No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1911		h. m. s.	s.	mm.	
		F				Lost in microseisms. No record on N damped 4:1.
176*	Dec. 23	eNS	21 22 43			Records tangled E–W and masked by microseisms.
		eL	21 26 25			
		F	21 37 41			
		eEP?	21 07 09			
		S	21 16 57			
		L	21 24 56			
		F	21 45			
176a	Dec. 23	NM	22 07 28	1-		Local shock. Ice crack; not felt by persons.
		F	22 07 30			
	1912.					
177	Jan. 4	eES	16 05 39	12		Ottawa P? 15–57–14.
		L	16 22 27	24		
		M	16 25 51	18	2	L–S, Δ 5400? miles.
		F	17 44 54			N chronograph not recording.
178	Jan. 11	NM	7 25 52			Local unfelt shock at Station. Crack in ground ice.
		F	7 25 55			
179	Jan. 11	NM	10 24 58			Local unfelt shock at Station. E gives preferred reading.
		EM	10 24 59			
		F	10 25 01			
180	Jan. 19	M	0 00 54	1–		14 secs. Local weak shock. Ice coated ground.
		F	0 00 56			
181	Jan. 19	M	1 08 15	1–		4 secs. Local shock. Ice coated ground.
		F	1 08 17			
182	Jan. 21	M	12 15 17	1–	0.5	Local shock. Ice crack.
183	Jan. 26	NM	4 21 22	1–	0.05	Local shock. Crack in ground ice. Not felt by persons.
		F	4 21 24			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
184	Jan. 26	M	4 25 16	1–	0.1	Local shock. Crack in ground ice. Not felt by persons.
		F	4 25 18			
185	Jan. 26	M	10 25 28	1	0.3	do.
		F	10 25 31			
186	Jan. 26	M	10 39 29	1	0.2	do.
		F	10 39 31			
187	Jan. 26	M	11 20 48	1	0.3	do.
		F	11 20 49			
188	Jan. 26	M	11 26 24	1	0.5	do.
		F	11 26 26			
189	Jan. 26	M	11 30 19	1		do.
		F	11 30 21			
190	Jan. 31	EL?	11 51 40	10		No record N–S by damped pendulum.
			11 52 52	13		Micros.
		M	11 53 20	10	0.5	
		L	11 55 03	15–12		
		F	11 56 54			
191	Jan. 31	eLN	20 35			
		M	20 36 56	10	14.0	Damping 4:1.
		F	21 ca			
		EP?	20 20 03			Micros.
		S	20 26 47	8		Δ 5040 kms.
			20 27 06	8		
		L	20 35 35	32		Qr. near Valdez, Alaska.
		M	20 36 40	20	34.5	
		F	21 33 22			
192	Feb. 15	e	18 41 12			
		eEL	18 44 56	15		Micros. only E–W. Damped 4:1. Not reported from Ottawa.
		F	18 48			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
193	Feb. 19	EL	23 00 56	17		Micros. only N–S.
		e	23 01 02	4		Damped 4:1.
		L	23 01 06	15		Ottawa e? 23–09–27.
		F	23 11 27			
194	Feb. 22	EL	7 38 29	15–20		QQr. Costa Rica ca. this time.
			7 47 24	20		
		e	7 55 14	11		
		F	7 55 54			
195	Feb. 22	e	8 43 30			
		eE	8 46 45	24–13		Possibly connected with preceding. L interval 1h. 04m. as if set off by S of 194 reflected to epicentre.
		F	8 51 36			
196	Mar. 11	eNS	10 35 44	8		P masked by micro-seisms.
		L	10 38 31	18		LE–SN: 2m. 39s.: Δ
		M	10 38 47	17	3.0	1800 kms? (Laska).
		F	11 04 28			F in micros.
		eE	10 33 39			P masked by micro-seisms.
		eS?	10 38 04			
		L	10 38 23			Pendulum undamped.
		M	10 38 46		9.5	Cf. Batavia e 10–12.
		F	11 13 50			Ottawa P 10–30–13.
197	Mar. 11	eEL?	19 09 58	20		No record N–S on damped pendulum.
		F?	19 12 28			
198	Mar. 11	eES?	19 47 04?			Micros. 4s. pd. N–S. only.
		L	19 59 10	20		Micros. superposed.
		F	20 16			F later?
199	Mar. 29	EL?	16 10 53	19		Among long period waves from 14h. 45m. to 20h. 20m. No record on N–S damped pendulum.
		L?	16 17 04	20		

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
200	Apr. 2	eEL?	0 46 51	25–18		Microseisms N–S.
		(F)	0 47 43			
		eL?	0 55 17	17		
		F?	0 56 01			Among waves 30–50s. period.
		L?	0 58 15	19–28		
		F	0 59 31			Not reported elsewhere.
200a	Apr. 13	eEL	19 04 18?	16–17		Undamped pendulum, per 22s.
		L	19 07 08?	22–24		
		F?	19 36 20			
200b	Apr. 14	eEP?	13 40 43	4		
		eL	13 56	13–14		
		F	14 20			
200c	Apr. 14	eEL	23 38 11	20		
		F	23 54 42			
201	Apr. 15	eES?	16 51 27	12		No record N–S by damped pendulum.
		e	16 53 40	12		
		eL	17 09 29	20–24	0.1	
		F	17 16 22			
202	Apr. 17	iNP	3 57 09	2–3		S–P, 6m. 33s. Δ 4830 kms.
		S	4 03 42	6–8		
		eL?	4 08 12	14–20		
		F	4 30			
		eEP	3 57 10	2–3		
		e	4 02 55	11		
		S	4 03 54	11		
		L	4 08 54	20–26	0.38	
		F	4 45			
203*	Apr. 20	eEL	2 34 11	20–24		Not shown N–S by damped pendulum. Ottawa e 2–31.
		F	2 53			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
204	May 6	NP	19 07 07	4		S–P, 5m. 40s. Δ 3870 kms. 2400 mi.
		S	19 12 48	8		O in southern Iceland.
		EP	19 07 09?			
		S	19 12 47	11		TO = 19–00–37.
		eL	19 16 55			Strassburg reports P
		M	19 20 20	16–19	36.5	19–04–42 Qf. in southern Iceland.
		F	20 43 43			Record partly masked by jars from heavy traffic.
205	May 6	eEL	23 27 08	22–24		One of several short
			23 34 20	24–28		groups of LL among
		F	23 36 23			longer irregular waves on May 6th to 12th. Not reported elsewhere.
206	May 16	eEP?	15 01 10			
		e	15 02 35	3		
		S	15 03 21	12		L–S, 7m. 6s., Δ 5600
		eL	15 10 27	22		kms.?
		F	15 13			N component out of commission for repairs from May 18, 21h. to 21h. 45m. E component out of commission for repairs May 18 from 21h. 45m. to 22h. 45m.
206a	May 21	eE	9 55 34			
		eL	9 20 59			
			9 34 52			
		F	10 36 30			
207*	May 23	eEP?	2 44 05	16		P masked by microseisms.
		S	2 51 34	8		Undamped pendulum; per 25s.
		eS?	2 59 17	15		
			3 03 3	16		N record faint; both
		eL?	3 06 15	28		obscure.
			3 10 27	20		

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h m. s.	s.	mm.	
			3 11 36	67		Record evidently of Q in Burma: Athens P 2–34–48.
			3 15 18	32		
			3 18 26	25		
		M1	3 22 34	31	22.5	
		M2	3 24 45	25	28.0	
		M3	3 29 09	22	27.0	
		F	4 50			
208	May 25	eN	16 29 42			Not recognized E–W. Not reported elsewhere.
		eL	16 37 42	22		
		F	16 45 52			
209	May 28	eNL	13 41	20		Ithaca, N. Y. eL 13–36.
		F	13 48 11			
		eEL	13 42 29	24–22		
		F	13 57 06			
210	June 3	eN	12 39 29			Strassburg P 12–45–18.
		eL	13 08 01		0.5	
		F	13 45			
		eE	12 39 53			
		eS?	12 55 40	15		
		eL	13 07 01	22–20	0.5	13h. 21m. changed record.
211	June 7	eE	4 05 53	9–10		
		F	4 13 37			
212	June 7	eE	5 01 14	17		
			5 03 57	10–8		
			5 05 08			
		F	5 18 41			
213	June 7	eE	7 42 02			
		eL	7 45 27	20		
		F	7 51			
213a*	June 7	Ee	8 28			
		F	8 50			
214	June 7	Ee	9 12 43	8		Ottawa M 9–23.
		L?	9 20 08	10–8		

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
			9 28 09	10		
		F	9 45 30			
215	June 7	P	10 04 29			O, Alaska. S–P, 7 m. 16s., Δ 5620 kms.
		S	10 11 26			TO 9h. 55m. 08s.
		L	10 23			F in next record.
		F?				L 1h. 02m. 52s. after L of 214 as if set off by S. of 214 reflected to epicentre.
216	June 7	eE	11 02			
		F?	12			Appears to merge into next group of waves.
217*	June 7	eES?	12 41 37			
		S	12 51 16	9		
			12 55 18	10	0.37	
		L	13 26 40	20		
		M	13 28 20	18	2.8	
		M	13 31 45	17	2.2	
		M	13 37 35	20	2.5	
		F	14 01			
218*	June 7	eE	18 49 17			
		S?	18 52 57			
		M	18 53 50			
		F	19 12			
219	June 8	eEP	7 44 44			S–P: 7m. 25s.; Δ 5790 kms.
		S	7 52 09			TO 7h. 35m. 40s.
		L	8 02 01			
		M	8 03 15			
			32			
		F?				F in next group of waves.
220	June 8	e	9 13 22			
		L?	9 16 36			
		M	9 18 31			
		F	9 18 43			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
221	June 8	e	10 26 05			Interval of 1h. 12m. after 220.
		L	10 30 07			
		F	10 34 30			
222	June 8	e	10 54 30			e at 33m. 20s. after e of 221.
		S?	10 59 25	8		Reflected P of 221 at epicentre?
		F	10 25 51			
223	June 9	eN	17 41 58			e = L?
		L?	17 46 56	16		
		C	17 48 01			
		F	18 03 31			
224	June 9	eN	22 05 22			Ottawa M 22–04.
		F	22 13 28			
225	June 9	eN	22 37			Ottawa M 22–39.
		F	23 10			
226	June 10	eNP	16 15 24			S–P: 7m. 29s.; Δ 5850 kms. or 3650 mi.
		S	16 22 53	10		Time at origin 16h. 06m.
		L	16 32 46	18		
			16 33 19	16		
		M	16 39 07	16	17.7	
		F	17 57			
227	June 12	eNL?	7 30 13	30		
		e	7 31 41			
		L?	7 35 51	13		
		F	7 49 13			
228	June 12	iNP	12 49 56	3		S–P, 5m. 17s.; Δ 3500 kms. (2175 mi.).
		R_1P?	12 50 57			T at origin 12h. 45m. 35s.
		S	12 55 13			
		eL	12 59 41			
		M	13 02 56	22	2.2	
		F	14 15			
229	June 15	eN	17 34 48			
		L	17 38 37	20		
		F	17 46 58			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
230	June 15	eL	18 50 41	20		
		F	19 01 40			
231	June 17	eN	11 39 58			P and S uncertain.
		eS?	11 49 15	28		
		L	11 51 33	20		
		M?	11 58 28	15	0.5	
		F	12 30			
		EP?	11 34 36			
		S?	11 43 22	9		
		L	11 51 42	20		
		M?	11 57 58		0.5	
		F	12 29 28			
232	June 18	eN?				
		S	12 17 01			
		L	12 34 42	20		
			12 44 32	20		
		eE				
		S	12 16 50			
		L	12 34 42			
			12 44 32			
		F?	14 30			
—	June 20	N				Long period irregular waves from ca 13h. to 16h. 15m.
233	June 28	eN	19 02 43			Irregular motion N–S from ca 13h. June 28 to ca 0h June 29. Microseisms E–W.
		F	19 10 09	8;15		
234	June 29	eNP	8 02 21	3–4		
		S	8 11 24			
		eL	8 25 53			eLE–SN, 12m. 36s., Δ 8000 kms.
			8 26 48	20		
		F?	9 10			
		ES	8 11 09			
		L?	8 23 45			
		F?	8 30			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
235	July 7	NP	8 06 27	3, 4		i Throw of pendulum N.
		S	8 13 29			S–P, 7m. 02s.; 5375
		eL	8 19 43	48		kms.
		M	8 23 13		75	Stylus went off drum
		iEP	8 06 23	4		and no further record.
		S	8 13 26			
		L	8 19 57	50		S-P, 7m. 03s.; 5390 kms.
		M	8 23 13	22	75	Stylus off drum.
			20 08			Stylus on again.
			31 42			Stylus off again.
			32 48			Stylus on again.
		C	35 02			Alaskan earthquake.
		F	10 13			TO, 7h. 57m. 26s.
236	July 7	eNP	22 51 10			
		S	23 03 02	8		
		L	23 08 11	13		
		F	23 22 28			
237	July 8	eN	3 34 58	3		
		F	3 40 31			
238	July 8	NP	22 02 32			S–P, 7m. 18s.; 5665 kms.
		S	22 09 50	8		
		L	22 18 19	15		Qr. Alaska.
		M	22 18 35		24	
		F	23 30 21			
		EP	22 02 34			
		S	22 09 44			
		L	22 19 16		31	
		M	22 18 31	15		
		F	23 02 10			
238a	July 9	eNL	9 13 39			Just visible; not shown
		F	9 21			E–W. Ottawa eL 9–11.3.
239	July 9	eN	17 05 34	3–4		
			07 52	8–10		
		F?	08 19			
240	July 11	NL	19 08 40	8–12		
		F	19 29 00			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
240a	July 22	eN	23 49 01			Masked by microseisms
			23 49 31	11		
			51 14	8		Micros. only E–W, pds. 3–4s.
		F	57 23			
241	July 24	NP	12 07 51	4–5		S–P, 6m. 50s.; Δ, 5150 kms.
		S	12 14 41	12		
		L	12 19 51	13		Qr. Piura, Peru.
		F	13 10 ca			
		eEP	12 08 11			
		S	12 14 45	8		
		L	12 19 51	16		
		F?	12 45 ca			
242	July 25	NP?	23 28 13			
	July 26	L	0 08 12			
		F	1 04 05			
243	July 26	NP?	3 09 22			
		L	3 33	20		
		F	4 ca			
244	July 30	e?				
		eL	21 55 02	20		Ill-defined LL preceded by irregular waves.
			22 44 19			
		F	23 19 40			
245*	July 31	eN?	9 51 19			Ottawa e9–51–36.
		L	10 00 19			
		F	10 01 52			

The above list where it varies from the monthly mimeographed bulletins issued from the Station is marked by an (*) asterisk, indicating some revision or correction of phase or time, made possible by comparison with the records from other stations or a rereading of the seismogram.

It will be observed in the column of Remarks that the epicentres of a few earthquakes only are determined. A more extensive list of exchanges with foreign stations would in part afford the data for such determinations, but in the case of the later records such information would not ordinarily be available until after the lapse of several months. Dr. Klotz of Ottawa is cited as authority for the location of several epicentres. The epicentres of important earthquakes are published by the International Commission, but this catalogue does not appear until four years or more after the annual report of an observatory should go to press.

The following notes supplement last year's records.

No. 126. Feb. 18, 1911. Epicentre located by Klotz in L. 41° 24′ N; L. 74° E.

No. 130. Mar. 11, 1911: agrees well with earthquake reported at Varzin, New Guinea (Vd. Monat. Uebersicht. für Marz).

No. 132. Mar. 20, 1911: appears to be record of earthquake at Marmaras-Sziget, Hungary (Vd. Monat. Uebersicht).

No. 136. Apr. 28, 1911, is put by Klotz in L. 0° 58′ N (?); L. 53° 20′ (?).

No. 143. June 15, 1911, has been placed in the Riu-Kiu Ids., Japan.

No. 145. July 1, 1911, is referred by Klotz to L. 33° 20′ N; L. 144° 50′ W. in California.

No. 146, July 4, 1911, a Turkestan earthquake, is laid by Klotz in L. 42° 58′ N; L. 75° 50′ E.

The use of the Lambert's projection drawn over a Mercator map of the world described in last year's report has been employed in the office, where data were available, for the location of epicentres. Mr. Winthrop P. Haynes, Assistant in Geology, prepared such projections for Strassburg, Ottawa, Batavia, Seattle, and redrew that for Cambridge. This method, which is confessedly approximate and designedly expeditious, requires but three or four minutes to indicate the approximate position of the epicentre and serves to show whether the elements for distance furnished by the several stations accord closely enough to warrant the labor of more refined methods of fixing the epicentre. With good records this method shows the latitude and longitude of the epicentre with an error of one or two degrees of latitude and longitude at great distances (10,000 kms. or 6,200 miles). Unfortunately the data from the three stations required to determine epicentres have not been available among our exchanges to apply the scheme for more than a few instances during the year. The following example worked out for the Turkestan earthquake of January 1, 1911, shows the position of the epicentre as determined by the approximate Lambert projection method and the more precise but somewhat more laborious graphical method invented by Dr. Klotz of Ottawa.

By Lambert's projection	L. 43° 36′ N.	L. 76° 24′ E.
By Klotz's graphic method	L. 43° 40′ N.	L. 78° 20′ E.
Difference	L. 0° 4′	L. 1° 56′

A comparison with Prince Gallatzin's determination of the same epicentre gives the following:

By Prince Gallatzin	L. 42° 59′ N.	L. 78° 00′ E.
By Lambert's projection	L. 43° 36′ N.	L. 76° 24′ E.
Difference	L. 0° 47′	L. 1° 36′

The difference in position as determined by Dr. Klotz and Prince Gallatzin is —

Position by Dr. Klotz	L. 43° 40′ N.	L. 78° 20′ E.
" " Prince Gallatzin	L. 42° 59′ N.	L. 78° 00′ E.
Difference	L. 0° 41′	L. 0° 20′

The differences in these respective comparisons are to be looked for in (1) discrepancies in the data employed for estimating the distance to the epicentre, since the data are from different groups of stations in each case: (2) errors in projection incidental to the graphic method; (3) the geodetic uncertainty as to measurements of distance on the surface of the geoid on different great circles.

The Lambert projection is weak in the second of these respects. The above determinations of the epicentre by it are subject to two refinements:— 1, a more accurate drawing of the curves of distance from the recording station upon the mercator map; 2, the use of a larger scale with a consequent closer intersection of the curves from the stations employed in determining the epicentre.

Dr. Klotz of the Dominion Astronomical Observatory at Ottawa has prepared a set of stereographic projection tables for determining epicentres in accordance with the method invented by him. These tables include the constants for this station. See Journal of the Royal Astronomical Society of Canada, May–June, 1911, p. 209.

Local or New England earthquakes. The daily press reported a slight earth tremor felt in Calais, Maine, at 7 a. m., Eastern Standard Time, on March 20, 1912. Not recorded at this Station.

Except for certain local unfelt shocks regarded as due to frost cracks during midwinter, no local shocks were recorded during the year; or, if they are shown on the records, they have been taken to be the effect of local traffic jars.

The earthquake of March 21, 1894, which was felt in Cambridge and in the region thence to the epicentre in Nova Scotia has been described by Prof. H. F. Reid in the Bulletin of the Seismological Society of America, 1911, **1**, p. 44–47, with isoseismal map.

Frost crack jars:— The unusual number of small local shocks in the list, referred to frost cracks, during the months of January and February, 1912, were so far as I am aware unfelt, though they were distinctly recorded on both components of the seismograph, invariably setting out with a sharp maximum of motion which quickly died down. In several instances the exact second of beginning of motion on one of the components was obscured by the quaquaversal oscillation of the stylus, the component being thrust to and fro in the direction of its horizontal axis as well as registering its proper lateral motion. These shocks came at times when the ground was largely covered by a sheet of ice resulting from the thawing and freezing of old snow, and during very cold nights. The night watchman reported booming noises in the courtyard surrounding the Station but none of the sounds noticed by him agreed in time with the shocks listed. Several extended wandering cracks in the frozen ground were at the time traceable on Divinity Avenue and in neighboring portions of the University grounds.

Powder explosion:— On Friday, May 24, 1912, there was a powder mill explosion at Acton, Mass., 17.5 miles (28.18 kms.) from the Station, recorded on the seismograph at 6h. 52m. 54s. P. M., (75th meridian time west). The vibrations lasted 4 secs. on the E–W component, whose steady mass was thrown relatively to the west or towards the origin of the disturbance as if the ground were thrust away from the origin. The exact time of the explosion could not be ascertained by correspondence with the officers of the company, so that nothing has been ascertained concerning the speed of propagation of the shock.

Lacunae in the records:— The north component was out of commission for repairs from 21h. to 21h. 45m. on May 18, 1912, and the east component was dismantled on the same day from 21h. 46m. to 22h. 45m. Again in June, 1912, the north component was out of commission for repairs on the regulator from 13h. 14m. on the 6th to 20h. on the 8th: the east component was not in use for the same reason from 15h. on the 10th to 2h. 35m. on the 14th, G. M. T., midnight to midnight.

NUMBER OF EARTHQUAKES RECORDED SINCE JAN. 1, 1910.

Year.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1910	5	2	5	5	12	9	8	4	10	3	11	12
1911	8	11	3	5	6	6	3	2	8	7	8	5
1912	3	4	4	7	7	25	13	—	—	—	—	—

The above table includes only the records of distant quakes or felt local shocks. With regard to the general character of the records made out during the year, they may be classified with reference to the phases (P, S, L, M) which they clearly exhibit as follows: PSLM 20%. PSL, 14%. PS, 1%. PL, 4%. SLM, 2%. SL, eL, 10%. LM, 1%. L, 29%. eF, 10%. Local (frost crack) records, 9%. The failure to recognize P, S, and possibly M in certain records has been due to microseisms and other local disturbances. The eF records are short disturbances of no regular period and are not well understood, though their seismic nature is frequently shown by their appearance at other stations at some distance, as at Ottawa and Ithaca, N. Y. If we combine those records containing the beginnings of P, S, and L and consider them good, only about 34% of the records for the year are entitled to this description. Eliminating the frost cracks from the count, this number becomes 37% of the total readings.

The reexamination of the records in the light of a knowledge of the times of occurrence of every earthquake registered at other stations would undoubtedly lead to the identification of scores of "irregular" vibrations, and "thickenings of the line" with the passage through Cambridge of one or another of the several phases of distant shocks.

Additions and alterations in equipment:— Through the generosity of Mr. Edward Wigglesworth funds were provided during the year for the purchase of a Wiechert seismographic clock, manufactured by Spindler and Hoyer of Göttingen. The electric contacts of this clock are on the outer face of the dial where they may be readily adjusted. The minute contact lasts one second; and the hour contact, adjustable to several seconds, is conveniently made to take 8 or 11 seconds as desired. So far, the contacts have worked perfectly. This clock is used as the standard station clock, while the old clock, whose electric contact for minutes is not reliable, is kept running and ready to be switched into service when needed.

The piano wire turnkey attachments of the guy wires of the booms of the pendulums of the tromometer, which were loosened in 1908 in overhauling the instrument and which could not since then be made to hold the wires taut, were replaced during the year by turn buckles of bronze and nickle-steel permitting a permanent adjustment of the attachment to any desired tension. A new set of indicators and styluses were purchased of Bosch Bros. to replace the original levers which had become deranged by accidents incident to the daily setting up of the instrument. It was discovered that the yoke of the north-south component had been placed upon the pier in a reversed position, preventing the lengthening of the boom to the full magnification of 100 or more times. This error should be corrected; but to do so will require the breaking down of the small concrete tablet on which the yoke stands and the construction of a new one.

Damping the tromometer: — As stated by the manufacturers, the 100 kg. tromometer works best when adjusted to a period of 25 seconds. So far the attempt to damp the east-west component with the air damping device has failed to produce the desired results. The pendulum fails to respond to seismic vibrations when the damper is attached. The period of the pendulum was reduced to 12 seconds with no better results. Better results have been obtained in the attempt to damp the north-south component. With the heavy diurnal tilt at this Station whereby the pendulums are thrown first to one side and then to other of the zero line, the horizontal pendulum is most of the time pulling or pushing the damper in such a manner as evidently to interfere with the free registration of the amplitude of motion of the instrument when actuated by seismic waves.

Setting the time tickers: — The inherent difficulty in the Bosch-Omori tromometer of setting the time tickers on the drum so as to give an interval of 60 seconds (15 mm.) between the minute mark and the stylus at the minute interval has, during the year, been successfully dealt with by swinging the stylus across the line of ticks and depressing the ticker at the instant of transit. Any variation in the space thus marked off from 60 seconds is measured in terms of seconds and applied to that record sheet as a correction for time. It is sufficient to blow against the clevis holding the stylus to produce the desired motion of the indicator.

In passing from this statement of the condition of the Station, it should be stated that many seismological observatories in this country are now equipped with two or more types of seismographs for recording horizontal motion and that in the vertical; and that the International Bureau recommends that every recording station should be provided with at least two types of seismograph. At present we have one instrument and this requires improvement as regards the damping device since at present our records are defective in not giving amplitudes free from resonance in the pendulums. This particular disqualification can probably be remedied through the purchase of an electric damping device to replace the air dampers now in part use.

Microseisms:— The microseisms of November 25, 1911, were particularly well defined and regular. During the maximum, these vibrations attained a period of six seconds. According to press reports, a furious gale prevailed over the coast of Newfoundland at the time of maximum microseismic vibration at this Station.

Macroseisms of irregular period: — During certain morning hours one or both components of the undamped pendulums have given more or less interlaced records having no regular but usually long periods ranging up to one minute, and this at times when no local winds were blowing, though such may have been the case over Massachusetts Bay. At times this motion has assumed a sinusoidal character indicating the passage of long or Rayleigh waves from a distant earthquake also registered at other stations. It has been assumed that such irregular disturbances were due to local causes of a nonseismic nature, and no account has been taken of them.

Diurnal wave: — During the month of July, 1912, both components of the seismograph were allowed to swing without damping, thus giving a good record of the "diurnal wave." The plotting of the departure of the stylus from the zero line (line of ticks on the seismogram) for each hour brought out the occurrence of a tilt from north-east to south-west and *vice versa*. The tilt towards the southwest sets in about 1 P. M. and attains its maximum about 7 A. M., when the tilt to the northeast begins and continues until about 1 P. M. This diurnal wave is superposed upon a longer period swinging of the pendulums corresponding with the passage of highs and lows of barometric pressure. These graphs are useful in determining the time of day at which the pendulums cross their respective mean positions and thus the hour at which they should be brought to the zero line if they have become placed too much to one side or the other. At this Station for July these hours would appear to be about 8.30 A. M. for the north-south component, and about 9 A. M. for the east-west component. As, however, the passage of highs and lows, cause the pendulums to wander across the theoretical zero line after an interval of several days, such adjustments should be made only when the pendulums are crossing the line in one of their long period phases. If the theory be correct that "lows" cause a broad doming up of the earth and "highs" a corresponding saucer-shaped depression, such adjustments should only be made at times when the centre of a high or low is over the station, for then only would the pier be level and a proper adjustment to the vertical be made, so as to secure a balanced elongation of the long period swing about the zero lines of the two rectangular components.

Earthquake investigations: — Seismology is a subject calling for the special knowledge of the physicist, the meteorologist, the astronomer, and the geologist, and each of these specialists best promotes the science by applying his talents to the development of his phase of the problems which earthquakes present. The study of the seismographic records of distant earthquakes concerns the physicist. The examination of the epicentral tract of an earthquake affords the geologist his opportunity for contributing to the subject as does also the survey of the geological structure of a region with reference to the occurrence and distribution of faults and rock areas liable to affect the intensity of shocks at the surface of the earth. The fact abundantly illustrated in the San Francisco earthquake of 1906 that a fault zone of geologically recent date may at any time undergo renewed motion giving rise to an earthquake makes it desirable in the interests of humanity to locate on maps such lines of danger and point out their existence for the avoidance of unnecessary risks such as arise from ignorance in the choice of location of important public works or private buildings.

Although Boston and vicinity experienced in colonial times earthquakes strong enough to throw down chimneys and the end walls of brick buildings, no evidence has been found to show that the seismic motion arose from an initial motion of the rocks along any one of the numerous faults and thrust-planes now known to intersect the region. Nevertheless, it seems to be desirable to construct a map of the Metropolitan District portraying the character of the ground with reference to its seismicity or liability to damage in case of earthquake motion. With this end in view some of the research work of advanced students in the Department of Geology has been turned to account. Mr. W. G. Foye was occupied in the fall of 1912 in mapping and studying the fault along the northern border of the Boston basin. The project involves plotting all the faults in the district, classified with reference to their relative geological age, direction of the movements upon them, and with regard to their visible and inferred extension. Upon the same map the superficial deposits having various degrees of stability, such as the glacial deposits and the areas of made-ground bordering the harbor and the Back Bay section of Boston and Cambridge, may be delineated.

The importance of engineers and architects taking into account the liability of earthquake shock strong enough to damage buildings in this district is amply shown by the history of earthquakes at Plymouth, Newburyport, and Boston in the 17th and 18th centuries. There can be little doubt that the recurrence of such shocks as were felt in Boston in 1755 would produce much damage. While the Atlantic coast of the continent is relatively immune from earthquakes, the case of Charleston in 1886 enforces attention upon the necessity of recognizing the risk of destructive shocks upon this coast at long intervals perhaps of a few centuries only. Sane precaution demands the avoidance of the mistake made at San Francisco of placing a public reservoir upon a fault zone of recent movement, and of the folly of cheap mortar and rubbly masonry which together were factors of first importance in the loss of life and property in Charleston in 1886, and in Messina in 1908. We may not be able to avoid building our houses and public edifices upon ground liable to destructive shocks, but we have abundant information as to how these structures should be built in order to reduce the risks of demolition to a minimum.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVII., XXXVIII., and XLI.

Vols. LIII. to LVII. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXVI., XXXIX., XL., XLII. to XLVIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
A. AGASSIZ and C. O. WHITMAN. Pelagic Fishes. Part II., with 14 Plates.
H. L. CLARK. The "Albatross" Hawaiian Echini.
S. GARMAN. The Plagiostomes.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
" The Thalassicolae.
O CARLGREN. The Actinarians.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
" The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
—— The Annelids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
J. M. FLINT. The Foraminifera and Radiolaria.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
H. LUDWIG. The Starfishes and Ophiurans.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
RICHARD RATHBUN. The Hydrocorallidae.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.
—— The Annelids.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LV. No. 3.

GEOLOGICAL SERIES. Vol. IX, No. 3.

HARVARD SEISMOGRAPHIC STATION. FIFTH ANNUAL REPORT INCLUDING RECORDS, 1 AUGUST, 1912 – 31 DECEMBER, 1913.

By J. B. Woodworth.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

October, 1914.

No. 3.— *Harvard Seismographic Station. Fifth Annual Report, including records from 1 August, 1912 to 31 December, 1913, G. M. T.*

By J. B. Woodworth.

These records are a continuation of the list given in Bull. M. C. Z. **55**, p. 22–52. The constants of the Station are as follows:—

Latitude 42° 22′ 36″ N. Longitude 71° 06′ 59″ W. Altitude 5.36 M.
Subsoil: — Glacial sand over clay.
Time: — Mean Greenwich, midnight to midnight. Eye and ear comparison with Harvard Observatory through telephone.
Instruments: — Two Bosch-Omori 100 kg. horizontal pendulums, with mechanical registration.
Nomenclature: — Göttingen.

In the column of Remarks the following peculiar abbreviations are employed:— Q, Earthquake; Qf., felt earthquake; Ql., local earthquake; Qr., earthquake reported by press: O, origin, or epicentre, or time at origin when followed by time calculated by Benndorf's table. Distance in kms. indicates distance from Cambridge to origin calculated from Zeppelin and Zeissig's tables for S–P. Micros., Microseisms masked the phases.

Constants of the Instruments.	*N–S.*	*E–W.*
	secs.	secs.
Period:	25	23
Magnification	50	80
Damping	4: 1	0.

This report covers the period of a year and a half, bringing the data to the end of 1913. This has been done in order to publish the seismic registrations for a calendar year in a single list instead of dividing the matter as heretofore into lists corresponding with the fiscal year of the Museum of Comparative Zoölogy (1 August–July 31).

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
246	Aug. 2	NeL	20 25 30?	15–20		Doubtful record. Not reported from other Stations.
		F	20 41 30			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
247	Aug. 6	Ne?				
		eL?	21 40 00	15		Cf. Strassburg e 21–30–20. Near New Hebrides.
		F	23 09			
248	9	N P	1 40 16	3		Qf in the Dardenelles, European Turkey. O 1h–29–13. 7765 kms.
		S	1 49 24	10–8		
		eL	2 00 05	35		
		M	2 06 40		19.5	
			11 48		12.5	
			13 07		14.0	
		F	4 45			
*249	17	EeP	19 32 21			SE–PN, 9m 20s, 8000 kms. Several groups of LL gradually increasing to maximum. E–W component restrained by faulty adjustment. Q Eastern Mindinao, Philippines.
		N	19 33 20	3		
			19 38 29	8		
		eS?	19 41 41	11		
		L	20 18 35	33		
			20 19 26	35		
		F	22 09 30			
*250	18	Ne	21 25 08	3		
		L?	21 29 51	8		Qr near Williams Arizona, from 2:05 to 2:10 p. m. in 105th M. W. time. Jena O, 21h–9m–26s.
		F	21 44			
		EeP	21 26 41	3		
		L?	21 29 25	8		
251	21	Ne?				
		eL	18 36 17	28		Irregular motion preceded record. Cf. Batavia & Parc St. Maur. In Borneo (Jena).
		F?	19 07 40			
252	23	Ne?				
		L	14 53 21	20–24		Qr Peshawar, N. W. India. Cf. Strassburg P. 14–14–18.
		F	15 53			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
253	Aug. 31	N L	23 04	13–17		No trace E–W. Cf. Strassburg P 22–35.5. O in Kamtschatka (Graz).
		F	23 29			Cf. Guadalajara, Mex. N. B. The Seismograph of this Station was out of commission from Sunday, Aug. 25th ca 15hrs. G. M. T. to Monday, Aug. 26th, 13h. 38m. G. M. T.
254	Sept. 1	NeS?	4 43	8		Ottawa P 4–34–26; 54. (O = 4–27–31).
		L?	4 46	20		E–W: short group of LL only.
		F	5 14			Batavia reported Q distant 4510 kms P 4–17–14. Samoa (Jena).
255	3	Ne	18 35 36	6–8		Like microseisms.
		F	18 40 50			Ottawa e 18–33–09.
		Ee	18 35 22	5–7		Ithaca-Cornell e 18–33–30.
		F?	18 40 37			
255a	10	Ne?	16 20 06	3		Records begin and end in microseisms. Cf. Ottawa.
		F?	16 23 32			
		Ee?	16 19 43	3–4		
			16 20 18	6		
		L?	16 22 51	12		
		F?	16 31 24			
256	13	NeP?	23 42 13	4		eLE–ePN? 7,800 kms.
	14	eL?	0 05 34	24		Qr Rodosto, Vilayet of Adrianople.
		F?	0 25			
	13	EeP?	23 42 21	4	0.3	N damped 3:1.
	14	eL	0 03 30	20		E damped 0.
		F	8 ca			

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
257	Sept. 20	Ee?	21 48 43	3–6		e in micros. Ottawa
			21 52 47	10		e 21–41–11. Tacabayu
		F?	22 57 57	6		P 21–11–48; F. in micros.
*258	29	Ne?	21 40 35			e–F in micros 3–4s pd.
		eL?	21 50 35	22		Qf Mariana Ids. Pacific
		F	22 33 15			Ocean. 13,300 kms. from Cambridge.
		EeP?	21 10 20	3		
		eS?	21 28 35	7		Ottawa S, 21–21–18.
		eL?	21 48 13	30		
			21 50 17	24		
		F	22 54			
259	Oct. 12	Ne?L	15 57			16–02 to 16–08– changing record.
		F	16 35			
		E				Microseisms.
		e?L	16 03	18		15–55 to 16–02 changing record.
		F	16 38			Ottawa P 15–40–26. Qf Aleutian Ids.
260	Oct. 18	NeL	12 30 03	25–20		Qf Aleutian Ids.
		F	12 54 41			
		EeS	12 21 40	6		
		L	12 29 09	18		Distance 5850 kms.
		M	12 31 19			
		F	13 25 ?			
261	31	Ee	12 27 17	6–12		Strassburg P 12–20.9.
		eL	12 32 35	16		
		F	12. 55 15			O, Azores.
262	31	EeL	18 21 00			Qf Philippine Ids.
		F?	19 21			Irregular pulsations for several hours before and after.

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
263	Nov. 7	N P	7 49 23	2–3		Cf. Qr. Seward, Alaska 10 P. M.
		S	7 56 43	6		
		eL?	8 08 19	15		
		M	8 08 44	16	1.3	Damped 4:1.
		F?	3 15			
		E P	7 49 23	3		Distance 5700 kms.
		S	7 56 53	6		
		L?	8 08 02	22		
		M	8 08 26	20		Undamped pendulum.
		F	9 27 ca			
264	7	Ne?				L_N–$eS?_E$ = 5m 1s = 4700 kms?
		L	17 02 41			
		F?				Vd. Ottawa.
		EeS?	16 56 50			
		eL	17 04 45			
265	7	NeL	17 46 36			Damped 4:1.
		EeL	17 48 24	27		Undamped.
		M	17 51		15.6	Vd. Ottawa.
265a	17	NeS?	11 49 47			Damped 4:1 and so in December.
		eL?	11 52 35	20		
		L	11 52 59			
		F	11 57 37			
		EeS	11 45 29			Undamped and so in December.
		eL	11 52 45	20		
		F	12 14 29			Distance 5300? kms.
*266	19	EeP?	13 58 25	3		eS?–eP? equals 6m equals 4225 kms. Qr at Acambay, Mexico.
		eS?	13 06 25	6		
		eL?	13 10 35	40		N–S micros only.
		F?	14 18			O 13h 52m.
267	Nov. 27	NeS?	9 37 27			Micros.
		EiS	9 37 13	12	0.5	i throw to W.
		eL?	9 38 28	13		
		F	9 49 47			
*268	Dec. 5	NeS	12 43 53	4		Qf Alaska.

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
		L	12 51 15	10		
		eL?	12 56 08	6–7		
		F?	13 28			F lost? Began to change records 13–28–13.
		EeP?	12 36 14	4–2		Micros?
		eS	12 42 32			
		eL	12 48 10	10		Dist. 4560? kms.
		L	12 58 38	16		F lost.
269	Dec. 5	Ee?	15 00 32			N–S faint. Irregular periods before and after. Wind effect? No reports.
		EL	15 01 37			
		F?	15 07 04			
270	5	NeL	18 07 19	18		Cf. Ottawa P ? 17–59–09.
			18 07 37	16		
		F	18 17 05			
		EeS?	18 04 22			
		eL	18 07 17	20–15		
			18 07 33	14		
		F	18 23 ca			
271	7	NeP	22 57 04			Dist. 6450 kms.
		iS	23 05 38	8		i throw N.
		L	23 09 04			O in S. Atlantic?
		F	23 22 05			
		EiS	23 05	12		i throw E.
		L	23 09 32			iS very strong.
		F	23 28 24			
272	9	NeL	0 40 46			e masked by micros.
		F?	0 49 52			Cf. Besancon P 0–01–44.
		Ee?	0 31 52			O in Japan. (Graz).
		eL	0 40 32			No maximum.
		F	0 56 36			
273	9	NeP?	8 37 22			In microseisms.
		e	8 38 35			
		S	8 43 13	8		Dist. 3600 kms.

No.	Date	Phase	Time	Periods	Amplitudes	Remarks
	1912		h. m. s.	s.	mm.	
		NeL	8 46 39	15		Off Central America?
			8 52 11			
		M	8 54 16		4.5	Damped 4:1.
		F	9 49 ca			
		E S?	8 42 46	6		e lost in micros. and
		eL	8 45 42	22		wind-quavers.
		M	8 51 40	25	14	Undamped pendulum.
			8 53 34	20	17.5	
			8 54 44	18	25	
		F	9 55 ca			
274	Dec. 12	Ee	12 05 52	52		Faint record of doubtful character. Unheard
		L	12 16 44	20		from.
		F?				N–S chronograph ran down at 17h–32m, Dec. 12. E–W stopt between 11h. 19m. and 13 h. 13m Dec. 13th.
275	22	Ee	23 45 03	6		Cf Ottawa 23–42–21.
			23 46 23	8		
		F	23 51 03			F? later? in micros.
276	23	Ee	12 44 51	16		N–S not recording.
			12 47 57	65		Faint record of doubt-
		L	12 58 37	20		ful character. Unheard
		F				from elsewhere. Record taken off at 13h 20m.
277	24	EeP	0 19 21	3		Faint. Not shown N–S
		?	0 35 36	27		on pendulum damped
		L	1 03 48	20		4:1.
		F	1 57 ca			Vd. Batavia & Strassburg. O. in Philippines.
	1913					
277a	Jan. 1	Ne	18 32 57			Qr. in S. W. Union Co.,
		F	18 35 43			So. Carolina.
		Ee	18 31 37	6		Vd. Bull. Seism. soc.
		F	18 35 16			Amer., 3, 6–13. Time at O reported 1h 27m E. S. T.