

THE REGISTRATION OF EARTHQUAKES AT THE DETROIT OBSERVATORY DURING THE YEAR 1913

By PAUL W. MERRILL

The equipment of this seismological station has been described in the reports for preceding periods. The disposition and constants of the instruments have not been altered.

NO.	DATE	INST. COMP.	P	S	L	M	F	A	Δ
	1913		h m	h m	h m	h m	h m	mm.	1000 km.
95	Jan. 15	B—EW B—NS				6 13 7		small small	
96	Mar. 4	B—EW B—NS		remark	6 38.1 37.8			0.3 0.2	
97	Mar. 8	B—EW B—NS W—EW	9 58.5 59.0	10 3.7 3.4	10 7.1 6.7 7.0	10 9.4 7.5 8.2	>10 30	3.0 0.4 0.9	3
98	Mar. 14	B—EW B—NS W—EW W—NS	3 5.4 4. 4. 4.4	3 23.1 17.0 23.0 23.1	3 42.4? 42.1 42.1 42.2	3 44.3 42.8 44.1 44.0	4 16 15 31 42	0.7 0.7 0.9 0.6	13
99	Mar. 30	B—EW B—NS W—EW W—NS	21 51.6* 51.4* 51.5* 51.5*		22 14.9 18.5 14.0 13.9	22 18.7 19.0 18.4 18.0	>22 50 > 50 >23 0 > 0	0.7 1.2 0.7 0.8	8
100	May 16	B—EW B—NS				6 17.5 17.5		0.2 0.2	
101	May 30	B—EW B—NS				6 55 54	> 7 8 > 9	1.2 0.5	
102	June 14	B—EW B—NS	2 43.2 42.7			3 4.1 3.4		0.3 0.2	
103	June 25	B—EW B—NS W—EW	23 16.0	23 30.7† 30.8	23 46.2* 56.7 56	23 55.9 56.7 56	1 30 0 39	1.9 0.5	11
104	July 8	B—FW B—NS W—EW W—NS		18 22.8 22.3 22.8	18 25.8 25.2 25.7 25.5	18 26.0 25.4 26.0 25.8	18 32 35 32 26	2.5 0.9 0.4 0.1	2
105	July 25	B—EW B—NS		6 50.4 50.1	6 53.6 54.4	6 55.2 56.7	7 10 9	1.5 0.7	2+
106	Aug. 6	B—FW B—NS W—EW W—NS W—V	16 27.1 23.9	16 32.2 31.8 33.8 31.1	16 38.6 41.0 41.2	16 44.2 48.3 44.0 48.2 50.2	17 48 45 16 58 17 1	9.8 12.0 1.0 1.1 1.	5
107	Oct. 1	B—EW B—NS	22 29.4	22 35.2 34.7	22 38.9 40.6	22 42.6 45.3	23 4.9 3.4	4.1 1.5	3½
108	Oct. 4	B—EW B—NS	16 11.8	16 15.6		16 21.9 27.0		0.2 0.15	
109	Oct. 10	B—EW B—NS				23 10 8		0.3 0.15	

* = well defined.

† = gradual.

REMARKS.

Measurements not conveniently included in the scheme of the table are given below. Some slight shocks are described under the head of microseisms.

The three values of the distance computed by the Laska formulae,

- (1) $\Delta = S - P - I.$
- (2) $\Delta = 1/3 (L - P).$
- (3) $\Delta = 1/2 (L - S + I).$

nearly always decrease from (1) to (3). The mean, which usually differs but little from (2), is apparently not far from the truth.

95. A weak shock extending over many minutes. Small motion shown on Wiechert. Slow microseisms during the day.

96. A slight shock of small irregular waves. B-E W strongest portion from 6 h 38.1 m to 42.5 m, with a lull from 40.2 m to 41.6 m. B-N S from 6 h 37.8 m to 41.4 m, with a lull from 38.8 m to 40.9 m. Nothing definite on W.

97. Tremors died out very gradually. W-N S record imperfect but recorded motion is of very small amplitude. On B-N S there is a stronger group of sinusoidal waves in the tail from 10 h 26.4 m to 29.4 m.

98. It is possible that S and L have been misidentified.

100. B-E W small waves beginning about 6 h 9 m coming to a maximum at 17.5 m, dying away again in a few minutes. B-N S same. Also shown on W-N S.

101. B-E W small waves beginning 6 h 34 m, gradually increasing. B-N S tremors begin gradually about 6 h 32 m. W-E W waves of maximum amplitude 0.2 mm from 6 h 53 m to 57 m. W-N S trace? W-V slight tremors (amplitude scarcely 0.1 mm) from 6 h 53.8 m to 57.3 m.

102. B-E W undulations last for half an hour after M, starting up again 70 m after M. B-N S undulations cease about 10 m after M but start up again about 70 m after M.

103. The stronger waves show for 2 or 3 m on W-E W. The slightest irregular trace on W-N S.

106. W-V record poor. Long waves began at 16 h 47.8 m and ended at 53.4 m.

107. The Panama earthquake.

108. A small record. No well marked phases.

109. A weak disturbance having a gradual increase and decrease in intensity.

MICROSEISMS.

The characteristic features of the microseismic disturbances recorded here have been described and discussed in previous reports.

The microseisms recorded as "groups of sinusoidal waves" may in some cases be due to the passage of trains on tracks one-half kilometer north. There is some evidence, however, that these are real seismic tremors which are assisted in recording themselves by the rapid vibrations given the pen by trains. In this connection see *Hobbs' Earthquakes*, p. 264. It appears that train effects are not the same, or even of the same general character, at all times.

MICROSEISMS 1913.

1913.

Jan. 1-7.

Irregular sinusoidal waves on the B instruments. Traces on W. On Jan. 3-4 stronger EW than NS.

Jan. 7-9.

Small irregular motions but nearly continuous.

Jan. 8-13.

Regular sinusoidal waves of small amplitude, increasing to a maximum on 9-10, and then dying away very slowly.

Jan. 13-14.

As above but more active.

Jan. 14-15.

Traces.

Jan. 20-23.

Weak sinusoidal tremors.

Jan. 28-29.

Small groups of sinusoidal tremors on B and W.

Jan. 29-30.

Same but weaker.

Jan. 31-Feb. 1.

Tremors, more or less continuous shown by B-NS.

- Feb. 1-10.
B—EW groups of sinusoidal waves. B—NS nearly continuous tremors. Motions of very small amplitude recorded on W.
- Feb. 3-4.
B—NS shows groups of sinusoidal tremors with very small waves connecting the groups.
- Feb. 5-8.
Stronger. B—NS shows continuous motion.
- Feb. 8-9.
Feebler.
- Feb. 9-10.
Somewhat stronger.
- Feb. 13-14.
Tremors throughout day, best recorded by B—NS as during all this period.
- Feb. 14-15.
Groups of tremors showing more plainly on NS records.
- Feb. 22-23.
Groups of sinusoidal tremors. Motion nearly continuous on B—NS.
- Feb. 23-24.
Continuous motion by B—NS.
- Feb. 24-25.
Traces nearly all day B—NS.
The amplitudes of the tremors during January and February have been small, scarcely exceeding one or two tenths of a millimeter.
- March 1-2.
B—EW a few slight tremors in latter part of day. B—NS strong irregular tremors during the last few hours. Effects are seen on W records.
- March 2-3.
B—NS small tremors all day with groups of stronger irregular waves.
- March 5-6.
B—NS lines slightly wavy all day.
- March 6-7.
Same. Slight irregularities shown by B—EW.
- March 7-8.
Very slight slow motion indicated by B—EW with a few groups of sinusoidal waves of about 0.1 mm amplitude.
- March 9-10.
B—NS small undulations in morning, gradually dying away.
- March 15-18.
Slight tremors.
- March 21-22.
B—NS microseisms beginning between 8 and 9 o'clock, quite strong for 5 or 6 hours, continue all day with diminished intensity; amplitude 0.5 mm, occasionally 0.7 mm. B—EW shows waves of 0.2 or 0.3 mm amplitude during strongest period on NS. Some evidences of action on W.
- March 28-29.
B—EW small sinusoidal waves throughout most of day. Trains seem to assist pen to record.
- March 29-30.
B—NS slight disturbances throughout the day.
- March 31-April 1.
B—NS feeble tremors particularly in first half of day.
- April 1-2.
Feeble sinusoidal microseisms on B—NS.
- April 4-7.
B—NS lines slightly wavy. Traces on W?
- April 30.
B—EW irregular waving of the pen from about 6h om to 30m; amplitude 0.1 mm \pm . B—NS same, with even smaller amplitude.
- May 9-11.
Very small sinusoidal waves.
- May 17-18.
B—EW groups of sinusoidal waves throughout the day—trains? B—NS same but weaker.
- May 18-19.
Small waves and irregularities throughout the day on B instruments.
- May 19-20.
Same, very slight.
- June 8-17.
Throughout this period there are numerous well-marked groups of sinusoidal waves of period 5 s \pm , extending over a minute or so. These may be due to trains.
- July 12.
B—NS a few irregular microseisms from 9h to about 20h.
- July 28.
B—NS slow microseisms or a feeble indefinite shock at 0h 15m. Shown on B—EW with strongest motion at 0h 11m.
- Sept. 3.
Microseismic shock from 15h 51m to 16h 12m on B—EW; from 15h 44m to 16h 17m on B—NS.
- Sept. 4-7.
B—EW irregular microseisms. Less conspicuously present on B—NS.

Sept. 14-15.
Microseisms of very small amplitude on B instruments.

Sept. 20-23.
Slow microseisms of very small amplitude on B-NS, with traces on B-EW.

Sept. 30-Oct. 1.
Some feeble irregular microseisms on B instruments.

Oct. 1-5.
W-EW shows occasional irregular disturbances.

Oct. 6-10.
B-EW a few weak microseisms.

Oct. 10-11.
B-NS shows weak disturbances similar to above.

Oct. 11-15.
Small microseisms on B instruments.

Oct. 14.
B-NS a maximum of slow waves of period $\frac{1}{2}$ m about 3h om. The waves are seen on B-EW but maximum is 8 or 10m later.

Oct. 15-16.
Weak microseisms of short period.

Oct. 16-17.
Trains seem to have an unusually strong effect. This has been noticed on other occasions.

Oct. 16.
B-NS shows slow irregular movements beginning about 15h and lasting for several hours. Less extensively recorded on B-EW.

Oct. 17-18.
B-NS lines irregularly wavy in small amplitude all day. A little of the same seen on B-EW.

Oct. 18-19.
The above dies away.

Oct. 22-23.
Sinusoidal microseisms of period 4 or 5 s and amplitude 0.1 mm are shown on B instruments, being better marked on B-EW.

Oct. 23-24.
B-EW above shown: there are larger waves (period 20 s) of amplitude 0.2 mm beginning about 8h 18m on Oct. 23, lasting for 5 or 6 m. Traces of same on B-NS.

Nov. 1-3.
B-NS and weaker on B-EW small rather irregular disturbances throughout day, which continue with about the same characteristics until Nov. 13.

Nov. 10.
Groups of waves shown as follows:

INST.	TIME			PERIOD s	AMPLITUDE mm.
	h	m	m		
B-EW	16	9 to 14		20	0.2
		16 to 20			
		20 to 27			
B-NS	18			20-25	0.15
W-EW	9 to 14			23	0.1
	15 to 27				

Only slightest trace on W-NS.

Nov. 21-22.
B instruments sinusoidal waves of short period and small amplitude, being stronger early in the day.

Nov. 22-23.
Weaker.

Nov. 23-24.
Stronger.

Nov. 24-27.
Same.

Nov. 27-28.
Fainter. Motion of trains exaggerated on B-EW showing waves 12s long.

Dec. 3-6.
Slight microseisms, being very weak on 4-5.

Dec. 5.
B-EW regular sinusoidal waves all day. Well marked group of waves of amplitude 0.3 mm beginning at 18h 29.5 m and stopping abruptly at 31.0 m.; Period of waves, 4s. B-NS irregular sinusoidal waves of 0.2 mm amplitude begin at 18h 26.4m, continuing to 30.2m after which they gradually die out. W-EW regular sinusoidal waves from 18h 29.7m to 31.1m; amplitude 0.3 mm, period 4 + s; beginning of disturbance at 18h 21.7m?

Dec. 6-12.
B instruments and W-EW show sinusoidal disturbances which are stronger on 8-9.

Dec. 12-15.
Small irregular waves on B-EW which are stronger on 12-13.

Dec. 15-27.
Sinusoidal microseisms throughout this period B-EW, B-NS, W-EW. Strongest 20-21.

Dec. 27-28.
B-NS numerous groups of regular sinusoidal waves, amplitude 0.1 to 0.4 mm, period 6s, with fainter waves connecting the groups. B-EW record imperfect but similar waves shown. W-EW similar waves, amplitude 0.2 mm, period 5s.

Dec. 28-29.
B-EW many sinusoidal waves particularly in early part of day, amplitude 0.3 mm, period 5-6s. B-NS same but weaker. Waves of smaller amplitude shown on W instruments.

ERRATA

Page 14, Column 1, Line 8: For 20".565, Read 20".656.

Other determinations are available as follows:

Urie	20".699
Lindsay	20".707
Dawson	20".634

Page 34, Last line: For May 1900, Read May 1912.

Page 41, Plate VIII: For Cillimator, Read Collimator.

Page 42, Second line of table: For 5,700 and 0.79Å, Read 4,000 and 1.12Å respectively.

NOTE ON SPECTROGRAPH DESIGN.

On page 37 of this volume, column 2, lines 39 to 42, Mr. W. H. Wright is mentioned by the author as the designer of the "Southern Mills Spectrograph"; and on page 43, column 2, lines 20 to 24, he is named as the inventor of the *type* of instrument adapted to single-prism construction at the Allegheny Observatory. These allusions to the development of the stellar spectrograph do not take into account the important work of Director W. W. Campbell of the Lick Observatory, from whose writings it is my pleasure to make the following quotations, by which any reference of mine in this connection should be superseded.

"A three-prism spectrograph, constructed in our instrument shop from my drawings, embodied the results of many conferences between Mr. Wright and myself." From *Publications of the Lick Observatory*, Vol. IX, page 6; under title, "Organization and History of the D. O. Mills Expedition to the Southern Hemisphere."

"My assistant and colleague, Wright, suggested that such an instrument should be supported *near its two ends*, like a bridge truss or beam, in order to give minimum flexure. Acting upon this suggestion I designed the supports of the spectrograph of the D. O. Mills Expedition to Chile, in 1901, as shown in the illustration. . . ." From *Stellar Motions*, Chapter II, page 47.

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