Seismological Investigations.—Sixth Report of the Committee, consisting of Professor J. W. JUDD (*Chairman*), Mr. J. MILNE (*Secretary*), Lord KELVIN, Professor T. G. BONNEY, Mr. C. V. BOYS, Professor G. H. DARWIN, Mr. HORACE DARWIN, Major L. DARWIN, Professor J. A. EWING, Professor C. G. KNOTT, Professor R. MELDOLA, Mr. R. D. OLDHAM, Professor J. PERRY, Mr. W. E. PLUMMER, Professor J. H. POYNTING, Mr. CLEMENT REID, Mr. NELSON RICHARDSON, *and* Professor H. H. TURNER.

CONTENTS.

I. *On Seismological Stations abroad and in Great Britain.*

SEISMOGRAPHS of the type recommended by the Seismological Investigation Committee of the British Association have been constructed for and in most instances are already established at the following stations :—

*1.	Africa	Cape Town.
*2.	„	Cairo.
3.	Australia	Melbourne.
4.	„	Sydney.
5.	„	Western Australia.
*6.	Canada	Toronto.
*7.	„	Victoria, B.C.
8.	Ceylon	Colombo.
*9.	England	Shide, Isle of Wight.
*10.	„	Kew.
*11.	„	Bidston.
12.	Germany	Strassburg.
13.	Honolulu	Hawaii.
*14.	India	Calcutta.
*15.	„	Madras, Kodaikanal.
16.	„	„ Jugga Row.
*17.	„	Bombay.
*18.	Java	Batavia.
*19.	Japan	Tokio.
*20.	Mauritius	Royal Alfred Observatory.
21.	Mexico	Mexico.
22. 23.	New Zealand (2 instruments)	Wellington (2 instruments).
24.	Portugal	Coimbra.
25.	Russia	Irkutsk.
26.	„	Tiflis.
27.	„	Taschkent.
*28.	Scotland	Edinburgh.
29.	„	Paisley.
*30.	S. America	Cordova.
31.	„	Arequipa.
*32.	Spain	San Fernando.
33.	Syria	Beyrut.
34.	Trinidad.	
35.	U.S. of America	Philadelphia.
36.	„	Baltimore.

The last instrument constructed is in charge of Mr. L. Bernacchi, of the ss. 'Discovery.' If possible it is to be used in the Antarctic Regions. Continuous records have been received from stations marked with an asterisk, whilst Mexico, New Zealand, Trinidad, Philadelphia, and Baltimore have sent occasional records.

The last registers issued by the British Association Committee are Circulars Nos. 2 and 3. These refer to Shide, Kew, Toronto, Victoria, B.C., San Fernando, Cairo, Cape Town, Mauritius, Calcutta, Bombay, Kodaikanal, Batavia, and Cordova. These are complete up to the end of December 1900, excepting for Cordova (Circular No. 2), the entries for which end on June 21, 1900.

The instruments now in use at the Shide station are :—

1. A photographic-recording horizontal pendulum oriented North and South. This is the type of instrument similar to those at other stations.
2. A pair of pendulums similar to the above oriented North-South and East-West. This instrument was kindly presented to your Secretary by Mr. A. F. Yarrow.
3. A pair of horizontal pendulums writing on smoked paper. These have arms 14 inches in length, and each carries a 10 lb. weight.
4. A pair of horizontal pendulums also writing on smoked paper The arms are 9 feet in length, and each weighs about 100 lb. This and instrument No. 3 give open diagrams.
5. A simple spiral spring seismograph for vertical motion. Record photographic.
6. A large balance arranged to show tilting.

Analyses of Records for 1900.

An analysis of the earthquakes recorded during the year 1900, similar in character to that given in the Fifth Report issued by your Committee for the records of the previous year, is in progress. Its length precludes it from appearing in these reports.

On the Approximate Frequency of Earthquakes at different Stations.

In the following table the large numerals to the right of or beneath the name of a given station indicate the actual number of disturbances recorded at that station during given intervals of time. For all stations, excepting three, these intervals are the years 1899 and 1900. The three exceptions are Cairo, for which the interval is the year 1900 ; Calcutta, from July to December 1900 ; and Cordova, from January to June 1900. Inasmuch as at all stations, for a variety of reasons, there have been interruptions in the continuity of observations, these time intervals must only be regarded as approximations. As it is difficult in the case of certain minute disturbances to determine whether these have a seismic origin or are due to some other cause, the large numerals are only approximations.

The small numerals to the right or left of a large numeral give the percentage of the earthquakes recorded at the station to which it refers, which are common to the registers of the other stations. For example, out of 210 records at Shide, 58 per cent. of them were also noted at Kew, and

40 per cent. at one or more stations in Europe.[1] These latter refer to Strassburg, Hamburg, Laibach, Trieste, or observatories in Italy.

	Shide	Kew	San Fernando	Toronto	Victoria, B.C.	Cairo	Madras	Bombay	Calcutta	Batavia	Mauritius	Cape Town	Cordova, Argentina	European Stations
Shide	**210**	58	32	47	49	5	12	23	7	34	19	25	19	40
Kew	54	**220**	29	35	35	3	9	19	8	24	14	19	20	33
San Fernando	87	84	**75**	79	75	11	23	48	15	63	36	59	53	69
Toronto	40	34	24	**241**	56	3	7	16	5	21	14	19	15	29
Victoria, B.C.	40	33	23	55	**246**	3	9	17	4	25	17	19	17	28
Cairo	18	12	14	15	12	**45**	2	14	2	20	18	15	12	14
Madras	22	19	15	18	19	3	**115**	19	4	17	9	15	0	18
Bombay	90	76	62	69	71	14	36	**58**	14	65	45	52	23	62
Calcutta	14	13	13	14	14	2	7	9	**57**	18	14	14	—	18
Batavia	29	24	21	26	29	4	9	14	9	**237**	19	18	17	21
Mauritius	46	42	39	47	53	9	13	31	13	54	**81**	41	14	38
Cape Town	53	47	45	48	50	8	17	32	10	47	35	**98**	21	45
Cordova (Argentina)	16	16	16	16	16	7	2	7	—	23	9	12	**43**	5

From what has been said it is clear that results indicated by the above table are, when we have at our disposal materials more definite in character, open to modification.

Numerous records, as at Shide (**210**) and Kew (**220**), may indicate that in the examination of the record-receiving films, in certain instances, minute disturbances have been wrongly accepted as having a seismic origin. The high number of records accredited to Batavia may partly be accounted for by the fact that at that place there are many local shocks the effects of which have not been appreciable at distant stations. That the percentage of the Shide records noted at other stations is, in all instances but one, greater than the percentage of the Kew records at corresponding stations (see the first two horizontal lines in the table) indicates that either the Kew instrument or the ground on which it rests is less sensitive to seismic influences than the instrument or the ground at Shide. A similar conclusion is arrived at if we inspect the two vertical sets of entries beneath the names of these two stations.

The fewness of the San Fernando and Bombay records, and the large percentage of these which are found at other stations, may indicate that at these stations disturbing influences non-recognisable as seismic but rarely occur. For Cairo and Calcutta not only are the records few in number, but the percentages of these common to other stations are also low. The explanation of this probably rests on the fact that these two stations are installed upon alluvium. At San Fernando and Bombay, where the installations are upon hard materials, although the records are not numerous, the percentages of these recognised at other stations are high. If this is correct we have here the reverse of what occurs in the case of earthquake motion that can be felt, the motion being greatest upon the alluvium, and least upon the harder strata.

The low percentages corresponding to the Cordova records may be accounted for by the supposition that many of its entries refer to shocks

[1] See footnote to p. 47.

which do not reach distant stations. Although a list might be made of earthquakes recorded at the European stations here considered, but not at the thirteen widely separated stations indicated in the above table, an inspection of this table shows the converse to be equally true, there having been many earthquakes recorded in the south of South America, on the east and west of North America, in South Spain, and in Great Britain which have apparently escaped record in Central Europe.

In connection with this subject attention may be drawn to the list of earthquakes on pp. 44–46. As this list has been drawn up with great care, it may be taken for granted that all entries which refer to approximately the same times represent seismic disturbances. The larger of these will have been recorded at distant stations. To determine whether this is true for the smaller records observers are asked to make a close inspection of their photographic traces.

Experiments upon Piers.—At the end of March Professor H. H. Turner, F.R.S., visited Shide, where, in conjunction with your Secretary, he measured the stiffness of various piers employed to carry seismographs. To make a measure of this description a rope was tied round the column to be tested about 2 inches from its top. A spring balance was attached to this, and a pull of from 5 to 30 lb. was exerted, with the result that the column was deflected. These deflections were measured by an astronomical level standing on the column, and in certain instances also by the deflection of the boom of horizontal pendulums. The stiffest column tested was a 12-inch earthenware drain pipe, 3 feet in length. The apparent deflection was $0''\cdot09$ per one-pound pull. A brick column 6 feet in height, and in cross-section 3 feet by 1 foot 6 inches, had per lb. pull a deflection angle in directions parallel to its sides of $0''\cdot192$ and $0''\cdot05$, the latter referring to its greatest width.

II. *On Earthquake Records obtained at Stations on different Geological Formations.*—The records referred to in this note were obtained at Kew, Shide, Bidston, and Edinburgh. The instruments used were Milne horizontal pendulums with photographic recording apparatus. They were similarly installed, and, so far as it has been practical, were kept with similar adjustments. The geological formations at these four stations may be briefly described as follows :—

Kew.—Thick alluvial deposits of the Thames Valley, which in their upper parts at least are saturated with water.

Shide.—Here the pier carrying the instrument rests upon the disintegrated outcrop of beds of chalk which form the east and west backbone of the Isle of Wight. These beds plunge at a steep angle, to rise again as a series of chalk downs to the north of the Solent beyond Portsmouth.

Bidston.—The Observatory at Bidston is situated on New Red sandstone.

Edinburgh.—Blackford Hill, on which the Royal Observatory is situated, is a great sheet of 'felstone' or porphyrite of Palæozoic age.

The records obtained from these stations are as follows :—

II. *Records obtained from similar Horizontal Pendulums at Kew, Shide, Bidston, and Edinburgh.*

A.T. means that the record was obscured by Air Tremors. An asterisk in the first column means that this earthquake was also observed at one or more stations in Europe.

Date	Commencement				Duration				Amplitude			
	Kew	Shide	Bidston	Edinburgh	Kew	Shide	Bidston	Edinburgh	Kew	Shide	Bidston	Edinburgh
1901												
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	MM. ″	MM.	MM.	MM. ″
Jan. 7*	0 38·3	0 43·2	Observations began Jan. 8		2 44	2 30			1·0 = 0·7	1 5 = 0·7		
„ 8*	20 0·0	20 26·8	20 6·5		0 46	0 30	0 41		0·6 = 0·4	0·5 = 0·2	0·4 = 0·1	
„ 9	14 26·7	12 0	14 39·5		0 4		0 4		0·25		Small	
	15 56·7	15 35	15 56·6				0 5					
	17 7·2	15 50	16 47·0				0 40					
		16 5										
		17 40										
„ 13*	23 2·3	22 7·0 ?	22 57·7	Lamp out	0 50	0 55	1 15		0·5 = 0·38	0·75 = 0·37	0·35 = 0·2	
„ 14			20 23·0									
						0 3				0·5 = 0·23		
„ 17*		10 31 0	11 7			0 11					Small	
„ 18*	4 56·8	4 35·0 ?	4 56·6	4 57·2	1 23	1 10	1 12	0 40	3·1 = 2·3	3·5 = 1 6	1·6 = 0·48	2·9 = 1·29
„ 20	14 31·0		14 30		0 5		0 7		0·25		Small	
„ 21		17·0 to 18·0	17 47·5			1 0	0 39			0·25	0·25 = 0·1	
„ 22*	2 35·5	2 34·9	2 36·5		0 24	0 25	0 30			0·25	0·25 = 0·1	
„ 24	? 18 56	A.T.	19 30 A.T.		? 1 4		2 0					
„ 25		19 10·0	19 45			0 25	?			0·25	Small	

Jan. 30	7 11·0	6 29·5	6 48·0	5 44	0 8	0 25	0 27	0 55		0·25	0·25 = 0·1	Small
				6 39								
Feb. 1	10 29·6				0 7				0·25			
„ 7*		14 30	14 30	14 29		0 5	1 20	0 1				0·25 = 0·11
				14 54			At intervals	0 2		0·25	Small	0·25 = 0·11
„ 11				3 29·5				0 4				0·2 = 0·09
„ 14		17 29	5 43·4			0 10	0 11			0·5 = 0·23	Small	0·5 = 0·22
*		23 47	17 33·5	17 38·5		0 7	0 8	0 2·5		0·5 = 0·23	„	
„ 15*	8 43·0	8 29·1	8 39·5	8 38·0	0 27	1 0	0 31	0 50	0·25	0·5 = 0·23	1·3 = 0·14	0·5 = 0·22
„ 16		A.T.	2 20·6				0 14				0·5 = 0·12	
„ 17*			23 58·2				0 31				0·4 = 0·10	
„ 20*	10 51·5	A.T.	10 4·1	10 59·5	0 37		1 54	0 34	0·4 = 0·29		0·5 = 0·18	0·25 = 0·11
„ 26	19 10·5			5 0								
				5 47	3 8				0·5 = 0·38			Small
„ 27*	19 34·0	1 0 abt.	0 45·0		0 56		0 20			0·25	Small	
Mar. 1		A.T.		10 6·5								Small
				18 0·0								
„ 2	12 0·6		12 1·0		0 15		0 28				slight	
„ 3	8 17·5	8 26·2?	8 17·0	8 6·0	0 25	0 10	0 21	0 50	0·5 = 0·4	0·5 = 0·23	0·3 = 0·1	1·0 = 0·44
„ 3	17 31·7				0 5							
	19 6·5											
„ 4		16 45·6	17 15·0	17 34·0		1 0	0 15	0 3		0·25	Line thickens	Small
„ 5*				9 57·5				0 4				Small
	?11 1·5	11 3·5	10 55·3	11 7·0	?1 44	1 40	1 31	1 46	1·0 = 0·80	1·25 = 0·58	1·3 = 0·54	1·75 = 0·77
			11 5·3									
„ 11		21 23·3		21 39·0		0 26?		0 18		0·25		1·0 = 0·44
„ 16*	12 12·2	12 14·1	12 5·2	12 14·0	1 35	1 40	1 21	1 43	2·0 = 1·66	2·5 = 1·17	1·8 = 0·61	1·75 = 0·77
„ 18			16 30·0				1 0				Slight; perhaps A.T.	
„ 19*	0 11·6	0 2·8	0 7·7	0 12·0	1 0	1 5	1 10	0 49	0·4 = 0·30	0·5 = 0·23	0·6 = 0·28	0·5 = 0·22
*		20 45·0 to 22 15·0	21 28·0				0 12				Slight	
„ 23*	14 55·6	14 41·7	14 33·7	14 52·0	0 35	1 5	1 5	0 56	0·5 = 0·4	0·5 = 0·23	0·5 = 0·19	0·5 = 0·22
„ 25*	11 47·4	11 48·8	11 48·0		0 44	0 8?	?		1·0 = 0·8	0·25	? A.T.	
„ 28*		18 28·2	19 0·2	18 30·0		0 10	1 0	0 10		0·5 = 0·23	? A.T.	Small

Records obtained from similar Horizontal Pendulums at Kew, Shide, Bidston, and Edinburgh—continued.

Date	Commencement				Duration				Amplitude			
	Kew	Shide	Bidston	Edinburgh	Kew	Shide	Bidston	Edinburgh	Kew	Shide	Bidston	Edinburgh
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	MM. "	MM. "	MM. "	MM. "
Mar. 31*	7 14 7	7 13·8	Lamp out	7 19·5	0 49	1 0		0 29	3·0=2·4	2·0=0·94		4·0=1·77
April 2*		16 59·5		4 48·0 to 17 8·0		0 10				0·25		Numerous A.T.'s.
„ 3*		16 3·3				0 7 or 0 18				0·25		
„ 4*		8 5 8 43 9 2	9 35·0	0 0·0 to 11 0·0			0 33			0·25	0·2=0·07	Numerous A.T.'s.
„ 5*	23 13·4	23 21·0	22 27·3	23 18·0	3 30	3 35	4 8	3 43	4·8=3·94	8·5=4·0	7·6=2·58	5·0=2·22
		12 34·3	13 0·5			1 35	0 23			0·25	Slight	
		14 9·6										
„ 6*	21 16·9	21 17·9	21 19·9	21 40·0	1 22	1 55	1 34	1 17	0·8=0·64	1·5=0·70	2·6=0·88	
„ 7	23 42·2	23 41·4	23 49·0	23 49·0	0 19	1 49	0 19		0·4=0·3	0·5=0·23	Small	Very small
„ 9				22 10·0				0 3				0·25=0·11
*	22 20·0	22 15·6	22 10·8	22 19·0	0 8	0 30	0 11	0 3		0·5=0·23	Small	0·25=0·11
„ 12		18 24·9?										
„ 18*			3 0·6	3 57·5			1 27	0 18			0·5=0·2	Very small
		14 39·3	5 0·0			0 5			0·5=0·4	0·5=0·23	Line thickens	
„ 26	19 33·0				2 21				0·4=0·3			
„ 27*	4 34?	A.T.	4 22·8	4 37·0	0 5?		0 39	0 20			0·5=0·18	0·5=0·22
*	8 39 0 to 8 4·5											
„ 30	8 4·5				0 6							

Earthquake Frequency.—As it is possible that an entry which only refers to one station and does not appear to have been noticed in Europe may not have had a seismic origin, in the summation of the above lists such entries have been omitted. Adopting this precaution, the number of earthquake records obtained at the different stations are as follows :—

Bidston, 33 or 36 ; Shide, 31 or 33 ; Kew, 26 ; Edinburgh, 21.[1]

Earthquake Duration.—In summing up the total number of minutes during which the pendulums have been moved, only the fourteen earthquakes are considered which were recorded or might have been recorded at the four stations. The results in minutes are as follows :—Bidston, 919 ; Shide, 887 ; Edinburgh, 825 ; Kew, 761.

Accuracy in the Observation of Times of Commencements.—The greatest possible difference in time we should consider likely to exist between the commencement of movement for a given earthquake at two stations would be for disturbances travelling in a northerly or southerly direction between Shide or Kew and Edinburgh, and this could not be expected to exceed five minutes. Between Shide and Kew there might be a difference of one minute, whilst between Bidston and the remaining stations the differences should not exceed two and a half minutes. In the columns relating to these differences the zero indicates the station at which motion was first recorded. The minutes which elapsed before the same disturbance was noted at the remaining stations are indicated by numerals to the right or left of the zero.

A minus sign following one of these numerals indicates that the time interval exceeds the expected interval, whilst a plus sign indicates that the numeral is a possible quantity. For the second entry the four minus signs indicate that there are not even two entries which are comparable. In the third entry for February 15, Edinburgh and Bidston, like Edinburgh and Kew, are possible figures, and therefore these three stations are credited with a plus.

Date	Duration in Mins.				Amplitudes								Duration of P.T.'s				Differences in time of Commencements			
	Kew	Shide	Bidston	Edinburgh	Kew		Shide		Bidston		Edinburgh		Kew	Shide	Bidston	Edinburgh	Kew	Shide	Bidston	Edinburgh
1901					MM.	"	MM.	"	MM.	"	MM.	"	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min
Jan. 18	83	70	72	40	3·1	2·3	3·5	1·6	1·6	0·5	2·9	1·3	25	23	19	18	0	?	0	1
" 22	24	25	30	0																
" 30	8	25	27	55													41−	0−	18−	9−
Feb. 14	0	7	8	3																
" 15	27	60	31	50	0·3	0·2	0·5	0·2	1·3	0·4	0·5	0·2	7 ?	18	15	10	14+	0−	10+	9+
March 3	*25*	*10*	*21*	*50*																
" 5	104?	100	91	106	1·0	0·8	1·3	0·6	1·3	0·5	1·7	0·8	30	30	25	29	6+	8+	0−	12+
" 16	95	100	81	103	2·0	1·7	2·5	1·2	1·8	0·6	1·7	0·8	24	22	27	25	7+	9+	0−	9+
" 19	60	65	70	49	0·4	0·3	0·5	0·2	0·6	0·3	0·5	0·2	29 ?	41	30	0 ?	8+	0−	4−	9+
" 23	35	65	65	56	0·5	0·4	0·5	0·2	0·5	0·2	0·5	0·2	5 ?	?	23	2	21+	7−	0−	18+
" 28	0	10	60	10																
April 5	210	215	220 or 248	223	4·8	3·9	8·5	4·0	7·6	2·6	5·0	2·2	60	73	80	74	46+	54+	0−	51+
" 6	82	105	94	77													0+	1+	2+	23−
" 7																	1+	0+	8+	8+
" 9	8	30	11	3													12−	5+	0+	0+

[1] 74 per cent. of the Shide records are common to Kew, and 88 per cent. of the Kew records are common to Shide. See pp. 42, 43.

Proceeding in this manner, we find that out of the eleven earthquakes considered, the number of commencements which may approximate to correctness are as follows :—Kew, 8 ; Edinburgh, 8 ; Shide, 6 ; Bidston, 4.

In considering these results it must be remembered that the earthquakes considered are for the most part small, and the difficulty of accurately analysing a small seismogram is greater than when analysing one that is large.

Amplitudes.—For seven earthquakes the sum of the amplitudes of motion reckoned in millimetres at the four stations are as follows :—Shide, 17·3 ; Bidston, 14·7 ; Edinburgh, 12·8 ; Kew, 12·1. Assuming that these displacements represent tiltings, which is improbable, the results are as follows :—Kew, 9″·8 ; Shide, 8″·0 ; Edinburgh, 5″·7 ; Bidston, 5″·1.

The following four figures are sketches made from seismograms obtained on the specified dates at Kew, Shide, Bidston, and Edinburgh. The figures following the letter S indicate the number of millimetres equivalent to one hour :—

FIG. 1. January 18, 1901.

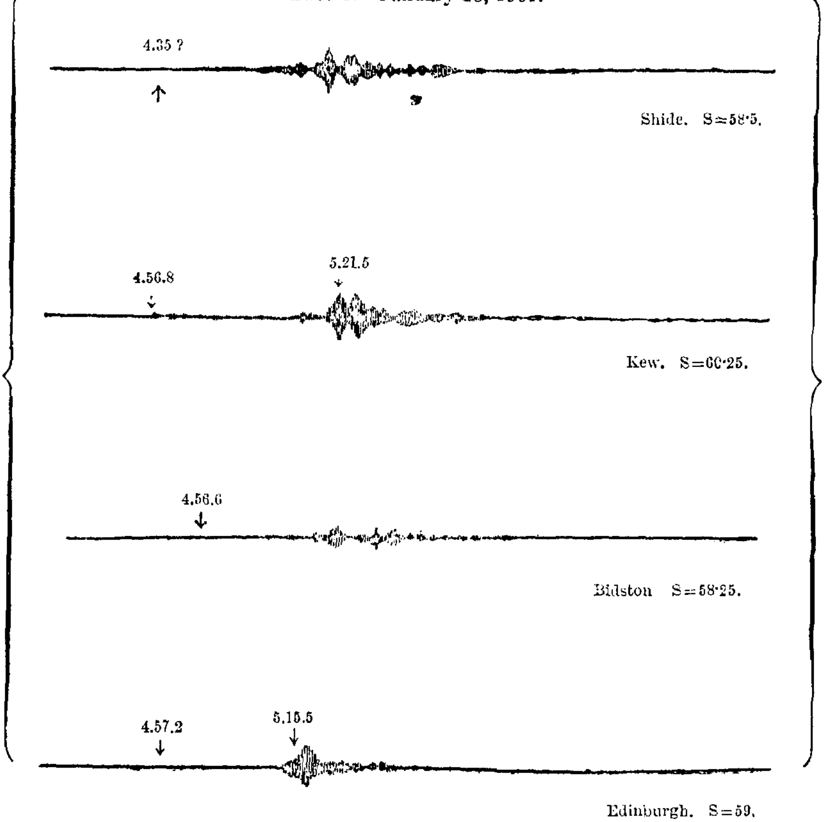


Fig. 2. March 5, 1901.

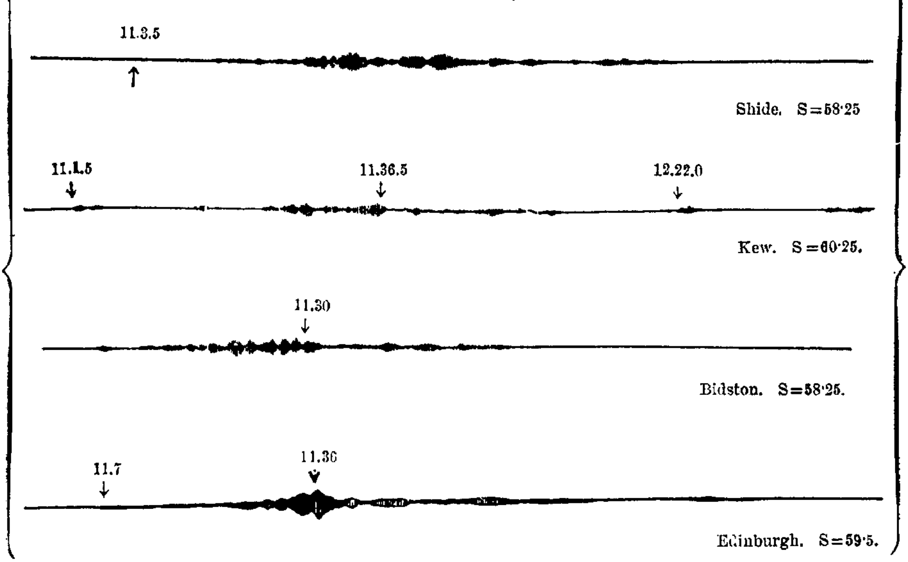


Fig. 3. March 16, 1901.

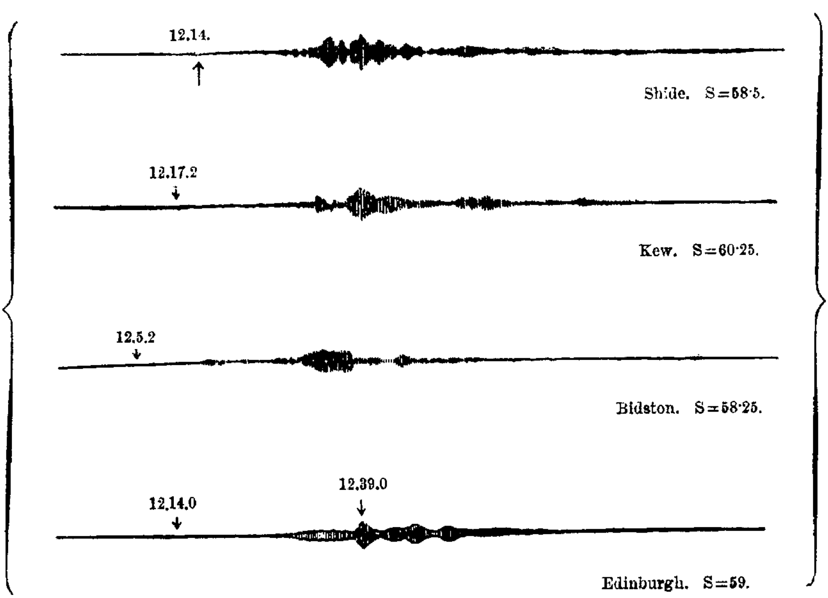
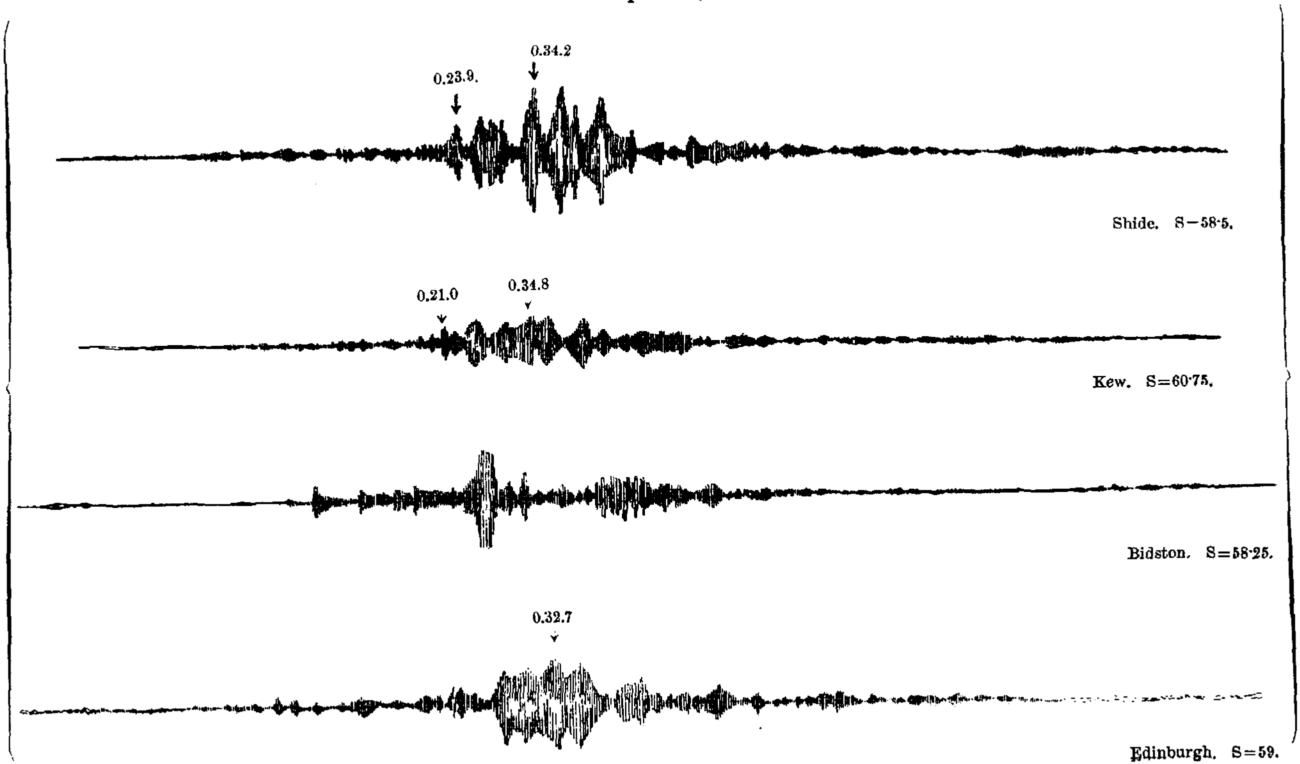


FIG. 4. April 5–6, 1901.



III. *On the Records from two similar Seismographs at Kew. From the National Physical Laboratory.* *By* CHARLES CHREE.

A Milne seismograph, No. 31, intended for Coimbra, was set up for examination at the National Physical Laboratory on October 30, 1900, its pendulum being at the same level and having the same orientation as that of the seismograph No. 9 belonging to the Laboratory. The points of suspension of the two pendulums were about 11 feet apart. At first the supports of No. 31 rested simply on the stone floor, while those of No. 9 passed through the floor down to a cement bed. After a month's trial, however, the seismographs were interchanged, with a view to eliminating the difference, if any, between the supports. The instruments were adjusted to nearly the same sensitiveness (assuming identity of gauge); they had very approximately the same period and the same rate of subsidence of artificially produced vibrations.

Seven considerable earth tremors were recorded by both instruments. In the four largest the times of commencement of the 'preliminary tremors' shown by the two traces were in excellent agreement, no difference exceeding 0·2 minute. In the other three cases the apparent times differed by from 1·7 to 4·6 minutes, the difference being greatest for the smallest tremors. The times of commencement of the large movements agreed better than those of the preliminary tremors.

As will be seen by a comparison of figs. 5 and 6, there were conspicuous differences in details in the records from the two instruments. This, presumably, is mainly due to the supports. The instrument standing on the floor had, as a rule, a lessened amplitude of vibration, the reduction averaging some 30 per cent. There were, however, not infrequent exceptions

FIG. 5. December 25, 1900.

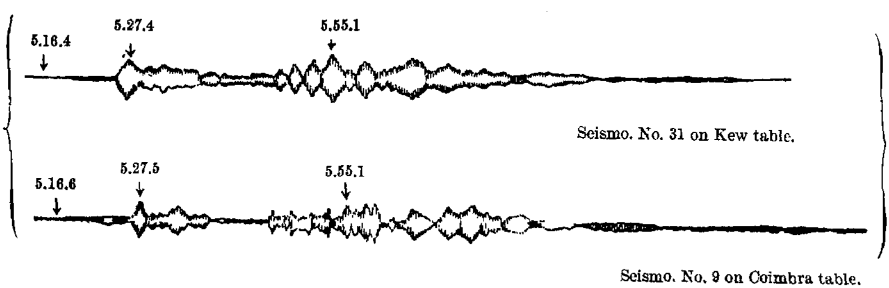
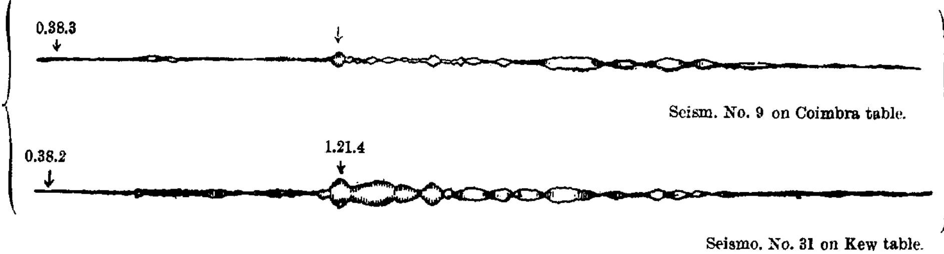


FIG. 6. January 7, 1901.



to the general rule. After allowing for the supports, a small difference still remained between the instruments, the mean apparent amplitude of disturbed movements being some 10 per cent. greater for No. 31 than for No. 9.

During the comparison the observer, Mr. Constable, noticed that on certain days of high wind the trace from the seismograph standing on the floor showed numerous small movements, many possessing distinct asymmetry. Further investigation showed that these undoubtedly arose from vibrations set up in the building by the gusts of wind. Minuter examination showed that the phenomenon also occurred, though to a much smaller extent, in the traces from the seismograph on the cement bed. Wind is thus clearly a cause of not infrequent tiny movements, whose source had hitherto escaped detection.

IV. *Movements of Horizontal Pendulums in relation to Barometric Pressure.*

For many years it has been recognised that there is a relationship between the movements of horizontal pendulums and fluctuations in barometric pressure.[1]

An important and apparently practical addition to our knowledge on this subject has recently been made by Mr. F. Napier Denison, of Victoria, B.C., in a contribution to the Royal Meteorological Society, entitled 'The Seismograph as a Sensitive Barometer.' The instrument referred to is the one adopted by the British Association. Briefly stated, Mr. Denison's conclusion is that the pendulum swings towards the area of greatest barometric pressure. For example, it has been found that when a storm area is approaching from the westward the boom of the pendulum moves steadily to the eastward, and this often occurs eighteen to twenty-four hours before the local barometer begins to fall. On the contrary, should there be an important high area to the West, the pendulum will swing in that direction before it is possible to ascertain the position of such an area on the current weather charts.

As partial confirmation of Mr. Denison's observation, it may be mentioned that a gradual but decided movement of the Shide pendulum towards the West precedes stormy weather, whilst in the Report for 1895 referred to above there are tables showing a close relationship between displacements of pendulums in Tokio and the barometric gradients at that place.

V. *An Attempt to Detect and Measure any Relative Movement of the Upway, that may now be taking place at the Ridgeway Fault, near Strata Dorsetshire. Second Report by* HORACE DARWIN, *June* 1901.

Many of the early readings have been found to be of no value, because water had got into the vessels containing the oil and had blocked its free passage through the pipe ; this difficulty has, we hope, been overcome by making the covers of the vessels more completely watertight.

[1] See Reports on 'Earthquake and Volcanic Phenomena,' issued by the British Association in 1883, 1885, 1887, 1888, 1892, 1893, 1895, 1896.

For a theoretical discussion of this subject see 'Applications of Physics and Mathematics to Seismology,' by Dr. C. Chree, *Phil. Mag.*, March 1897, p. 185.

No slip of the Fault has been detected at present; but we should hardly expect a definite result during the short time in which the apparatus has been in working order.

The results obtained so far have been of use in pointing out the difficulties to be overcome and the various defects of the instrument. The movement of the ground caused by slight earthquakes and earth-tilts is one of these difficulties, and our experiment on April 24 brought this to light in a very striking manner. The instrument was placed at the station SS. at the south end of the pipe,[1] and readings were taken every few minutes from 1 to 3 P.M. These readings give the relative movement of a fixed point in the strata and the surface of the oil. The movement was most irregular, and during that time the maximum displacement was about 0·3 mm. This can only mean that a line passing through fixed points in the rock was constantly changing its angle with the horizon; and that the oil was always flowing backwards and forwards in its attempt to remain level. At about 1.40 P.M. the value of the readings reached a minimum, and then began to increase, showing that the angular movement of the strata changed its direction at this time. If we assume that the oil was level when the two readings were taken which differed by about 0·3 mm., it shows that the rock tilted through an angle of about six and a half seconds.

No doubt there was an exceptionally large movement due to slight earthquakes and earth-tilts during the time that these observations were being taken, as Mr. J. Milne tells me that his large pendulum at Shide, Isle of Wight, was swinging regularly, and that this is supposed to be due to earth pulsations.

A telegram from Rome appeared in the daily papers reporting a slight earthquake on April 24 at 3.30 P.M. at Lisbon, and a severe shock at 4.30 P.M. in Algarve, near Lisbon. (4.30 P.M. at Lisbon is 5.7 Greenwich time.)

A note appeared in 'Nature' of July 18, 1901, saying that an account of the earthquake of April 24 in the neighbourhood of Palombara Sabina is given by Dr. Luigi Palazzo in the 'Atti dei Lincei,' x. 9. He thinks it probable that the epicentre was at a sulphur spring about a kilometre distant from Cretone, and that the origin of the shock was in the strata from which the spring arises, at a comparatively small depth. Considerable damage was done at Cretone. The shock was registered at the Central Meteorological Office at about 15h. 20m. 25s. Italian time: this is 2h. 20m. 25s. P.M. Greenwich time.

Mr. Rollo Russell noticed an unusual agitation of the sea at Bournemouth on April 24 at 7.50 A.M., and between 12 and 1 P.M. There was also an exceptionally large wave soon after 3 o'clock.[2]

Mr. C. Davison[3] thinks that the disturbances may have been due to the firing of heavy guns. The disturbances were noticed in South Devon and Guernsey as well as at Bournemouth.

The movement of the earth on April 24 was no doubt exceptionally large, but observations at other times lead me to think that such movements, due to slight earthquakes and earth-tilts, take place very frequently,

[1] A lead pipe connects four vessels which contain oil; they are in a straight line at right angles to the Fault; two of them are on each side of it at four and a half and nine metres from it.

[2] See *Nature*, May 2, 1901.

[3] *Nature*, June 6, 1901.

and these are sufficiently large to make the last two figures in the delicate micrometer measurements almost useless.

I hope to reduce this motion of the oil by making the holes through which it enters and leaves the vessels sufficiently small to damp the oscillatory movement without preventing the oil finding its own level.

A similar instrument fixed to the rock at a place where there is no Fault would give a delicate and accurate method of measuring these slow earth-tilts.