
| | | | | | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|---|-----------------|-----------------|--|--|---------------|----------------|----------------|----------------|--|
| | | | | | | A _E | A _N | A _V | |
| During the time from 15 ^h 27 ^m ± to 18 ^h 17 ^m there are numbers of long flat waves on all components. These are hardly noticeable on the vertical component but are much stronger on the east-west component. | | | | | | | | | |
| 35 | 1918 15 Aug. | I? | e r' | h m s 18 17± 19 27± | | μ | μ | μ | Trace of a distant earthquake; visible on all components. |
| 36 | 19 Aug. | I _v | e F | 11 56 29 12 00 30 | | | | | Trace of a near shock; a series of irregular vibrations of small amplitude. |
| 37 | 20 Aug. | I _v | e P _{EN} i LM _V i LM _{EN} C F | 18 44 10 18 44 26 18 44 27 indefinite 18 47 02 | 1 1 | 6 | 4 | 3 | |
| 38 | 23 Aug. | I? | e F | 6 58 30± 8 18 30± | | | | | Trace of a distant earthquake on all components. |
| 39 | 7 Sept. | II _a | O e P _V e P _E e P _N e S _N e S _E e L _E e L _N M _N M _E M _V F | 17 15 24 17 26 40 17 26 50 17 26 57 17 35 54 17 36 01 17 42 15 17 42 17 17 45 21 17 46 33 17 49 21 21 33± | 12 14 8 | 335 | 480 | 65 | Δ = 7900 km. Phases appear well marked but there is poor agreement between measurements on different records. |
| 40 | 10 Sept. | I _a | e F | 10 45 18 10 46 02 | | | | | A series of minute vibrations on horizontal components. |
| 41 | 11 Sept. | I? | e F | 3 51 05 4 08± | | | | | Trace of a distant earthquake on horizontal components. |
| 42 | 30 Sept. | I? | e F | 13 52± 14 34± | | | | | Trace of a distant earthquake on horizontal components. |
| 43 | 30 Sept. | I? | e F | 18 27 45± 20 05 45± | | | | | Trace of a distant earthquake; visible on all components. |

THE LICK OBSERVATORY STATION

CONSTANTS

CONSTANTS OF THE STATION

Latitude and longitude of the center of the seismographic room:

$$\phi = 37^{\circ} 20' 24.75'' \text{ N. Lat.}$$

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

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

| | Period | Magnif. | Damping |
|--|--------|---------|---------|
| Wiechert Seismograph N-S component | 7.0 | 80 | 8:1 |
| Wiechert Seismograph E-W component | 6.0 | 80 | 8:1 |
| Wiechert Seismograph Vertical component | 3.0 | 80 | 8:1 |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-----|----------------|------------------|--------------------|---------------------|--------|----------------|----------------|----------------|---|
| | | | | | | A _E | A _N | A _V | |
| 1 | 1918 1 Apr. | I _a | e _{NV} | 20 57 27.8 | 1/2 | 5 | 8 | | Thickening of pen trace on east-west component. |
| | | | M _N | 20 57 31.3 | | | | | |
| | | | M _V | 20 57 35 | | | | | |
| | | | F | 20 57 38 | | | | | |
| 2 | 1 Apr. | I _a | i P | 22 00 38.8 | 1/2 | 8 | | | Strong thickening of pen traces on horizontal components. |
| | | | i LM _V | 22 00 41.1 | | | | | |
| | | | M _{V2} | 22 00 44 | | | | | |
| | | | F | 22 00 46 | | | | | |
| 3 | 2 Apr. | I _a | e | 22 43 10 | | | | | Thickening of pen traces on all components. |
| | | | F | 22 43 17 | | | | | |
| 4 | 12 Apr. | II _a | i P | 1 54 38.5 | 1/2 | 37 | 51 | 10 | |
| | | | i LM | 1 54 40.0 | | | | | |
| | | | C | 1 54 44 | | | | | |
| | | | F | 1 54 04 | | | | | |
| 5 | 16 Apr. | I _a | e | 0 15 56 | | | | | Strong thickening of pen traces on all components. |
| | | | F | 0 16 04 | | | | | |
| 6 | 17 Apr. | II _v | e P | 6 43 55 | 2 1/2 | 74 | 125 | | Origin near Eureka. Registered on vertical seismograph by a series of small irregular vibrations. |
| | | | e L | 6 45 08 | | | | | |
| | | | M _E | 6 45 45 | | | | | |
| | | | M _N | 6 47 00 | | | | | |
| | | | F | 7 05 ± | | | | | |
| 7 | 21/22 Apr. | III _v | e P _N | 22 33 45 | 3 | 910 | 590 | | See discussion in text. Maximum movement of ground is greater than values given as pen strokes are limited by safety stops. |
| | | | e P _V | 22 33 46 | | | | | |
| | | | e P _{E?} | 22 33 48 | | | | | |
| | | | e S _{N?} | 22 34 35 | | | | | |
| | | | e S _{E?} | 22 34 38 | | | | | |
| | | | i L _E | 22 35 16 | | | | | |
| | | | i L _V | 22 35 18 | | | | | |
| | | | i L _N | 22 35 20 | | | | | |
| | | | M _V | 22 35 22 | | | | | |
| | | | M _E | 22 35 37 | | | | | |
| | | | M _N | 22 35 40 | | | | | |
| | | | C | 22 47 32 | | | | | |
| | | | F | 0 30 ± | | | | | |
| | | | 8 | 1 May | | | | | |
| F | 4 43 21 | | | | | | | | |
| 9 | 1 May | I _a | i P _{EN} | 22 32 02.2 | 1/2 | 7 | 7 | 11 | |
| | | | i P _V | 22 32 02.6 | | | | | |
| | | | i LM _{EN} | 22 32 04.3 | | | | | |
| | | | i LM _V | 22 32 05.2 | | | | | |
| | | | C | 22 32 09 | | | | | |
| F | 22 32 13 | | | | | | | | |
| 10 | 2 May | I _a | e | 23 54 55 | | | | | Strong thickening of pen traces on all components. |
| | | | F | 23 55 04 | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-----|---------------|------------------|--------------------|---------------------|--------|----------------|----------------|----------------|--|
| | | | | | | A _E | A _N | A _V | |
| 11 | 1918 6 May | I? | e | 5 02 18 | s | μ | μ | μ | Faint trace of a distant earthquake on horizontal components. |
| | | | F | 5 20 ± | | | | | |
| 12 | 14 May | I _a | i P | 5 58 50.8 | 1/2 | 4 | 6 | 8 | |
| | | | i LM | 5 58 52.7 | | | | | |
| | | | C | indefinite | | | | | |
| | | | F | 5 58 59 | | | | | |
| 13 | 14 May | I _a | i P | 21 49 56.0 | 1/2 | 4 | 6 | 6 | |
| | | | i LM | 21 49 58.5 | | | | | |
| | | | C | 21 50 02 | | | | | |
| | | | F | 21 50 05 | | | | | |
| 14 | 16 May | I _a | e | 23 20 44 | | | | | Strong thickening of pen traces on all components. |
| | | | F | 23 20 55 | | | | | |
| 15 | 17 May | I _a | e | 23 25 32 | | | | | Strong thickening of pen traces on all components. |
| | | | F | 23 25 41 | | | | | |
| 16 | 20 May | I _a | O | 17 55 14 | | | | | Δ = 8960 km. No definite maxima. |
| | | | e P _{EN} | 18 07 24 | | | | | |
| | | | e S _{EN} | 18 17 32 | | | | | |
| | | | e L | indefinite | | | | | |
| | | | F | 19 50 | | | | | |
| 17 | 23 May | III _r | O | 11 57 26 | | | | | Δ = 1580 km. † Trace amplitude. |
| | | | e P _{ENV} | 12 00 49 | | | | | |
| | | | e S _{EN} | 12 03 34 | | | | | |
| | | | e L _{EN} | 12 04 40 | | | | | |
| | | | M _{E1} | 12 05 33 | | | | | |
| | | | M _{N1} | 12 06 25 | | | | | |
| | | | M _V | 12 06 34 | | | | | |
| | | | M _{E2} | 12 07 42 | | | | | |
| | | | M _{N2} | 12 09 33 | | | | | |
| | | | C | 12 13 10 | | | | | |
| | | | F | 14 05 ± | | | | | |
| 18 | 4 June | I? | e | 17 40 ± | | | | | Trace of a distant earthquake. |
| | | | F | 18 25 ± | | | | | |
| 19 | 6 June | I _v | e | 22 33 39 | | | | | A series of irregular vibrations of small amplitude on all components. |
| | | | F | 22 36 19 | | | | | |
| 20 | 7 June | I? | e | 21 32 40 ± | | | | | Trace of a distant earthquake on horizontal components. |
| | | | F | 22 16 ± | | | | | |
| 21 | 12 June | I? | e | 4 26 20 ± | | | | | Record of a distant earthquake. Phases not determinable. |
| | | | F | 5 05 ± | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-----|-----------------|----------------|--|--|--------------------|----------------|----------------|----------------|--|
| | | | | | | A _E | A _N | A _V | |
| 22 | 1918 14 June | I _a | e M F | h m s 8 36 14 8 36 19 8 36 26 | s $\frac{1}{2}$ | μ 5 | μ 9 | μ 9 | Strong thickening of pen traces on all components. |
| 23 | 14 June | I _a | e M F | 22 27 12 22 27 18 22 27 21 | | | | | Strong thickening of pen traces on all components. |
| 24 | 14 June | I _a | e F | 22 54 26 22 54 35 | | | | | Strong thickening of pen traces on all components. |
| 25 | 21 June | I _a | e F | 0 07 37 0 07 49 | | | | | Strong thickening of pen traces on all components. |
| 26 | 21 June | I _a | i P i LM C F | 14 25 51.0 14 25 54.1 14 25 58 14 26 04 | $\frac{1}{2}$ | 6 | 9 | 9 | |
| 27 | 21 June | I _a | e F | 23 59 26 23 59 38 | | | | | Strong thickening of pen traces on all components. |
| 28 | 29 June | I _a | e P _V e P _{EN} e L _V e L _{EN} M _V M _N M _E C F | 16 15 40 16 15 41 16 15 49 16 15 50 16 15 56 16 16 03 16 16 06 16 16 23 16 19 53 | 4 6 6 | 55 | 48 | 20 | Felt at Salinas and Spreckels. |
| 29 | 1 July | I _a | i P i LM C F | 21 49 11.1 21 49 13.8 indefinite 21 49 19 | $\frac{1}{2}$ | 6 | 11 | 6 | |
| 30 | 3 July | I _a | i P i LM C F | 0 13 28.0 21 49 13.2 indefinite 0 13 38 | $\frac{1}{2}$ | 6 | 11 | 6 | |
| 31 | 3 July | I? | e F | 7 10± 8 40± | | | | | Trace of a distant earthquake on all components. |
| 32 | 7 July | I _a | e F | 7 02 53 7 03 21 | | | | | Strong thickening of pen traces. |
| 33 | 12 July | I _a | i P i LM C F | 0 04 59.5 0 05 03.5 0 05 08 0 05 13 | $\frac{1}{2}$ | 6 | 9 | | No vertical record. |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks |
|-----|-----------------|------------------|--|--|---------------|----------------|----------------|----------------|--|
| | | | | | | A _E | A _N | A _V | |
| 34 | 1918 12 July | I _a | e F | h m s 23 10 45 23 10 50 | s | μ | μ | μ | Thickening of pen traces. No vertical record. |
| 35 | 12 July | I _a | i P i LM C F | 23 15 31.5 23 15 34.5 indefinite 23 15 41 | $\frac{1}{2}$ | 4 | 6 | | No vertical record. |
| 36 | 13 July | I _a | i P _{EN} i L _{EN} M _E M _N C F | 14 20 43.7 14 20 51.3 14 20 55 14 21 01 14 21 11 14 21 41 | 1 1 | 9 | 6 | | No vertical record. |
| 37 | 15 July | III _v | e P _{EN} e L _{EN} M _{EN} C F | 0 24 12 0 25 26 0 26 58 0 35 48 1 40± | 6 | 810* | 865 | | No vertical record. *Maximum on east-west greater than this; pen leaves paper after a stroke of this amplitude. Origin near Eureka. |
| 38 | 17 July | I _a | e F | 0 12 14 0 12 25 | | | | | Strong thickening of pen traces. No vertical record. |
| 39 | 17 July | I _a | e F | 0 13 20 0 13 25 | | | | | Strong thickening of pen traces. No vertical record. |
| 40 | 18 July | I _a | e F | 6 10 52 6 11 55 | | | | | A series of minute irregular vibrations in which no phases are discernible. No vertical record. |
| 41 | 19 July | I _a | e F | 23 21 53 23 22 02 | | | | | Strong thickening of pen traces. No vertical record. |
| 42 | 19 July | I _a | e F | 23 22 58 23 23 05 | | | | | Thickening of pen traces. No vertical record. |
| 43 | 21 July | I? | e F | 6 39± 7 45± | | | | | Trace of a distant earthquake on horizontal components. |
| 44 | 31 July | I _a | e F | 23 34 55 23 35 03 | | | | | Strong thickening of pen traces on all components. |
| 45 | 11 Aug. | I _a | e F | 20 28 52 20 29 40 | | | | | A series of very small irregular waves on all components. |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks | | |
|-----|----------|----------------|---------------------|---------------------|--------|----------------|----------------|----------------|---|----|-------|
| | | | | | | A _E | A _N | A _V | | | |
| 46 | 15 Aug. | I _a | e | 12 37 28 | s | μ | μ | μ | Phases not separable. Trace amplitudes. | | |
| | | | M _N | 13 09 17 | | | | | | 24 | 1300† |
| | | | M _E | 13 26 23 | | | | | | 18 | 4850† |
| | | | M _V | 13 26 23 | | | | | | | 750† |
| | | | F | 15 00 ± | | | | | | | |
| 47 | 15 Aug. | I _a | e | 23 29 58 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 23 30 07 | | | | | | | |
| 48 | 16 Aug. | I _a | e | 22 43 36 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 22 43 48 | | | | | | | |
| 49 | 20 Aug. | I _a | e P _{EN} | 18 44 01.5 | 2 | 12 | | | A series of weak irregu- lar vibrations on the vertical. | | |
| | | | e L _N | 18 44 06.7 | | | | | | | |
| | | | i L M _E | 18 44 06.7 | | | | | | | |
| | | | M _N | 18 44 09.7 | | | | | | 2 | 15 |
| | | | C | indefinite | | | | | | | |
| F | 18 45 38 | | | | | | | | | | |
| 50 | 21 Aug. | I _a | i P | 15 05 09.4 | ½ | 7 | 7 | 9 | | | |
| | | | i LM | 15 05 12.4 | | | | | | | |
| | | | C | 15 05 14 | | | | | | | |
| | | | F | 15 05 17 | | | | | | | |
| 51 | 22 Aug. | I _a | e | 1 39 58 | | | | | Marked thickening of pen traces on all components. | | |
| | | | F | 1 40 06 | | | | | | | |
| 52 | 22 Aug. | I _a | e | 20 33 15 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 20 33 29 | | | | | | | |
| 53 | 23 Aug. | I? | e | 6 59 ± | | | | | Trace of a distant earth- quake on all components. | | |
| | | | F | 8 05 ± | | | | | | | |
| 54 | 27 Aug. | I _a | i P | 5 53 33.0 | ½ | 12 | 10 | | Registered on vertical by a marked thickening of the pen trace. | | |
| | | | i LM | 5 53 35.0 | | | | | | | |
| | | | C | 5 53 37 | | | | | | | |
| | | | F | 5 53 41 | | | | | | | |
| 55 | 29 Aug. | I _a | e | 22 33 10 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 22 33 22 | | | | | | | |
| 56 | 29 Aug. | I _a | e | 23 17 38 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 23 17 50 | | | | | | | |
| 57 | 30 Aug. | I _a | e | 23 07 59 | | | | | Strong thickening of pen traces on all components. | | |
| | | | F | 23 08 10 | | | | | | | |
| 58 | 7 Sept. | I _a | O | 17 16 13 | | | | | Δ = 7300 km. Vertical component shows fair record but is illeg- ible through overseor- ing. | | |
| | | | e P _{EN} ? | 17 26 56 | | | | | | | |
| | | | e S _E | 17 35 36 | | | | | | | |
| | | | e S _N | 17 35 43 | | | | | | | |
| | | | e L _N | 17 42 18 | | | | | | | |
| | | | e L _E | 17 42 24 | | | | | | | |
| | | | M _N | 17 49 36 | | | | | | 10 | 560 |
| | | | M _E | 17 49 42 | | | | | | 11 | 700 |
| | | | C | indefinite | | | | | | | |
| | | | F | 21 20 ± | | | | | | | |

| No. | Date | Charac. | Phase | Time G. M. C. T. | Period | Amplitude | | | Remarks | | | | |
|-----|------------------|-----------------|-------|---------------------|--------|----------------|----------------|----------------|--|---|----|----|---|
| | | | | | | A _E | A _N | A _V | | | | | |
| 59 | 1918 10 Sept. | II _a | i P | 10 44 46.5 | s | μ | μ | μ | | | | | |
| | | | i LM | 10 45 08.0 | | | | | | ½ | 33 | 31 | 4 |
| | | | C | 10 45 13 | | | | | | | | | |
| | | | F | 10 45 44 | | | | | | | | | |
| 60 | 27 Sept. | L _i | e | 3 35 36 | | | | | A series of small irregular vibrations on horizon- tal components. | | | | |
| | | | F | 3 35 49 | | | | | | | | | |
| 61 | 30 Sept. | I _a | e | 17 14 31 | | | | | Strong thickening of pen traces on all components. | | | | |
| | | | F | 17 14 40 | | | | | | | | | |
| 62 | 30 Sept. | I? | e | 18 28 ± | | | | | Trace of a distant earth- quake on all components. | | | | |
| | | | F | 19 44 ± | | | | | | | | | |
| 63 | 30 Sept. | I _a | e | 23 22 23 | | | | | Strong thickening of pen traces on all components. | | | | |
| | | | F | 23 22 32 | | | | | | | | | |

THE SAN JACINTO EARTHQUAKE OF APRIL 21, 1918

Excellent records of this earthquake were obtained on all the instruments at the Berkeley Station. The movement of the ground began with shifts to the north and west while the first vertical movement was upward, indicating a wave of expansion. The origin of the disturbance was thus shown to be southeast of Berkeley.

The first preliminary tremors consist of vibrations having a period of about 10 seconds and amplitudes averaging about 20 microns. Superposed on these larger movements are smaller vibrations having periods of 3 to 5 seconds and amplitudes in the neighborhood of 5 microns.

The beginning of the second preliminary tremors is marked by a change in the character of the waves. This portion of the seismograms consists of simple vibrations having periods of 3 to 5 seconds and amplitudes averaging about 75 microns.

The beginning of the chief phase is well marked by a sudden increase in the amplitude of the vibrations. During the chief phase the pen traces move back and forth in long even strokes,

complicated here and there by the superposition of a smaller vibration.

At the Lick Observatory Station well-written seismograms were obtained on all components. A slight amount of friction in the instruments is apparent from the difference in times of beginning of movement of the pens.

The first preliminary tremors consist of vibrations having a period of 4 to 6 seconds and amplitudes of about 30 microns, on which are superposed smaller vibrations.

The beginning of the second preliminary tremors is marked by a simpler type of vibration coinciding with an increase in amplitude on the north-south component.

The chief phase begins abruptly with large movements of the pen traces and the records during this phase consist of long even strokes of the pens limited in places by the safety stops.

On calculating the epicentral distances from these records certain difficulties appear. Professor S. D. Townley has investigated the region shaken by this earthquake and has prepared a map showing isoseismal lines IX to V.* The meizoseismal area, enclosed by isoseismal IX, lies on the San Jacinto Fault and encloses the town of San Jacinto. The epicentral distances from Berkeley Station and from Lick Observatory Station are therefore in the neighborhood of 660 kilometers and 580 kilometers respectively.

Using the table of epicentral distances given by Dr. Klotz, the Berkeley records with an average value of (S-P) equal to $1^m 23^s$ give an epicentral distance of 760 kilometers. The Lick Observatory records with an average value of (S-P) equal to 51^s give an epicentral distance of only 460 kilometers.

Using Omori's formula ($x^{km} = 7.27y^{sec} + 38^{km}$) the Berkeley records with an average value of (L-P) equal to $1^m 41^s$ give an epicentral distance of 772 kilometers and the Lick Observatory records with an average value of (L-P) equal to $1^m 32^s$ give an epicentral distance of 708 kilometers.

Discrepancies of this kind are encountered in reducing the records of earthquakes originating at distances of 200 to 1000 kilometers from Berkeley. They may be due to faulty interpre-

* Bull. Seis. Soc. Am., vol. VIII, plate 5 (1918).

tation of the seismograms at this station or to the fact that sufficient information has not been accumulated for the exact construction of velocity curves for these epicentral distances.

A reëxamination of the seismograms of the Berkeley Station confirms the first measurements. There are marked changes in the character of the seismograms at the points designated S and L. There are no other points where such changes are apparent.

The identification of S on the Lick Observatory records is not so certain. However, there is a marked change of character on both horizontal records at the place called S. Other points which might be fixed upon in examining the record of one component have no equivalent on the other component.