REGISTRATION OF EARTHQUAKES AT THE DETROIT OBSERVATORY DURING THE YEAR 1912

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The seismographic equipment of this observatory has been described in a previous number of this publication. The seismographs have been in constant operation during the past year, and have probably recorded all the severe earthquakes wherever occurring, besides numerous minor disturbances and microseisms. The total number of distinct shocks recorded is eighteen; of these, the most severe was that of July 7th.

There have been few changes in the adjustments of the instruments. The periods of the pendulums of the Bosch Tromometers have been adjusted so that now both have the same value, approximately 12 seconds. The Wiechert Vertical Seismograph made a feeble response to our efforts at adjustment, and has yielded two very small records,—this was in the early part of the year. Since then it has relapsed to its former state of inefficiency. The principal fault seems to be one of design; the instrument apparently lacks sensitiveness.

Microseismic disturbances have been less numerous during the year 1912, than during the preceding years. This is particularly true of the short period, or "regular" microseisms. The irregular microseisms of the type shown in Figures 3 and 4, Plate XIII of this volume, have been proportionately more frequent than in the preceding period.

As before noted all types of microseisms are more frequently recorded during the winter months than at any other time of year. The irregular microseisms have been almost invariably recorded during the coldest weather, at the times when the surface of the ground is frozen. During January and February these tremors were almost continuous, and those months were by far the coldest of the year. Similarly during a short period of cold weather in the month of December, these irregular microseisms were conspicuous on the seismograph records. One feature in connection with these tremors has been particularly noted, namely, that the strongest irregular tremors are almost invariably recorded during the early hours of the day; that is during the three or four hours after 8 a. m., at which time the sheets are changed. This seems to indicate that there is some connection between these tremors and the daily rise in the temperature resulting from the appearance of the sun above the horizon. The presence of actual sunshine does not seem to be essential, as is learned from a comparison of the record of microseisms with the meterological record. However, the daily rise in temperature takes place regardless of actual sunshine, so that the absence of this would not necessarily preclude the heating effect as a contributing cause. It seems more likely that the causes of these irregular microseisms will be found in the changes of the temperature of the air, and in the barometric pressure rather than in any change in the actual temperature of the surface of the ground. That the causes are atmospheric is supported by Klotz' investigations of the correlation between microseisms observed at Ottawa and barometric pressures over the neighboring regions. It seems safe to assume that the surface of the ground must be in a proper condition to render changes of atmospheric conditions effective. The frozen condition of the ground is probably a contributing cause, but is apparently not sufficient in itself to produce microseisms of this character, for frequently the seismograph records nothing unusual when the surface of the ground is hard frozen.

The interpretation of these particular types of disturbances recorded by the seismograph is one of great difficulty, as there are probably many factors which modify the appearance of the actual record. The problem is one of great interest, but it is one that can only be solved by cooperation, and by the comparison of records and observations made at many stations. It is hoped that the present type of seismograph will be ma-

terially improved, so that the seismogram will be a record of the actual movement of the earth particle, free from the spurious vibrations and tremors due to the swinging of the pendulum.

The data referring to the several shocks recorded and to the microseisms are given below. The manner of presenting this data, and the notation used, follow the scheme employed in the former paper with the exception that in accordance with the customs of other observatories the times of the phase "K" (end of long waves) have been omitted. All times are given in Central Standard Time, midnight to midnight; to obtain Greenwich civil time add six hours. Remarks follow, which give the nature and the peculiarities of the record of the shock.

NO.	DATE	INSTRUMENT COMPONENT	P	S	L	M	F	A	Δ
	1912		h m	h m	h m	h m	h m	m.m.	mgm.
77	Jan. 31	B—EW	14 20.0	14 26.2	14 34.3	14 34.6	15 7	18.1	5.0
		B—NS	14 19.9	14 26.1	14 34.3	14 35.0	15 12	12.0	
		W—EW	14 21.1	14 25.9	14 34.0	14 34.9	14 50	5.0	
		W—NS		14 25.3	14 33.9	14 34.3	14 48	4.0	
78	Mar. 11	B—EW		4 35.3	4 39.2	4 40.0	5 17	15.5	
		B—NS			4 38.0	4 40.0	5 16	15.1	
		W—V			4 38.8			0.2	
79	May 6	B—EW	13 9.5	13 14.2	13 24.0	13 26.1	14 7	25.1	4.7
		B—NS	13 9.4	13 14.2	13 25.0	13 27.2	14 7	36.1	
		W—EW		13 14.2	13 23.8	13 24.5	13 5	5.2	
		W—NS	13 9.5	13 14.4	13 24.9	13 25.2	13 4	6.1	
		W—V			13 24.2			0.4	
80	May 22	B—NS	20 46.5	21 12.5	21 29.1	21 35.7	22 18	6.0	
81	June 8	B—EW		0 13.0	0 16.0			1.1	
		B—NS		0 12.8	0 16.8			3.0	
82	June 8	B—EW	1 45.7	1 54.5	2 2.3	2 3.3		37.1	
		B—NS	1 50.7	1 59.8	2 2.3	2 3.7		24.2	
83	June 10	B—EW	10 12.6	10 23.0	10 32.8	10 33.1	11 14	11.1	6.5
		B—NS	10 12.5	10 23.0	10 32.6	10 32.8	11 14	14.9	
		W—EW	10 14.6	10 25.0	10 34.7	10 34.9	11 6	3.1	
		W—NS	10 14.6	10 25.0	10 34.8	10 34.9	11 5	3.2	
84	June 12	B—EW	6 49.5	6 54.3	6 57.1	6 57.4	7 16	4.0	3.1
		B—NS	6 49.3	6 54.1	7 0.1	7 1.1	7 15	4.0	
		W—EW	6 49.7	6 54.3	6 57.3		7 4	2.5	
		W—NS	6 49.5	6 54.3	6 59.8	7 1.2	7 5	1.5	
85	July 7	B—EW	3 5.9	3 12.3	3 20.0		4 15	>72.0	4.4
		B—NS	3 7.3	3 13.8	3 21.0		4 20	>71.0	
86	July 8	B—EW	16 2.7	16 9.0†	16 16.8	16 20.5	16 41	16.2	4.5
		B—NS	16 3.2	16 9.7†	16 17.8	16 20.8	16 46	15.8	
		W—EW	16 2.8	16 8.9†	16 17.6	16 18.0	16 36	19.8	
		W—NS	16 2.7	16 9.2†	16 17.3	16 20.3	16 33	14.8	
87	Aug. 8	B—EW	19 51.8	20 2.1†	20 17.3	20 20.3	20 55	10.0	8.1
		B—NS	19 51.7	20 1.1†	20 10.6	20 18.4	21 6	9.0	
		W—EW	19 51.0	20 2.2	20 17.0	20 17.2	20 55	3.8	
		W—NS	19 51.7	20 2.2	20 12.2	20 17.4	20 56	2.5	
88	Aug. 18	B—EW	15 21.4	15 23.0	15 24.9*	15 25.3	15 29	3.0	1.8
		B—NS		15 21.7	15 24.9*		15 30	1.1	
		W—EW		15 22.3*	15 24.3		15 28	4.0	
		W—NS		15 22.3*	15 24.3		15 24	1.5	
89	Sept. 10	B—EW		10 18.6	10 20.4	10 20.5	10 23	5.3	1.4
		B—NS		10 18.5	10 20.4	10 20.5	10 22	2.0	
		W—EW		10 17.5	10 19.4	10 19.5	10 21	4.4	

NO.	DATE	INSTRUMENT COMPONENT	P	S	L	M	F	A	Δ
	1912		h m	h m	h m	h m	h m	m.m.	mgn.
90	Sept. 29	B—EW			15 55.0		16 6	0.2	
		B—NS			15 56.9	15 58.3	16 7	0.5	
91	Nov. 7	B—EW	1 48.8*	1 55.5*	1 59.3*		2 52	7.8	3.7
		B—NS	1 48.7*	1 55.5	1 59.2*		2 38	7.5	
		W—EW	1 49.0*	1 55.5*	1 59.2		2 39	3.0	
		W—NS	1 49.0*	1 55.6*	1 59.3		2 38	3.0	
92	Nov. 19	B—EW		8 0.8	8 5.5*		8 29	5.5	
		B—NS		8 0.8	8 5.5*		8 28	8.5	
		W—EW		8 0.6	8 5.3		8 28	3.0	
		W—NS		8 0.6	8 5.3		8 28	4.0	
93	Dec. 7	B—EW			17 6.1*		17 14	2.0	
		B—NS			17 5.8*		17 11	1.8	
		W—EW			17 6.0*		17 13	2.3	
		W—NS			17 6.1*		17 11	1.5	
94	Dec. 9.	B—EW		2 44.6	2 51.0		3 7	5.1	4.4
		B—NS	2 38.2	2 43.6	2 52.4	2 52.6	3 8	26.0	
		W—EW	2 38.2	2 43.9	2 50.3		3 7	2.5	
		W—NS		2 44.3	2 52.3		3 7	4.0	

REMARKS

77. According to newspaper reports this shock occurred in Alaska. Agreement in distance good.

78. Preliminaries are very indistinct. Hence times are uncertain, and no estimate is made of distance. Slight record on Wiechert Vertical. No record on Wiechert Horizontal.

79. Distance is somewhat uncertain as P is not clearly marked. Two main shocks. Second follows first after an interval of three minutes. Recorded on Wiechert Vertical Siesmograph.

80. Preliminaries are very uncertain, hence no attempt is made to determine the distance. Shock consists of four groups of waves or pulses, at intervals of about 2.5 minutes. Time signals are defective on B-EW and both Wiechert records, hence these cannot be read.

81. Continuous tremors and small shocks during the previous day. See in record of microseisms.

82. This shock while quite severe is very unsatisfactory, as it is quite impossible to differentiate the phases owing to continuous tremors. The hour signals on the Wiechert record are nearly all missing. Consequently no times can be given for this instrument. B-EW time signals are very faint and uncertain. Another smaller shock followed at about 7 hrs, but all time signals are missing.

83. Distance probably not accurate.

84. Times a little uncertain owing to incomplete clock signals. Record in both instruments is so similar that it is conspicuous. Distance fairly accurate.

85. A severe shock. Recording pen swung off sheets from 3 hrs 25 min to 3 hrs 28 min. Wiechert Horizontal out of order, hence no record. Distance fairly accurate.

86. Preliminaries are not well marked, but distance seems to be accurate. Times may not be accurate as signal clock was moved to a new location during this day.

87. Distance is probably not accurate.

88. A very small disturbance, probably not far distant. Times are somewhat uncertain owing to irregularity of signal clock.

89. A very small disturbance, mainly in the EW component. Not recorded on W-NS.

90. This disturbance consists of sine curves of small amplitude. No preliminaries are visible. Only faint traces of this shock on the Wiechert record.

91. Preliminaries are well marked. Main waves consist of irregular tremors without the characteristic maximum. A second impulse fol-

lows at 2 hrs 5.5 min. Direction of movement SE-NW. Distance not accurate.

92. P is not distinguishable. A single sharp impulse at L, followed by irregular tremors of small (2-3mm) amplitude.

93. No preliminaries visible. Small irregular tremors frequent all during the day. Shock commences with a single impulse, direction NE-SW. End of tails lost in microseisms.

94. A decided shock. Movement almost entirely NS. Distance accurate.

MICROSEISMS.

1912.

Jan. 1-2.

Slight irregular tremors during the day. These show most prominently on B — E W record.

Jan. 2-3.

The same tremors are continued.

Jan. 3-4.

Strong irregular tremors on both Bosch records. Stronger in E W component until Jan. 4. 0 hrs. when the N S component becomes stronger. No traces of these tremors on the Weichert records.

Jan. 4-5.

Strong irregular tremors continued. These die out in E W component by Jan. 4, 18 hrs., but continue with only slightly diminished intensity in the N S. No traces on the Weichert record.

Jan. 5-6.

Moderately strong irregular tremors on both Bosch records. Scattered groups of short period microseisms on the N S record. No traces on Weichert record.

Jan. 6-7.

Strong irregular tremors on Bosch records during the early part of this period.

Jan. 7-8.

Tremors continued.

Jan. 8-9.

Tremors continued. But on B — E W these are much diminished after Jan. 8, 17 hrs. Nothing on Weichert records.

Jan. 9-10.

Occasional tremors during the day, but intensity is much diminished.

Jan. 12-13.

Irregular tremors. Stronger in early part of this period on E W record.

Jan. 13-14.

Moderately strong irregular tremors on B — E W, but not on B — N S. Weichert shows nothing.

Jan. 14-17.

Tremors continued. N S component increasing in strength.

Jan. 17-18.

Intensity of tremors much reduced.

Jan. 19-20.

Occasional irregular tremors of small intensity.

Jan. 20-22.

Tremors continue, gradually increasing in strength.

Jan. 29-30.

Occasional irregular tremors with short period microseisms, the latter are stronger on N S record. Faint traces on Weichert.

Feb. 1-4.

Irregular tremors during this period. These become very strong on Feb. 4.

Feb. 4-5.

Irregular tremors continue, but with diminishing intensity.

Feb. 5-8.

Continuous irregular tremors of small intensity.

Feb. 8-9.

Intensity of tremors diminishing. There have been no traces of these on the Weichert records.

Feb. 12-14.

Continuous irregular tremors, intensity diminishing towards the end of this period. Tremors are more conspicuous on E W record. No traces on Weichert.

Feb. 21-24.

Continuous irregular tremors of small intensity during this period. More conspicuous on E W record. Faint traces on Weichert.

Aug. 22-23.

Scattered groups of regular microseims on B — E W record. Traces of these on W — E W.

Sept. 16-17.

Regular microseisms of small amplitude on B — E W record.

Sept. 29-30.

Slight traces of irregular tremors on both Bosch records.

Nov. 3-4.

Faint traces of regular microseisms with very small amplitude. These show on the Weichert records.

Nov. 7.

A series of regular tremors beginning at 10 hrs. 55 min. continuing for 9 min. These commence again at 11 hrs. 42 min. and continue for 10 min. This was probably a small shock, but phases cannot be distinguished. Amplitude less than 0.5 mm. These tremors are most conspicuous on B — E W, only very slight traces on Weichert record.

Nov. 13-14.

Irregular tremors of small amplitude on B — N S.

Nov. 14-15.

Irregular tremors continue on B — N S. Supporting pier shifts during day, indicated by decided "drift" of recording pen.

Nov. 16-19.

Irregular tremors on B — N S continue.

Nov. 21-22.

Slight tremors on B — E W, these appear also on B — N S, with traces on Wiechert records.

Nov. 23-24.

Slight irregular tremors on B — N S.

Nov. 28-29.

Tremors begin at the end of this period. These are generally irregular and quite prominent on B — N S. Conspicuous on Wiechert records.

Nov. 29-30.

Tremors continue through this period, diminishing in intensity at the end.

Dec. 2-3.

Faint traces of irregular tremors on B — N S.

Dec. 6-7.

Strong irregular tremors during the early portion of this period, gradually diminishing in intensity. Conspicuous on B — N S, but not recorded on B — E W. Not recorded on Wiechert instruments.

Dec. 7-8.

Small irregular microseisms. These are more conspicuous on B — E W than on B — N S. The Wiechert records also show distinct tremors.

Dec. 9-12.

Conspicuous irregular microseisms on B — N S. These show slightly on B — E W. Intensity diminishes during latter portion of period.

Dec. 12-13.

Very strong irregular tremors on the morning of the 12th. These are strong on the B — N S record, with only traces on the B — E W. Wiechert records do not show these tremors.

Dec. 13-14.

Tremors continue, but with greatly diminished intensity.

Dec. 22-23.

Slight irregular tremors on B — N S.

Dec. 25-26.

Short period regular microseisms. These are equally prominent on both Bosch records. Traces on W — E W. Line traced by pen of Wiechert Vertical is very uneven in intensity, but no tremors.

Dec. 28-30.

Scattered short period regular microseisms on both Bosch records.

Dec 31-Jan. 1.

Scattered regular microseisms continue. Traces on Wiechert records.