Seismological Investigations.—Seventeenth Report of the Committee, consisting of Professor H. H. TURNER (*Chairman*), Mr. J. MILNE (*Secretary*), Mr. C. VERNON BOYS, Sir GEORGE DARWIN, Mr. HORACE DARWIN, Dr. R. T. GLAZEBROOK, Mr. M. H. GRAY, Mr. R. K. GRAY, Professor J. W. JUDD, Professor C. G. KNOTT, Professor R. MELDOLA, Mr. R. D. OLDHAM, Professor J. PERRY, Mr. W. E. PLUMMER, Dr. R. A. SAMPSON, *and* Professor A. SCHUSTER. (*Drawn up by the Secretary.*)

[PLATES I. AND II.]

CONTENTS.

I. *General Notes.*

THE above Committee seek to be reappointed with a grant of 60*l.*

During the last year the expenditure in connection with seismological work exceeded 320*l.* Out of this sum 200*l.* had kindly been placed at the disposal of your Secretary by the Government Grant Committee of the Royal Society. This covered the salaries of two assistants, without whom it would not have been possible to carry out the work at Shide and that connected with fifty co-operating stations.

Registers.—During the last year Circulars Nos. 24 and 25 have been issued. They refer to Shide, Kew, Bidston, Guildford, Stonyhurst, West Bromwich, Haslemere, Edinburgh, Paisley, Eskdalemuir, Ponta Delgada, St. Vincent, San Fernando, Rio Tinto, Valetta, Cairo, Mauritius, Cape of Good Hope, St. Helena, Ascension, Fernando Noronha, Seychelles, Lima, Baltimore, Toronto, Victoria, B.C., Alipore, Bombay, Kodaikanal, Colombo, Cocos Island, Tokyo, Honolulu, Perth, Sydney, Wellington.

Many of the Registers are received monthly. On arrival, the commencement and maximum of each disturbance they record are entered on a sheet opposite the date on which they were noted, and beneath the name of the station to which they refer. A glance at this table shows whether a given earthquake was noted at only one or at several stations. In the former case the original entry is rejected, and these uncorroborated entries are frequently so numerous that registers have to be recopied before they are passed on to the press. All entries in the circulars, therefore, refer to disturbances which have affected large areas. If this course were not pursued the list of local earthquakes for many districts would contain possibly one thousand or more entries per year. Another reason for not publishing local disturbances is that a catalogue of this description is prepared by the International Seismological Association.

Visitors.—The largest party of visitors to the Observatory at Shide was some seventy members of the British Association. Among others who came for instruction or to obtain special information were the following: Dr. E. Naumann, from Frankfurt; Dr. F. Omori; Major A. J. Peile, R.A.; R. C. Franck, University of Paris; Maxwell Hall, from Jamaica; Professor J. Perry; W. E. Plummer; Professor J. W. Gregory; J. J. Shaw; E. T. Cottingham, who kindly put our regulator in order; Hon. H. Lockward, from Bermuda; Sir William Crookes; Mrs. L. H. Hoover; M. H. Gray; J. Woodrow, Jun.; Rev. F. E. Pigot, S.J.; Professor H. H. Turner; Professor T. Swain.

Stations.—Paisley: At the Coats Observatory arrangements are being made for the installation of a twin-boom seismograph.

A new station is to be established at Accra on the Gold Coast.

Records are now being received from the Seychelles and Cocos, and shortly it is expected that records will be received from Fiji.

Situation of Stations.

Zikawei.—This station is on a plain of alluvium as flat as the sea, extending in certain directions 30 km. and in other directions more than 100 km. The alluvium is said to be about 100 metres deep. Two Omori pendulums are fixed each on a block of concrete (0·80×1·00 ×1·80 metres). A Wiechert astatic seismometer of 1,000 kilogrammes is on a similar block (1·00×1·45×1·65 metres). Water is found in the ground at a depth of 1·5 to 2 metres. The building (which is the old magnetic room) is composed of two concentric rooms to avoid effects due to rapid variations of temperature. It is 10 kilometres distant from Shanghai and far away from a public road. The terminus of the tramways on the Zikawei road is about 800 metres distant.

Agincourt.—This station is nine miles from Toronto. It is on alluvial soil of very considerable depth. The underlying rocks at Toronto and Agincourt are the same (Hudson River Shale). The drift deposits no doubt are different to some degree, but there are no sections from Agincourt to compare with those at Toronto.

II. *Seismic Activity,* 1904 *to* 1909 *inclusive.*

The following catalogue is continuous with the one in the British Association Report for 1911, p. 57. The earthquakes to which it refers have been recorded at stations all over the world, or at stations repre-

0.70a

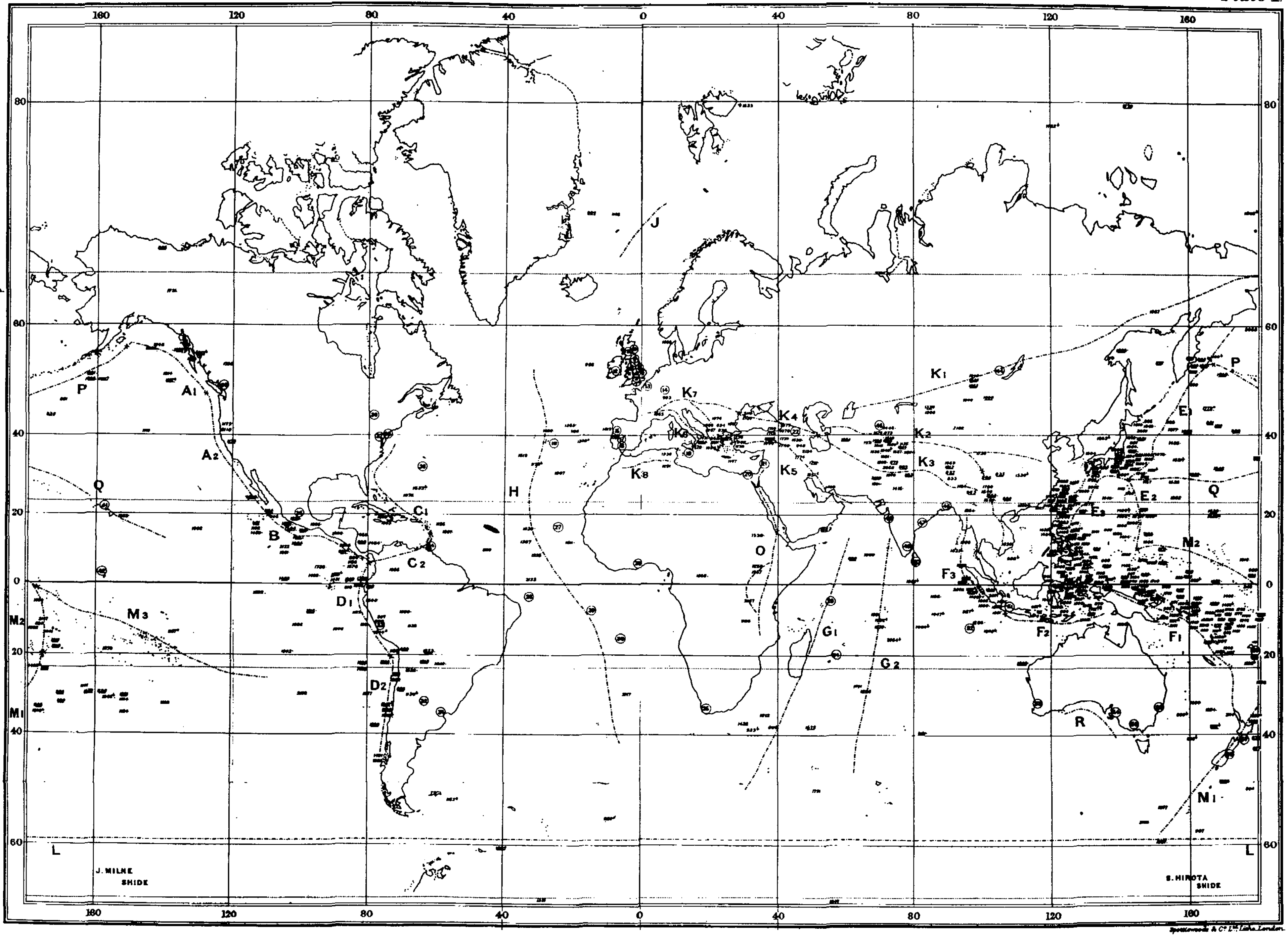
British Association, 82nd Report, Dundee, 1912.]

ORIGINS OF LARGE EARTHQUAKES, 1904-1909.

Plate I.

STATIONS.

Shide.
Kew.
Haslemere.
Guildford.
West Bromwich.
Bidston.
Stonyhurst.
Eskdalemuir.
Paisley.
Edinburgh.
Cardiff.
Cork.
Paris.
Strassburg.
Coimbra.
San Fernando.
Rio Tinto.
Azores.
Malta.
Cairo.
Beirut.
Tiflis.
Seychelles.
Mauritius.
Cape Town.
Accra.
Cape Verde.
Fernando Noronha.
Ascension.
St. Helena.
Chacarita.
Pilar.
Lima.
Trinidad.
Mexico.
Bermuda.
Baltimore.
Philadelphia.
Toronto.
Victoria, B.C.
Honolulu.
Fanning Island
Tokio.
rkutsk.
Tashkend.
Calcutta.
Vizagapatam.
Bombay.
Kodaikanal.
Colombo.
Batavia.
Cocos.
Perth.
Adelaide.
Melbourne.
Sydney.
Wellington.
Christchurch.
Fiji.



Spottiswoode & Co Ltd Lith. London.

Earthquake Districts are indicated A. B. C., etc. Small numbers refer to Shide senting an area of not less than two continents. The number given to an earthquake corresponds to that which is given to the same disturbance in the Shide Register published in British Association circulars. On the map, a number underlined means that it was recorded all over the world, but if it is not underlined means that it only disturbed a hemisphere. For the methods in which the positions of origins have been determined reference must be made to the British Association Report, 1911. When the time at which an earthquake originated is followed by *plus* or *minus* so many minutes, this means that there is a corresponding uncertainty in the position of its origin. The names of places at which an earthquake has been felt are followed by the letter F. If destruction has taken place, this is indicated by the letter D. The dotted lines on the map are the axes or troughs of districts from which megaseisms have radiated.

Date		No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1904			h. m.			
Jan.	7	804	14.50*ca*	M_1	175 E. 50 S.	
,,	10	805	2.46	F_1	155 E. 7 S.	
,,	20	806	14.50±2	B	82 W. 7 N.	Costa Rica and Panama, F.
,,	29	807	0.6±3	F_1	143 E. 3 N.	
Feb.	4	810	20.40±2	D_1	85 W. 1 S.	
Mar.	1	820	16.10±2	M_2	178 W. 13 S.	
,,	4	823	10.19±3	D_1	76 W. 12 S.	Lima, D.
,,	16	823*b*	7.25*ca*	F_1	160 E. 0 N.S.	Determined from Manila, Batavia, Christchurch and Honolulu
,,	19	826	6.28±2	D_2	71 W. 29 S.	Chile, Vallenar, D.
,,	31	832	2.16±1	K_3	89 E. 31 N.	
,,	31	833	5.45±1	K_3	89 E. 31 N.	
April	4	834	10.3 10.26	K_7	23 E. 42 N.	Macedonia, Kossovo and Salonika, D.
,,	5	835	10.20	K_2	105 E. 30 N.	China, Ssuchuan, D. Also Taichu, Formosa, 10·20, F.
,,	10	836	8.51.5	K_7	23 E. 42 N.	
,,	11	837	13.55*ca*	F_1	165 E. 13 S.	
,,	12	838	18.48*ca*	P	175 W. 44 N.	
,,	14	839	1.8±3	F_1	135 E. 15 N.	
,,	24	841	6.38	E_3	126 E. 23.5N.	Formosa, Tainan, D.
May	1	845	6.37*ca*	M_1	178 W. 33 S.	
,,	1	847	15.24*ca*	F_1	130 E. 2 N.	Ceram, Amahei, at 15.29, F.
,,	1	848	23.20*ca*	F_1	130 E. 2 N.	
,,	14	851	14.0*ca*	P	170 W. 47 N.	
June	7	857	8.15	E_1	144 E. 38 N.	
,,	18	857*c*	6.6*ca*	M_3	139 W. 14 S.	
,,	24	858	1.4	E_1	160 E. 53 N.	Petropaulovski, F.
,,	25	859	14.46	E_1	160 E. 53 N.	,,
,,	25	860	21.1	E_1	160 E. 53 N.	,,
,,	26	861	10.41	E_1 PQ	166 E. 42 N.	,,
,,	27	863	0.10	E_1	160 E. 53 N.	,,
July	1	865	13.29	E_1	148 E. 42 N.	
,,	10	869	23·0*ca*	H	45 W. 10 N.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt ; D=Destructive
1904		h. m.			
July 23	870	0.28	F_2	133 E. 5 S.	Fak-Fak, New Guinea, F. Perth record does not agree.
,, 24	872	10.45±3	E_1	160 E. 53 N.	Petropaulovski, F.
,, 27	873	5.20	K_3	72 E. 33 N.	
,, 27	874	15.30	M_2	179 E. 2 N.	
Aug. 8	877	22.49.3	M_1	179 E. 42 S.	Wellington, New Zealand, F.
,, 11	878	6.6	K_5	27 E. 38 N.	Samos, D.
,, 14	879	2.49	M_1	180 E. 40 S.	New Zealand, Waipawa, F.
,, 18	881	4.42	F_2	119 E. 10 S.	Bima and Lombok, F.
,, 18	882	20.5.5	K_5	27 E. 38 N.	Samos, Chios, Smyrna, F.
,, 24	884	21.0	E_3	135 E. 32 N.	
,, 27	885	21.56±2	A_1	141 W. 67 N.	
,, 30	886	11.41	K_3	101 E. 30 N.	Tachien lu, Ssuchuan, D.
Sept. 8	888	2.29	F_1	135 E. 8 N.	
,, 11	889	5.48±3	K_3	106 E. 23 N.	
,, 13	890	17.5±5	M_1	170 W. 32 S.	
,, 19	892	4.56	M_1	180 E. 20 S.	
,, 25	895*b*	15.10*ca*	M_1	160 E. 40 S.	
,, 27	896	15.9*ca*	G_1	38 E. 38 S.	
Oct. 1	898*b*	10.10	E_3	126 E. 7 N.	Caraga, Davao, Cotabato, D.
,, 2	899	21.50	E_1	160 E. 50 N.	
,, 3	900	3.3	G_1	61 E. 7 N.	
,, 8	903	18.36	E_3	122 E. 18 N.	Ilocos Norte and Cagayan, D.
,, 9	904	13.51	J	15 W. 70 N.	Another earthquake near Wellington, at 13.58 ; Namdalam, Norway, at 14.0 ; also Quito, at 14.15, F.
,, 28	911	13.51	F_2	113 E. 8 S.	E. Java, Batoe, in Pasoervean, D.
Nov. 5	918	20.25	E_3	120 E. 23 N.	Time and origin given by Omori ; Formosa, D.
,, 6	919	4.20±2	E_3	120 E. 27 N.	
,, 21	922*b*	3.20	M_1	167 E. 39 S.	
,, 22	923	1.7	F_1	157 E. 2 N.	
,, 23	923*b*	16.37	G_1	32 E. 39 S.	
Dec. 2	924	1.30*ca*	E_3	132 E. 10 N.	Origin determined from Manila, Batavia and Christchurch.
,, 2	924*b*	2.19	B	85 W. 7 N.	
,, 4	925	10.23*ca*	O	30 E. 10 S.	
,, 11	930*b*	17.3	D_2	68 W. 30 S.	Santiago to Valparaiso, F. Centre at Vallener.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1904		h. m.			
Dec. 19	937	17.43	M_1	162 E. 57 S.	
" 20	938	5.44*ca*	B	83 W. 12 N.	Nicaragua, Costa Rica, Panama, Port Limon, D.
1905					
Jan. 9	948	6.17	K_4	46 E. 38 N.	Szirtes gives origin S.E. of Tiflis.
" 13	949	13.18±2	F_1	143 E. 0 N.S.	
" 20	952	2.32	K_7	22 E. 40 N.	Aghuia, Greece, F.
" 20	953	18.1±2	B	82 W. 13 N.	
" 20	954	22.27*ca*	F_2	123 E. 7 S.	
" 22	955	2.42	F_1	123 E. 3 N.	Zamboanga, F.
" 29	956	12.45*ca*	H	16 W. 53 N.	
Feb. 2	957*b*	21.4*ca*	F_3	93 E. 7 S.	
" 4	958*b*	6.26	K_3	108 E. 6 N.	
" 13	960	5.16*ca*	F_1	146 E. 2 S.	
" 13	960*b*	23.31*ca*	F_1	157 E. 35 S.	
" 14	961	8.50	Q	180 E. 35 N.	
" 17	963	11.42	K_3	96 E. 26 N.	
" 19	964	4.35±3	F_1	168 E. 10 S.	
" 26	965	2.26	F_1	170 E. 14 S.	
" 27	966	17.25	M_1	176 W. 23 S.	
Mar. 4	967	16.0±2	F_1	158 E. 2 S.	
" 4	968	18.30	F_3	158 E. 2 S.	
" 4	969	23.15±2	F_1	142 E. 2 N.	
" 14	973	10.41	K_2	72 E. 40 N.	
" 17	975*b*	22.14	H	32 W. 33 N.	
" 18	977	23.56	M_2	168 E. 10 S.	
" 22	980	3 40±2	Q	173.5 E. 40 N.	
April 4	982	0.48	K_3	76 E. 32 N.	Kangra Valley, D.
" 10	984	12.3	E_3	120 E. 23 N.	
" 19	986	12.25	M_1	171 W. 32 S.	Origin given by Szirtes.
" 24	988	8.6	E_3	124 E. 12 N.	Masbate, S.E. Luzon, F.
25	989	9.13±2	M_2	177 E. 3 N.	
" 26	990	21.42±2	D_1	70 W. 19 S.	
" 29	993	0.47	K_7	7 E. 46 N.	
May 9	995	6.43	B	105 W. 20 N.	Autlan, E. of Jalisco, Mexico, F.
" 11	996	17.5±2	E_2	144 E. 21 N.	
" 12	997	2.45±5	D_1	76 W. 10 S.	
" 12	998	15.30±5	D_1	77 W. 12 S.	Batanes Is. felt at 16.49.
" 18	1001	13.42	F_1	149 E. 4 S.	Origin given by Szirtes.
" 23	1004*b*	7.1±8	G_2	83 E. 12 S.	
" 31	1008	18.21	E_3	126 E. 12 N.	
June 1	1009	4.40	K_7	19 E 42 N	
" 2	1010	5.39	E_3	132.5 E. 34 N.	Kyushu, Shikoku, F.
" 9	1018	12.22±2	M_2	160 E. 3 N.	
" 12	1020	5.13*ca*	M_2	168 E. 5 S.	
" 14	1021	11.25±3	M_3	153 W. 30 S.	
" 30	1025	17.6±2	F_1	167 E. 16 S.	
" 30	1026	19.46±2	D_1	100 W. 12 S.	
July 6	1031	16.18	E_1	144 E. 39 N.	N.E. Japan, F.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1905		h. m.			
July 9	1036	9.39	K_1	98 E. 50 N.	
,, 11	1038	8.38	K_1	101 E. 47.5 N.	
,, 11	1039	15.37	E_1, E_2	140 E. 34 N.	
,, 14	1045	8.50	A_1	142 W. 56 N.	
,, 14	1046	22.0	K_1	98 E. 50 N.	
,, 16	1047	18.50*ca*	F_3	87 E. 8 S.	
,, 17	1048	0.22*ca*	F_1	171 E. 18 S.	
,, 23	1052	2.45	K_1	98 E. 50 N.	
,, 27	1054	22.19±2	E_3	130 E. 7 N.	Southern part of Samar, Leyte, F.
Aug. 4	1057	5.9*ca*	K_7	19 E. 41 N.	
,, 25	1063*b*	9.45±3	E_3	135 E. 39 N.	
Sept. 1	1063*c*	2.36*ca*	E_2	148 E. 20 N.	Origin determined from Manila, Zikawei, Honolulu and Tashkend. Ten minutes later there was an earthquake in Japan, Aomori to Iida, F.
,, 8	1064	1.43	K_6	16 E. 39 N.	Calabria, D.
,, 14	1065	19.41	E_1	160 E. 40 N.	
,, 15	1066	5.57	E_1, P	164 E. 53 N.	Origin given by Szirtes.
,, 26	1070	1.29	K_3	73 E. 30 N.	
,, 29	1071	11.50	F_1	131 E. 8 S.	
Oct. 8	1074	7.27	K_7	23 E. 42 N.	Bulgaria, F.
,, 14	1075*b*	14.37*ca*	C_1	76 W. 19 N.	Cuba, Santiago, F.
,, 15	1076	21.42	C_1	68 W. 24 N.	
,, 21	1077	11.1	K_4	42 E. 42 N.	
,, 21	1078	13.20	K_4	42 E. 42 N.	
,, 24	1082	17.40±2	Q	130 W. 15 N.	
Nov. 6	1086	16.51±2	F_1	146 E. 0 N.S.	
,, 8	1087	22.6	K_7	24 E. 40 N.	Macedonia, Mt. Athos, D.
,, 21	1092*a*	21.50*ca*	F_1	165 E. 10 S.	
,, 21	1092*b*	23.5	G_2	80 E. 0 N.S.	
,, 21	1092*c*	23.45*ca*	G_2	70 E. 10 S.	
Dec. 4	1096	7.5	K_5	39 E. 39 N.	Malatia: Asia Minor, D.
,, 4	1096*b*	9.40	K_5	39 E. 39 N.	
,, 10	1097	12.30	P	160 W. 50 N.	
,, 10	1098	18.6	E_3	130 E. 5 N.	Mindanao and Visayas, F.
,, 17	1101	5.27	B	113 W. 17 N.	
,, 17	1102	9.34	B	113 W. 17 N.	
1906					
Jan. 3	1107	1.54±4	F_1	169 E. 15 S.	
,, 6	1109*b*	21.27±3	E_1	167 E. 54 N.	Petropaulovski, F.
,, 10	1110	13.2±2	A_1	146 W. 40 N.	
,, 15	1110*b*	19.27	F_3	97 E. 0 N.S.	Padang, F.
,, 21	1111	13.46	E_2	143 E. 34 N.	Origin given by Omori, E. coast of Japan, F.
,, 22	1111*b*	4.2±2	F_1, M_2	168 E. 13 S.	
,, 24	1112*a*	6.40	A_1	139 W. 50 N.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1906		h. m.			
Jan. 24	1112*b*	21.35±2	A_1	130 W. 55 N.	
,, 27	1114	21.33±3	E_1, P, Q	168 E. 42 N.	
,, 28	1116	14.33±2	E_2	140 E. 26 N.	Tokio, F.
,, 31	1118	15.33	D_1	80 W. 1 N.	Columbia, Pacific Coast, D.
Feb. 1	1120	2.16±2	M_3	170 E. 12 S.	Origin determined from Christchurch, Perth, Honolulu, Batavia, Manila and Tokio. Another earthquake occurred in Europe at nearly the same time.
,, 2	1122	16.43±3	D_1	84 W. 8 S.	Tumaco, F.
,, 5	1124	4.15	M_3	152 W. 35 S.	
,, 10	1124*c*	8.47±2	F_2	128 E. 4 S.	
,, 16	1126	17.35	C_1	59 W. 17 N.	It broke cables.
,, 19	1128	1.58±2	M_2	170 E. 10 S.	
,, 23	1129*b*	15 14	E_2	149 E. 31 N.	Awa Kazusa, F.
,, 24	1130	0.12	E_2	140 E. 31 N	,, ,,
,, 27	1133	19.40	K_3	79 E. 30 N	Rampur, D.
Mar. 2	1135	6.16	K_2	77 E. 38 N.	Jarkent, F.
,, 3	1135*b*	8.35*ca*	D_1	90 W. 2 N.	
,, 8	1136	17.43±2	H	20 W. 40 N.	
,, 9	1137	19.24±4	F_1	172 E. 20 S.	
,, 10	1138	6.30±5	M_3	158 W. 28 S.	
,, 10	1139	16.18±2	M_3	160 W. 30 S.	
,, 11	1141	8.36±3	M_3	162 W. 28 S.	
,, 13	1143	13.19±2	E_3	133 E. 30 N.	
,, 16	1145	22.42	E_3	120.5 E. 23.5 N.	Formosa, D. Origin given by Omori.
,, 19	1146	7.57	J	9 W. 70 N.	
,, 20	1146*b*	1.53±2	F_1	145 E. 5 S.	
,, 20	1147	3.48*ca*	K_5	27 E. 33 N.	
,, 26	1150	3.28	E_3	120 E. 23.5 N.	
,, 27	1152*a*	5.0	L	55 W. 52 S.	Origin determined from Cordova, Christchurch and Mauritius. The distance apart of these origins is 156°.
,, 27	1152*b*	5.23±2	J	120 E. 78 N.	Origin determined from Cairo, Bombay, Shide, Honolulu and Beirut.
,, 27	1152*c*	22.53	E_3	119 E. 25 N.	Tainan, F.
,, 28	1154	18.0	M_3	152 W. 32 S.	
,, 29	1156	21.44±2	B, D_1	85 W. 7 N.	
April 5	1160	22.20*ca*	F_1	147 E. 0 N.S.	
,, 8	1163	17.30±2	E_2	142 E. 25 N.	
,, 10	1164	21.18	A_2, B	110 W. 20 N.	
,, 13	1166	19.17	E_3	120.5 E. 23 N.	Formosa, D.
,, 14	1168	3.44*ca*	M_3	140 W. 32 S.	Tanna, New Hebrides, F.

Seismic Activity—continued.

Date		No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1906			h. m.			
April	18	1170	13.12	A_2	121 W. 38 N.	California, D.
,,	19	1171	6.54*ca*	F_1	168 E. 9 S.	
,,	23	1172	9.10	A_2	123 W. 42 N.	Grant Pass, Oregon, Berkley, California, F.
,,	25	1175	1.30	E_3	126 E. 7 N.	Caraga, Davao, Cotabato, S.E. Mindanao, F.
,,	29	1181	16.20*ca*	G_2	82 E. 40 S.	
May	2	1182	1.12	E_3	124 E. 23 N.	Ishigakijima, F.
,,	5	1183	0.18±2	D_1, D_2	71 W. 20 S.	Arica, F.
,,	12	1184	5.50±2	K_3	92 E. 28 N.	
,,	12	1185	10.38	E_1	155 E. 42 N.	
June	1	1190	4.30±2	F_1	145 E. 0 N.S.	
,,	2	1191	14.20	F_1	153 E. 5 S.	
,,	10	1195	20.50	G_2	85 E. 3 S.	
,,	19	1199	11.21±2	E_3	128 E. 20 N.	
,,	20	1203	2.25±2	B	89.5 W. 13.5 N.	San Salvador (the capital), F. An eqke. originated N. Luzon about 3.41 or 1h. 16m. later. The time taken to travel from Salvador would be 1h. 23m. Therefore the large waves from Salvador 132° may have caused the Manila eqke.
,,	22	1205	3.17	B	95 W. 17 N.	Mexico, Chiapas, F.
,,	24	1208	11.20	F_3	91 E. 5 N.	
July	10	1219*b*	19.40±2	E_3, F_1	128 E. 6 N.	S. of Agusan River Valley, F.
,,	13	1220	23.42±2	H	34 W. 16 N.	
,,	20	1225	11.16±2	H	33 W. 8 N.	
,,	22	1226	18.30±2	G_1	63 E. 29 S.	
Aug.	1	1232	23.20	Q	155 E. 23 N.	
,,	9	1237	11.0±3	F_1	170 E. 12 S.	
,,	15	1240	22.2±2	K_2	95 E. 44 N.	Russian Turkestan, F.
,,	17	1242	0.6±2	Q	168 E. 31 N.	
,,	17	1242*b*	0.41	D_2	72 W. 33 S.	Valparaiso, D. See Brit. Assoc. Seis. Report, 1911.
,,	18	1246*b*	6.45±3	M_3	157 W. 30 S.	
,,	19	1248	9.27*ca*	D_2	72 W. 33 S.	After-shock of 1242*b* Valparaiso, F.
,,	19	1248*b*	15.34*ca*	D_2	72 W. 33 S.	After-shock of 1242*b* Valparaiso, F.
,,	21	1252	11.15±2	D_2	76 W. 45 S.	
,,	21	1253	20.43±2	H	21 W. 42 N.	
,,	22	1254	19.41	M_1, F_1	165 E. 34 S.	
,,	24	1255	1.58*ca*	C_2	73 W. 4 N.	
,,	25	1256	11.51±2	O	33 E. 4 N.	Addis Abeba in Abyssinia, F.
,,	25	1257	13.47±2	O	33 E. 4 N.	After-shock of 1256.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt ; D=Destructive
1906		h. m.			
Aug. 26	1258	6.0±2	F_1	146 E. 0 N.S.	
,, 28	1261	5.9	B	107 W. 8.5 N.	
,, 30	1263	2.33±2	D_2	75 W. 23 S.	Tacna, Arica, and Iquique, F.
,, 31	1264	14.58	K_3	95 E. 21 N.	
Sept. 6	1265*b*	19.2*ca*	M_1	178 W. 34 S.	
,, 7	1266	18.51	E_1, E_2, E_3	145 E. 35 N.	Japan and Manila, F.
,, 14	1271	13.12*ca*	L	23 E. 69 S.	
,, 14	1272	16.0±2	F_1	148 E. 4 S.	
,, 17	1274	4.15	E_1, E_2, E_3	145 E. 35 N.	Tokio, F.
,, 17	1275	8.36	F_1	148 E. 4 S.	
,, 20	1277	17.24*ca*	D_2	81 W. 29 S.	
,, 21	1278	1.30*ca*	M_3	157 W. 20 S.	
,, 28	1281	15.23*ca*	D_2	82 W. 12 S.	P_1 for Cordova, Trinidad, Honolulu, Victoria, B.C., and Shide agree with time at origin.
Oct. 2	1284	1.50±2	F_1	152 E. 2 N.	Buna Bay with sea waves, F.
,, 2	1285	14.17±3	L	10 W. 79 S.	
,, 6	1286	12.34	F_3	98 E. 11 S.	Origin determined from Batavia, Perth, Colombo and Kodaikanal.
,, 10	1289	7.21	E_3	128 E. 12 N.	Surigao and Caraga, F.
,, 10	1290	12.52±2	E_3	125 E. 9 N.	Surigao and Caraga, F.
,, 10	1291	23.19	K_8	7 E. 32 N.	Origin determined from Cairo, Tiflis, Rome and Edinburgh.
,, 11	1291*b*	5.9	F_1	155 E. 10 S.	
,, 15	1292*b*	13.23	F_1	177 E. 22 S.	
,, 17	1292*c*	9.41	E_3	126 E. 16 N.	Luzon, F.
,, 24	1293	14.41	K_2	73 E. 38 N.	Samarkand, Khojent, Karki, Kelif, &c., F.
,, 28	1293*b*	15.47	F_3	101 E. 13 S.	S.W. Java and Sumatra, F.
,, 29	1294	1.9	F_1	132 E. 1 N.	Origin determined from Manila, Batavia, Honolulu and Perth.
,, 31	1296	1.46±2	K_1	140 E. 55 N.	
Nov. 5	1297	19.45±2	F_1	132 E. 3 S.	Fak-Fak, F.
,, 5	1297*b*	22.57	F_1	125 E. 0 N.S.	
,, 8	1299*a*	0.39	E_1, E_2, E_3	144 E. 33 N.	
,, 10	1299*b*	5.3±2	F_1	160 E. 10 S.	
,, 12	1300	17.33	K_2	83 E. 44 N.	
,, 14	1301	17.35±2	F_1	170 E. 10 S.	
,, 19	1303	7.16±2	F_3 (S. of)	111 E. 22 S.	W. Australia, Albany to Shark's Bay, F.
,, 28	1305	8.58±2	D_2	82 W. 23 S.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1906		h. m.			
Dec. 3	1307	22.58	C_1	57 W. 15 N.	George Town, F. Origin determined from Porto Rico, Toronto, San Fernando, measured by commencement of Large Waves.
„ 18	1318	20.58±2	M_1, M_2	172 W. 19 S.	
„ 19	1319	1.13	M_1, M_2	172 W. 18 S.	Tonga and Apia, F.
„ 22	1320	18.21	K_2	86 E. 44 N.	Manass, Urumtsi (N.W. China), D. Kopal, Semiretchensk, F.
„ 23	1321	7.0±2	P	163 W. 51 N.	
„ 23	1322	17.16±2	P	163 W. 51 N.	
„ 26	1323	5.54	D_1, D_2	73 W. 20 S.	Arica, F., observation agrees with Cordova and Trinidad. Com. of L.W. agrees with Cheltenham, U.S.A., Azores, San Fernando, Bidston and Shide.
„ 26	1323*a*	6.4±2	H	18 W. 38 N.	Origin determined from Azores, San Fernando, Bidston, Messina and Rome.
1907					
Jan. 1	1324	0.20±4	F_2	140 E. 12 S.	
„ 2	1327	11.57	M_1	180 E. 10 S.	There was a second shock about 14.30 or 12.43, Tonga, F.
„ 4	1328	5.17±1	F_3	95 E. 2 N.	Simalur, Nias, Sumatra, D.
„ 7	1330	13.54±4	M_1	160 E. 32 S.	
„ 8	1331	5.10±5	L	30 W. 65 S.	
„ 12	1332*b*	7.45±5	K_1	180 E. 70 N.	N.E. end of K_1, or 157 W. 55 N.
„ 14	1333	15.26	C	76 W. 18 N.	Jamaica, Kingston, D.
„ 19	1334	13.9	K_1	130 E. 50 N.	Alexandrovsky, F.
Feb. 3	1334*b*	6.14	F_1	122 E. 0 N.S.	Gorontalo and Celebes, F.
„ 3	1335	19.25±5	M_2	147 E. 12 N.	Wareo, N. Guinea, F.
„ 16	1342	21.14±1	F_1	175 E. 10 S.	
„ 24	1347	7.10±5	L	55 E. 65 S.	
Mar. 19	1350*b*	22.2±1	F_1, F_2	126 E. 0 N.S.	N.E. Celebes, F.
„ 26	1350*c*	11.18±1	E_2	140 E. 30 N.	
„ 27	1350*d*	0.14±2	L	10 W. 55 S.	
„ 29	1351	20.44	F_1	128 E. 7 N.	Caraga, Talou Is. and N. Celebes, F. Origin determined from com. of Manila, Zikawei, Calcutta, Honolulu, Samoa, and Shide records.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt ; D=Destructive
1907		h. m.			
Mar. 29	1351*b*	20.53*ca*	K_3	70 E. 35 N.	Origin determined from the max. of Calcutta, Kodaikanal, Irkutsk, and Shide records. Also agrees with Verny and Tiflis. Perth and Sydney also suggest third eqke. at 110 E. 60 S. Time, 20.46*ca*.
" 31	1351*c*	14.12±2	K_5	50 E. 30 N.	
" 31	1352	21.49±2	F_1, M_2	167 E. 5 S.	Tonga, F.
April 13	1359*b*	17.53	K_3	72 E. 38 N.	Ferghana, F.
" 15	1361	6.4±1	B	99 W. 16 N.	Guerrero, Mexico, D.
" 18	1362	20.59	F_1, E_3	124 E. 13 N.	Camarines, D.
" 18	1363	23.53	F_1, E_3	123 E. 13 N.	" "
" 24	1366*b*	23.24±1	F_1	135 E. 5 S.	Elat., Gt. Kei Is. and Merauke, S. New Guinea, F.
May 3	1369	20.34	E_3	121 E. 17 N.	N. Luzon, F.
" 4	1371	5.45±2	E_2, M_2	153 E. 10 N.	Namatani, N. Guinea, F.
" 4	1372	8.35±2	E_2	150 E. 23 N.	
" 7	1375	10.15±1	E_3	130 E. 23 N.	
" 13	1379	20.50±3	F_1	150 E. 10 S.	New Guinea, F.
" 20	1381	7.45.5	E_3	126 E. 10 N.	N.E. Mindanao and Leyte, F.
" 22	1384	22.52	E_1	142 E. 37 N.	Rikuzen, F.
" 25	1386	11.53	E_2, M_2	138 E. 13 N.	Borneo, F.
" 25	1387*a*	13.58±2	E_1, E_3	125 E. 24 N.	
" 25	1387	14.7.5	H	35 W. 12 N.	Another eqke. at Bonin Islands at 14.4*ca*.
" 25	1388	15.52±2	E_1, E_3	125 E. 24 N.	N. Luzon, D.
" 31	1389	12.45	F_1	161 E. 5 S.	Tonga, F.
June 1	1390	8.45±3	D_1	82 W. 0 N.S.	Guayaquil, Ecuador, F.
" 5	1393	3.18±3	D_1	86 W. 0 N.S.	Guayaquil, Ecuador, F.
" 13	1398	9.18±2	D_2	80 W. 38 S.	Valdivia, Chile, F.
" 24	1404	3.31±1	E_2	140 E. 14 N.	Celebes, F.
" 25	1405	17.56	F_1	126 E. 1 N.	Menado and N. Celebes, F.
" 26	1405*b*	4.50	E_2	140 E. 20 N.	
" 26	1405*c*	17.15±2	E_2	140 E. 20 N.	
" 27	1406	22.26±1	F_1	170 E. 3 S.	New Hebrides, F.
July 1	1408	13.6±3	D_1	105 W. 0 N.S.	Honduras, F.
" 4	1409	9.21	K_5	55 E. 27 N.	
" 9	1414	18.52	E_3	123 E. 13 N.	S. Luzon and Visayas Is., F.
" 12	1415	17.20	K_3	72 E. 26 N.	
" 20	1419	13.33	E_3	126 E. 7 N.	Mindanao, F.
" 29	1422	0.51±4	G_1	28 E. 38 S.	
" 29	1425	19.27	F_1	120 E. 0 N.S.	Menado, D.
Aug. 5	1427	1.55±1	E_2	140 E. 32 N.	Akita, F.
" 5	1428	6.32±2	D_2	82 W. 24 S.	Antofagasta, Chile, F.
" 9	1431	19.0±2	B, D_1	90 W. 1 N.	

Seismic Activity—continued.

Date		No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1907			h. m.			
Aug.	13	1432*b*	21.36±3	F_1	165 E. 3 S.	
,,	17	1433	17.21*ca*	G_1	66 E. 20 N.	Origin determined from Calcutta, Mauritius, Cairo, and Shide.
,,	17	1433*a*	17.27	E_1	160 E. 50 N.	Origin determined from Chita, Honolulu, Shide and Osaka.
,,	22	1435	22.14±5	E_1	155 E. 38 N.	Origin determined from Samoa, Honolulu and Shide. Doubtful.
Sept.	2	1439	16.2±3	Q	166 E. 20 N.	
,,	2	1439*b*	17.34±2	Q	166 E. 20 N.	
,,	15	1446	17.45	K_2	72 E. 40 N.	Khokand, Margelan, and Adishan, F. Second shock at 19.12*ca*, Osch, D.
,,	22	1448	12.9	E_2	135 E. 23 N.	
,,	23	1450	21.34±2	B	115 W. 16 N.	
Oct.	2	1453*b*	1.42±2	F_1	167 E. 15 S.	Origin determined from Christchurch, Sydney, Samoa and Honolulu. Another eqke. about 13.5, nr. Capetown.
,,	4	1454	10.27	F_3	103 E. 6 S.	S.E. Sumatra and W. Java, F.
,,	5	1456	3.30	E_3, F_1	122 E. 10 N.	Panay, Negro Is., F.
,,	10	1458	21.41	M_2	155 E. 9 S.	
,,	11	1460	14.28	M_2	162 E. 5 S.	
,,	16	1463	13.55	A_2	115 W. 23 N.	Guaymas, Mexico, F.
,,	17	1464	11.20±2	B	80 W. 10 N.	
,,	21	1468	4.17	K_3	68 E. 39 N.	Karatagh, D.
,,	23	1471	20.25	K_6	16 E. 39 N.	Ferruzzano, S. Calabria, D. Same time at Kerki, Is. of Samor.
,,	27	1475	5.12	K_2	68 E. 40 N.	Samarkand, F.
Nov.	3	1481	19.49±2	F_1, M_2	172 E. 13 S.	
,,	12	1486*b*	7.0±3	M_1	180 E. 23 S.	
,,	13	1487	3.12±2	M_2	178 E. 10 S.	
,,	16	1489	10.10±5	B, D_2	97 W. 2 N.	Peru, F.
,,	16	1489*b*	22.3	E_3	122 E. 14 N.	S. Luzon, F.
,,	19	1491	12.10±2	D_2	75 W. 44 S.	Punta Arenas, F.
,,	19	1492	21.24±2	M_2, E_2	140 E. 5 N.	
,,	21	1495	20.1	F_3	93 E. 0 N.S.	N.W. Sumatra, F.
,,	24	1496	13.58	F_3	123 E. 13 N.	Camarines, S.E. Luzon, D.
Dec.	5	1505	12.34	F_3	104 E. 4 S.	S.E. Sumatra, N.W. Java, F.
,,	5	1506	20.12	F_3	104 E. 4 S.	S.E. Sumatra.
,,	15	1509	17.32±2	M_2	153 E. 5 N.	New Guinea
,,	23	1510	1.14	E_1	145 E. 42 N.	Kushiro, F.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1907		h. m.			
Dec. 24	1511	13.26±2	H	32 W. 12 N.	
,, 25	1513	22.34±1	K_2	77 E. 36 N.	Kokand, F.
,, 30	1515	5.22±2	D_1	97 W. 8 S.	
1908					
Jan. 5	1518	2.6	E_3	124 E. 13 N.	Legaspi, S.E. Luzon, F.
,, 11	1522	3.35	E_3	121 E. 23 N.	Tainan, Formosa, F. Origin determined by Omori.
,, 12	1523	10.19*ca*	K_3	70 E. 33 N.	
,, 15	1526	12.56	E_1	142 E. 36 N.	Central and North Japan, F.
,, 16	1527	9.3±2	E_3	117 E. 23 N.	Formosa, F.
,, 25	1530	20.6*ca*	O	32 E. 15 N.	
,, 27	1530*b*	15.52±2	K_2	110 E. 31 N.	
Feb. 1	1532	23.17*ca*	M_3	113 W. 2 S.	Origin determined from Lima, Pilar, Honolulu and Samoa.
,, 1	1532*b*	23.22*ca*	C_1	67 W. 26 N.	Origin determined from Trinidad, Baltimore, Toronto, Victoria, B.C., and Shide.
,, 5	1536	22.0	D_2	67 W. 23 S.	Salta and Tucuman, F.
,, 6	1537	1.27*ca*	F_3	100 E. 5 S.	Southern and Middle Sumatra, F. With sea waves.
,, 9	1540	18.13	K_2	100 E. 26 N.	
,, 14	1544	8.50*ca*	D_1	80 W. 5 S.	Lima, F. Eqkes. also in Alaska, Tiflis and Bohemia.
Mar. 2	1546	20.21	E_1	145 E. 30 N.	Nemuro, F.
,, 5	1549	2.16	F_1, E_3	126 E. 9 N.	Agusan River Valley, F. Six mins. later felt at Buitenzorg, Java.
,, 12	1549	19.25	K_2	70 E. 36 N.	Bokara, F.
,, 13	1550	6.18	K_3	100 E. 23 N.	Mandalay, F.
,, 15	1553	9.6±3	F_1	174 E. 12 S.	
,, 19	1556*a*	3.0*ca*	M	178 E. 35 S.	
,, 23	1560	12.20±2	F_2	129 E. 10 S.	Timor, F.
,, 23	1560*a*	12.28*ca*	E_3	112 E. 22 N.	Origin determined from Manila, Tokio, Calcutta and Siberian stations.
,, 25	1562	19.0*ca*	M_3	105 W. 20 S.	Origin determined from Lima, Pilar, and Honolulu.
,, 26	1563	23.2	B	101 W. 17 N.	Chilapa, D.
,, 27	1564	3.45.5	B	101 W. 17 N.	,,
April 2	1568	5.52±2	O	26 E. 2 N.	
,, 4	1569	6.18	K_3	89 E. 33 N.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks *F*=*Felt*; *D*=*Destructive*
1908		h. m.			
April 9	1570	23.52±5	F_2	120 E. 7 S.	Apparently three *earthquakes*.
„ 12	1570*b*	19.2±2	E_2	145 E. 20 N.	
„ 16	1571	17.38	K_2	69 E. 39 N.	Pendschikent, Tashkent, F.
„ 19	1572	7.58	E_1	142 E. 38 N.	Central and North Japan, F.
„ 22	1575	23.45±3	G_1	48 E. 38 S.	
„ 30	1576	4.45	B	85 W. 5 N.	San José, Costa Rica, F.
May 3	1577	0.50	E_1	155 E. 41 N.	North Japan, F.
„ 5	1578	6.16±2	E_3, F_1	123 E. 3 N.	Basilan Island, F.
„ 5	1579	11.19±2	G_2	68 E. 12 S.	
„ 11	1581	13.44	F_1	119 E. 2 N.	E. Borneo, F.
„ 12	1582	20.18	E_2	142 E. 32 N.	Central Japan, F. Another shock at 20.34.
„ 15	1585	8.32	A_1	145 W. 56 N.	Yakutat, Alaska, D.
„ 17	1587	12.33	K_7	25 E. 42 N.	
„ 20	1589	7.39	F_2	122 E. 5 S.	
June 3	1591	15.56	K_3	67 E. 28 N.	Quetta, F.
„ 9	1593	2.56	E_1, E_2, E_3	142 E. 35 N.	Awa, Kazusa, F.
„ 27	1595	14.21	E_2	147 E. 33 N.	Central and North Japan, F.
July 1	1596	7.26	E_3	124 E. 22 N.	Batanes Island, E. Formosa and Ishigakijima, F.
„ 13	1600	21.6±5	E_1	145 E. 35 N.	Origin determined from com. at Osaka, *Irkutsk*, *Honolulu*. Agrees with Bombay and Baltimore.
„ 26	1601	16.0	F_3	104 E. 6 S.	Second shock 17.12, S. Sumatra, *F*.
Aug. 12	1604	15.40±3	M_2	160 E. 5 S.	Origin determined from com. of Samoa, Perth, Osaka. Agrees with Calcutta, Capetown and Lima records.
„ 12	1605	18.39	F_2	130 E. 5 S.	Banda Island, D.
„ 17	1607	10.32±2	L	40 W. 60 S.	
„ 19	1609	0.29*ca*	D_1	70 W. 8 S.	Trujillo and Pacasmoya, F.
„ 20	1612	9.53	K_2	89 E. 32 N.	
„ 22	1618	19.8*ca*	M_2	175 E. 6 N.	
„ 29	1619	18.15±3	H	36 W. 36 N.	
Sept. 4	1620	16.52±1	H	30 W. 40 N.	
„ 13	1621*b*	4.6	E_2	154 E. 33 N.	N.E. Japan (Honshu), F.
„ 21	1622	6.31	Q	155 W. 19 N.	Puna, Hawaii, F.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt ; D=Destructive
1908		h. m.			
Sept. 22	1622*b*	2.49	F_1	149 E. 6 N.	
,, 23	1623	7.7	F_3	90 E. 10 N.	
,, 26	1627	5.18±2	L	150 E. 60 S.	Origin determined from Christchurch, Sydney, Capetown and Pilar.
,, 28	1628	6.28	K_5	44 E. 38 N.	
Oct. 7	1630*a*	0.48±2	F_1	142 E. 0 N.	
,, 13	1632	5.6	B	102 W. 18 N.	Mexico City, F.
,, 14	1633	14.54	J	30 E. 80 N.	Origin determined from Shide, Irkutsk, Victoria, B.C., and many other stations.
,, 20	1634	2.40	E_3	122 E. 16 N.	E. Luzon, F.
,, 20	1635	5.37	E_3	122 E. 16 N.	,,
,, 23	1636	20.13	K_3	70 E. 35 N.	
,, 24	1637	21.12	K_3	75 E. 36 N.	
Nov. 2	1638	5.16	F_3	97 E. 2 S.	Padang and N. Sumatra, F. Second shock 7.20.
,, 6	1639	7.12±5	Q	160 E. 30 N.	S. Bonin Island, F.
,, 6	1640	13.45±2	P	169 E. 51 N.	
,, 9	1642	15.6	D_2	60 W. 23 S.	
,, 10	1643	18.51	E_3	126 E. 9 N.	Agusan River Valley, F.
,, 11	1644	13.18	E_3	121 E. 10 N.	Panay Island, F.
,, 12	1644*a*	12.8	D_1	78 W. 14 S.	Lima, F.
,, 12	1644*b*	16.37	F_3	98 E. 1 S.	Batoe Island, D.
,, 15	1645	1.30	F_2	118 E. 4 S.	S.W. Celebes, F.
,, 22	1649	7.15	E_1	146 E. 42 N.	
,, 23	1650	12.42±2	K_3	108 E. 11 N.	Origin determined from com. of Manila, Batavia, Calcutta, and Osaka. Agrees with Perth, Tashkent.
,, 30	1656	21.20	M_1	177 E. 37 S.	Whale Island, F. Origin determined from the com. of records from all the world stations, also max. for Christchurch.
,, 30	1656*a*	21.33	E_3	122 E. 20 N.	Babuyan Island, F. Origin determined from Manila, Zikawei, Irkutsk and Indian stations. Distance from 1656 to 1656*a*, 75°. Time taken for P_1 to travel this distance would be 14 min.

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1908		h. m.			
Nov. 30	1656*b*	21.36	A_1	135 W. 55 N.	Queen Charlotte Is., F. Origin determined from Victoria, Toronto, Baltimore, Shide and European stations. Distance, 1656 to 1656*b*, 100°. Time taken for P_1 to travel this distance would be 17 min., and this it practically did. Five maxima were recorded at Shide. At 22.15 - 22.20 (which refers to the Queen Charlotte Is. shock), 22.22–22.23 (which refers to Manila), and 22.53 (which refers to New Zealand).
Dec. 12	1659	12.53	K_3	102 E. 25 N.	
,, 12	1660	18.50±2	F_1	130 E. 0 N.S.	N.W. New Guinea, F. Origin determined from com. of Manila, Batavia, and Sydney.
,, 18	1663	15.35	G_1	52 E. 17 N.	
,, 22	1664	2.41	E_3	121 E. 25 N.	Formosa, F.
,, 28	1670	4.20.4	K_6	15.35 E. 38.10 N.	Messina, D.
1909					
Jan. 3	1677	21.40	M_1	151 E. 53 S.	
,, 15	1692	16.35	F_1, E_3	128 E. 8 N.	
,, 21	1695	2.20±3	F_1	169 E. 8 S.	
,, 23	1701	2.48	K_5	50 E. 33 N.	Burujird to Ispahan, D.
,, 29	1707	0.39±2	F_1	130 E. 0 N.S.	
,, 29	1708	12.43±2	F_1	133 E. 5 N.	
Feb. 9	1718	11.23	K_5	38 E. 40 N.	Harpoot and Alexandropol, F.
,, 9	1719	14.38	K_5	38 E. 40 N.	Harpoot and Alexandropol, F.
,, 10	1721	19.49	K_5	38 E. 40 N.	Harpoot and Alexandropol, F.
,, 10	1721*b*	20.30±2	F_2	133 E. 6 S.	Great Kei, F.
,, 15	1728	0.48	K_3	99 E. 36 N.	
,, 16	1730	7.58	K_3	100 E. 25 N.	
,, 16	1731	16.34	A_1	140 W. 63 N.	
,, 22	1735	9.21?	F_1, M_2	175 E. 12 S.	Determined from com. of Christchurch, Sydney, Perth, Honolulu, Manila. and Osaka. Multiple earthquake,

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1909		h. m.			
Feb. 22	1736	14.14	K_5	37 E. 39 N.	Sivas, F.
„ 26	1738	16.42±2	B	95 W. 5 N.	
Mar. 5	1748	12.16	K_5	40 E. 39 N.	Temran, F.
„ 7	1751	18.5±5	G_1, G_2	50 E. 50 S.	
„ 8	1753	11.20	M_2	165 E. 9 S.	
„ 10	1755	23.54	E_3	130 E. 29 N.	Oshima and Satsuma, F.
„ 11	1756	20.28	E_1, E_2, E_3	140 E. 32 N.	
„ 12	1757	0.21	E_1, E_2, E_3	140 E. 32 N.	
„ 12	1758	23.14	E_1, E_2, E_3	140 E. 32 N.	From Aomori to Bonin Is., F., and Shimosa, Hitachi, D.
„ 13	1760	14.21	E_1, E_2, E_3	140 E. 32 N.	Awa, Kazusa, D. Yokohama and Tokio F.
„ 17	1763	22.53	F_1, F_2	121 E. 2 S.	Central and North Celebes, D.
„ 22	1766	4.23	E_2	146 E. 29 N.	East coast of Japan, F.
„ 22	1767	20.2	E_2	146 E. 29 N.	East coast of Japan, F.
„ 22	1768	22.3	M_1	168 E. 48 S.	South New Zealand, F.
„ 27	1769	13.20±3	F_1	152 E. 2 S.	
April 10	1772	5.23±2	M_2	180 E. 9 S.	
„ 10	1773	18.43±2		140 E. 80 N.	Determined from Victoria, Toronto, Indian stations, Osaka and European stations.
„ 10	1773*a*	19.36±3	E_1	165 E. 45 N.	
„ 11	1774	4.2	K_5	45 E. 36 N.	
„ 11	1775	13.30±3	M_2	175 E. 7 S.	
„ 12	1777	1.1	M_2	170 E. 11 S.	
„ 13	1780	22.33	E_3	126 E. 13 N.	
„ 14	1781	19.53	E_3	125 E. 23 N.	
„ 23	1785	17.40		9 W. 39 N.	Benavente and Samora, D.
„ 25	1786	1.8	A_1	122 W. 53 N.	North Victoria, B.C., F.
„ 25	1787	21.49	E_2, M_2	140 E. 10 N.	
„ 25	1788	22.36	F_1, M_2	135 E. 6 N.	Determined from Manila, Osaka, Sydney, Perth, and Calcutta.
„ 27	1790	12.44±3	F_1	147 E. 0 N.S.	
„ 29	1791	22.34±2	G_1	63 E. 27 S.	
May 2	1792	6.49±5	M_1	180 E. 25 S.	Determined from Samoa, Sydney, Perth and Honolulu.
„ 2	1793	18.9±3	F_1, M_2	173 E. 10 S.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1909		h. m.			
May 10	1801	20.14	G_1	67 E. 8 S.	
,, 11	1802	13.0	M_2	179 W. 11 S.	
,, 12	1805	0.4±2	D_1	84 W. 1 S.	
,, 13	1807	14.0±5	H	25 W. 30 N.	
,, 17	1812	8.3	D_1	65 W. 22 S.	Topiza, D. Determined from Pilar, Toronto, Honolulu and European stations.
,, 17	1812	8.11	K_3	68 E. 37 N.	Determined from Indian stations, Tiflis and Zikawei.
,, 17	1812	8.16	G_1	33 E. 35 S.	Determined from Capetown, Mauritius and Perth.
,, 17	1812	8.21.2	K_6	9 W. 41 N.	Determined from max. of San Fernando, Azores and Shide.
,, 18	1813	16.44	A_1	132 W. 53 N.	
,, 18	1814	18.9	A_1	140 W. 51 N.	
,, 23	1823	10.43	E_3	120 E. 25 N.	
,, 25	1825	4.50	F_1	145 E. 0 N.S.	
,, 26	1826	2.0±3	F_1	145 E. 0 N.S.	
,, 30	1831	6.15	K_5, K_6, K_7	23 E. 39 N.	Bolo, D.
,, 30	1832	20.57	F_2	131 E. 6 S.	
June 3	1844	18.44	F_3	102 E. 2 S.	Korintji, Djambi, D., 200 killed.
,, 6	1848	4.50	M_2	147 E. 9 N.	
,, 8	1851	5.46	D_2	73 W. 25 S.	Coquimbo, D. Taltal, F.
,, 9	1852	0.-6	D_2	73 W. 25 S.	
,, 11	1855	21.6	K_6	5.3 E. 43.5 N.	St. Cannat, D.
,, 12	1859	20.20	F_1	170 E. 19 S.	
,, 22	1893	13.55		10 E. 58 N.	Determined from British, German stations, Malta, Cairo, Tiflis and Calcutta.
,, 22	1893	13.14	E_2	140 E. 17 N.	Determined from Osaka, Manila and Honolulu.
,, 27	1910	7.15*ca*	M_2	162 E. 10 S.	
July 3	1928	19.53.5	K_8	7 E. 36 N.	Ain-Trab, Ain-Fakrouna, F.
,, 7	1944	21.34	K_2	71 E. 37 N.	A district 8° by 6° shaken.
,, 13	1957	13.2	K_1	148 E. 62 N.	Determined from Osaka, Manila, Tiflis and British stations.
,, 15	1958	0.36	K_5	21.15 E. 37.45 N.	Havari, Kalivia and Sosti, D. More than 100 killed and wounded.
,, 26	1980	10.54	G_2	63 E. 8 N.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt ; D=Destructive
1909		h. m.			
July 30	1982	10.47	B	101 W. 13 N.	Acapulco and Chilpancingo, D.
„ 31	1984	19.18	B	101 W. 13 N.	Acapulco and Chilpancingo, D.
Aug. 2	1986	10.14	F_3	95 E. 14 N.	
„ 7	1999	16.45	M_2	178 W. 6 S.	
„ 10	2001	6.42	M_2	175 W. 15 S.	Tonga, F.
„ 12	2004	11.23	E_3, F_1	126 E. 8 N.	
„ 15	2008	6.27	E_3	136 E. 36 N.	Central Japan, D.
„ 16	2016	6.58	B	84 W. 10 N.	San José, Costa Rica, F.
„ 18	2018	0.34	F_1	167 E. 14 S.	
„ 22	2024	15.40±2	K_3	75 E. 37 N.	
„ 29	2039	10.28	E_2	128 E. 26 N.	
Sept. 5	2054*b*	9.10±2	G_1	72 E. 16 S.	
„ 7	2058	15.28±2	K_3	70 E. 33 N.	
„ 8	2059	16.45±5	E_1	180 E. 60 N.	Two earthquakes ?
„ 8	2060	23.17	F_1	135 E. 0 N.S.	Doré, D.
„ 10	2062	18.7	E_3	26 N. 130 E.	Nase, F.
„ 10	2063	19.44	E_3	127 E. 10 N.	E. Visayas, F.
„ 11	2065	10.52	E_2	142 E. 17 N.	
„ 16	2071	18.49	F_3	102 E. 4 S.	S. Sumatra, F.
„ 16	2072	19.35	E_1	145 E. 40 N.	
„ 21	2076	18.49	F_1	132 E. 3 N.	
„ 23	2078	6.29	F_3	92 E. 0 N.S.	
„ 28	2082	19.57	E_3	122 E. 18 N.	Aparri, F.
Oct. 4	2091	13.39±2	F_1	160 E. 12 S.	
„ 17	2102	22.12±2	K_2	91 E. 41 N.	
„ 20	2108	23.42	K_3	68 E. 29 N.	Quetta and Bellpat, D.
„ 27	2114	1.30	M_1	172 E. 36 S.	
„ 28	2117	3.53	H	5 W. 30 S.	
„ 29	2118	6.45	A_2	124 W. 41 N.	Fortuna, N. California, D.
„ 29	2119	16.4±1	K_4	31 E. 44 N.	
„ 29	2120	17.39±1	K_4	31 E. 44 N.	
„ 30	2121	10.13±2	F_1	132 E. 5 S.	N.W. New Guinea to Ambon and Timorlaut, F.
„ 31	2122	10.18	B	105 W. 8 N.	
Nov. 1	2123	6.15±2	H	33 W. 0 N.S.	
„ 1	2124	9.16	K_3	47 E. 36 N.	
„ 3	2126	6.11±5	M_1	145 E. 56 S.	
„ 8	2132	20.12	D_2	100 W. 30 S.	Santiago, Copiapo, F.
„ 10	2134	6.12	E_3	132 E. 32 N.	Miyazaki, D. Another earthquake at 135 E. 34 N., Okayama, D.
„ 12	2137	19.48±2	O	30 E. 4 S.	
„ 20	2141	12.40±3	E_3	132 E. 15 N.	
„ 21	2142	7.36	E_3	122 E. 25 N.	
„ 28	2147	0.53±3	M_2	176 W. 12 S.	
Dec. 3	2154	3.2	F_1	145 E. 1 S.	
„ 8	2159	9.1	F_1	160 E. 7 S.	
„ 9	2160	15.33	F_1	161 E. 8 S.	
„ 9	2161	21.5	F_1	165 E. 10 S.	

Seismic Activity—continued.

Date	No.	Time at Origin	District	Lat. and Long. of Origin	Remarks F=Felt; D=Destructive
1909		h. m.			
Dec. 9	2162	21.42	F_1	127 E. 2 S.	Ambon and Piroe, F.
„ 9	2163	23.27	E_2, M_2	147 E. 14 N.	
„ 9	2163	23.27	M_2	176 E. 0 N.S.	Determined from Samoa, Honolulu and Sydney.
„ 22	2180	12.38*ca*	F_1	152 E. 3 S.	
„ 23	2182	22.13±3	F_1	160 E. 9 S.	
„ 28	2187	19.17±2	F_1	129 E. 5 S.	

III. *Relation of Amplitude in Seconds of Arc to the Distance of an Origin.*

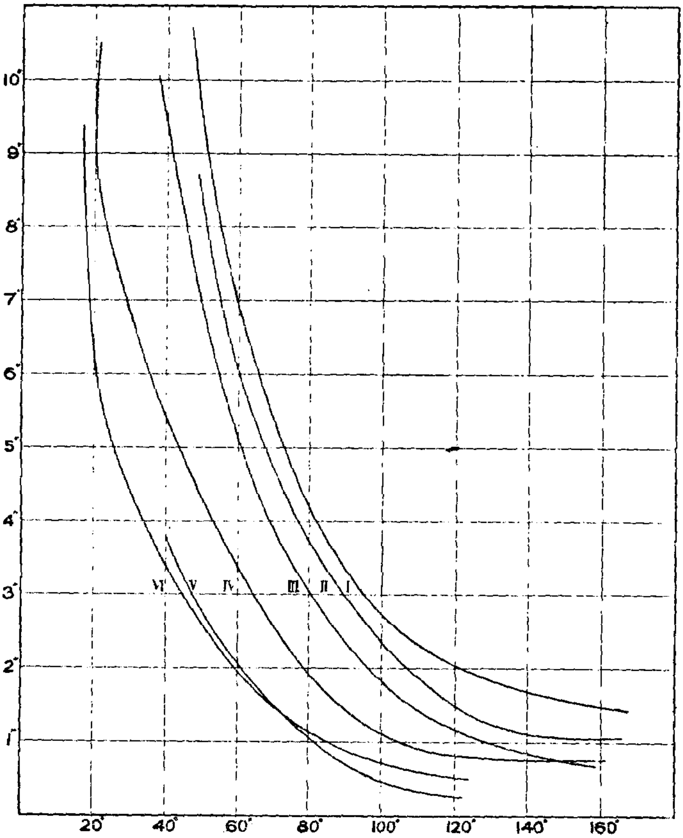
Those who have experienced earthquake movement in the vicinity of an epicentre have many reasons to conclude that it is undulatory in character. Earthquake earth-waves have frequently been seen. Water in tanks, ponds, and in small vessels has been observed to flow irregularly and intermittently first in one direction and then in another. The movement of the fluid suggests that the containing vessel has been subjected to a series of tilts. Pictures and objects free to swing do so in an extremely irregular manner. They may move, say, to the right, stop, go further to the right, and again come to rest, after which they may swing suddenly in an opposite direction. The hanging lamp or whatever the object may be does not swing freely like a pendulum, but follows a series of irregular displacements of the supporting point.

At considerable distances from an origin where the movements are less violent, although they are not so irregular in character, the records from seismographs also give evidence of angular displacements. Two similar horizontal pendulums similarly oriented, but adjusted to have different periods, give for the large waves of crypto or teleseismic disturbances records of amplitude the linear measurements of which are very different. The instrument with the longer period yields the larger diagram. If, however, we convert these displacements into angular measure we find that the two records are comparable.

In the British Association Report for 1893, p. 221, I gave angular measurements for earth-waves which form portions of earthquakes which could be felt. I obtained these records from an 'angle measurer or clinometer.' A similar but much more sensitive apparatus was in 1903 devised by Dr. Schlütter. The object was to measure the angular component of teleseismic motion. This does not appear to have been detected.

This means that the conclusions arrived at by Dr. Schlütter, which at the present time are shared by several seismologists, are very different from mine.

Following my own ideas, in the accompanying diagram I have given curves which show for six large earthquakes the approximate relation between the amplitudes of teleseismic disturbances in angular measure and the distance from an origin measured in geographical degrees. These measurements are deduced from information published in the British Association circulars, which contain records from the particular kind of instrument they have adopted. The earthquakes considered, which I number according to their order in the accompanying diagram, were as follow:—



Relation of Amplitude (in seconds of arc) to distance from an origin for six large earthquakes.

I. California, April 18, 1906: observations from 30 stations, 17 good.
II. Mexico, March 26, 1908: 25 observations, 12 good.
III. Mexico, July 30, 1909: 20 observations, 11 good.
IV. Chile, June 8, 1909: 19 observations, 9 good.
V. Japan, November 10, 1909: 22 observations, 11 good.
VI. Messina, December 28, 1908: 23 observations, 12 good.

The observations indicated as 'good' fall on or near to the curve to which they refer; the remainder are far removed and erratically placed with regard to the same. The curves as they stand can therefore only be regarded as rough approximations to the truth. They indicate that up to about 80° from an origin amplitude decreases uniformly. From 80° to 120° it decreases less rapidly, and beyond this distance the decrease is very slow and the curve tends to become asymptotic to the axis representing distance. Professor H. H. Turner very kindly examined these curves, together with the observations on which they are founded, with the result that two of them were brought more closely in conformity with the remaining four.

At the present time this investigation is, with additional material, receiving careful attention from Professor Turner.

IV. *Direction of Earthquake Motion.*

Between 1881 and 1882, partly in conjunction with the late Professor T. Gray, I carried out an extensive series of experiments on earth-vibrations produced by firing dynamite or some other explosive in boreholes of varying depth. The resulting movements were recorded by seismographs. One result repeatedly shown indicated that the first movement was invariably in the direction of the origin of the explosion.[1]

An observation corresponding to this has been shown by Prince Galitzin to accompany teleseismic motion, and when it is pronounced it furnishes the azimuth of the epifocal district. To determine whether the *maximum* movements of teleseisms showed any relationship to the direction in which they had been propagated I examined forty-two seismograms of North-South and East-West motion as recorded at Shide. In the following table I give the number of a seismogram as entered in the Shide Register, published in the British Association circulars, its date, the latitude and longitude of origin of the disturbance to which it refers, the azimuth of this origin from Shide, and the azimuth as calculated from the North-South and East-West amplitudes. Each of these latter may be read as so many degrees east or a similar number degrees west of North.

Register No.	Date	Position of Origin	Azimuth of Origin	Azimuth as calculated
	1901			
496	May 25	165 E. 12 N.	N. 20 E.	N. 30 E.
565	Dec. 14	121 E. 14 N.	N. 57 E.	N. 60 E.
571	Dec. 31	173 W. 41 N.	N. 15 W.	N. 11 W.
	1903			
705	Apr. 29	143 W. 43 S.	N. 55 W.	N. 54 W.
	1904			
820	Mar. 1	178 W. 13 S.	N. 20 W.	N. 25 W.
838	Apr. 12	175 W. 44 N.	N. 8 E.	N. 12 E.
847	May 1	130 E. 2 N.	N. 22 E.	N. 30 E.
860	June 25	160 E. 53 N.	N. 11 E.	N. 17 E.
863	June 27	160 E. 53 N.	N. 11 E.	N. 17 E.
872	July 24	160 E. 53 N.	N. 15 E.	N. 25 E.
877	Aug. 8	179 E. 42 S.	N. 5 E.	N. 13 E.
884	Aug. 24	135 E. 32 N.	N. 42 E.	N. 47 E.
885	Aug. 27	141 W. 67 N.	N. 18 W.	N. 20 W.
886	Aug. 30	101 E. 30 N.	N. 62 E.	N. 57 E.
889	Sept. 11	106 E. 23 N.	N. 65 E.	N. 65 E.
924	Dec. 2	132 E. 10 N.	N. 55 E.	N. 62 E.

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[1] See *Phil. Trans. R.S.*, part iii., 1882, p. 871; *Trans. Seis. Soc.*, vol. viii., 1885, pp. 1-82; *Brit. Assoc. Reports*, 1885, pp. 363, 364.

We have here sixteen instances in which the azimuth of an origin determined from the maxima of North-South and East-West motion approximately agrees with the azimuth as measured on a globe. There are, however, in the same interval of time twenty-six instances where no such agreement exists, and this I find to be the case for all the large records obtained during the latter half of 1909. The inference is that the main portion of teleseismic motion, like that of macroseismic motion, generally takes place in directions independent of the azimuth of its origin.

V. *On the Relative Duration of Two Rectangular Components of Earth-movement at a given Station.*

The records I refer to were made at Shide by a pair of light horizontal Milne pendulums mounted on the same cast-iron frame, and installed upon a brick column. One of these recorded N.-S. motion and the other E.-W. motion. The duration of the movements of the latter practically agreed with the duration recorded by a similar and similarly oriented pendulum on a separate column. From this it is inferred that although two light pendulums are carried on one stand they had no sensible effect upon each other's movements. I have divided the records into the following four groups, the natural period of the pendulums being different in each group:—

Group 1.—May 25, 1901, to January 1, 1902. Period of N.-S. boom 19 seconds, and E.-W. boom 17 seconds. Ten large earthquakes had a total duration of 1,341 minutes for N.-S. movements, and 1,313 for E.-W. motion. Pendulum with the longest period moved for the longest time, but the difference is very small.

Group 2.—February 27 to December 23, 1903. Period of N.-S. boom 20 seconds, and E.-W. boom 17 seconds. Eleven large earthquakes had a total duration of 730 minutes for N.-S. motion, and 725 for E.-W. motion.

Group 3.—January 20 to June 27, 1904. Period of N.-S. boom 20 seconds, and E.-W. boom 30 seconds. Nine large earthquakes had a total duration of 1,036 minutes for N.-S. motion, and 1,067 for E.-W. motion. Here again the pendulum with the longest period was disturbed for the greatest length of time.

Group 4.—July 24 to October 9, 1904. Period of both pendulums 25 seconds. The total duration for eight earthquakes was for N.-S. motion 725 minutes, and for E.-W. motion 732 minutes. In this instance pendulums with similar periods have been kept in motion for equal intervals of time. Nineteen large earthquakes between July 3 and December 10, 1909, show a similar result.

From the above notes it might be inferred that the apparent duration of a teleseism largely depends on the sensibility of the recording apparatus to tilting. A detailed examination of these records, however, distinctly shows that this is not the case, and that a pendulum with a short period is frequently in movement for a longer interval of time than one with a long period. Amongst the earthquakes referred to in the above groups I find eight instances in which the direction of the N.-S. motion has exceeded the E.-W. motion by intervals of from 10 to 69 minutes. The azimuths of the origins of these earthquakes were 41, 36, 45, 8, 20, 13, 15, and 5 degrees east of north, which is the direction of Japan or the Central Pacific. In six instances where the E.-W. motion exceeded the N.-S. motion by intervals of from 10 to 46 minutes the azimuths of the origins were 70 E., 79 W., 90 W., 90 W., 69 E., and 12 W., which with the exception of the last suggest origins in Central Asia or Central America. It would therefore appear that marked differences in the duration of two rectangular components of motion are possibly associated with the azimuth of its origin.

VI. *Megaseismic Activity and Periods of Quiescence.*

In the British Association Report, 1910, p. 54, I gave a note on megaseismic activity and rest. The result showed that a large group of megaseisms was followed by a long period of quiescence, while small groups were followed by comparatively short periods of quiescence. This result was based on the examination of twenty-eight groups of large earthquakes. The present discussion is based upon eighty groups, found in the Registers for the years 1899-1908 inclusive. The number of earthquakes in these groups varies from two or three to fifteen. In two cases, however, the number of earthquakes is forty-six and fifty-one. If an earthquake has been recorded over the whole world I have considered its intensity double that of a disturbance which is only recorded over a hemisphere. The intensity of a group is assumed to be the sum of the intensities of each earthquake it contains. Groups usually extend over from one to three days, and it is seldom they extend over more than six days. The intensity per day is the intensity of a group divided by the number of days over which it extended. This quantity does not appear to show any relationship to the number of days of rest which preceded or followed the group which it represents.

The number of days which have elapsed between the centre of one group and the centre of the group which follows has usually been from fifteen to fifty days. In the accompanying figure the number of earthquakes in different groups are plotted in relation to these intervals.

At first sight it would appear that these two quantities had a rough relationship, but it must be remembered that the intervals between centres of groups have frequently been increased by the duration of the groups.

VII. *Megaseismic Frequency in Different Seasons.*

In the Report for 1906 for the seven years 1899-1905 I compared the frequency of large earthquakes in the following three districts:—

1. Districts A, B, C refer to the East Pacific coast north of the Equator, including the Antillean fold.
2. Districts E, F refer to the West and South-west portions of the North Pacific.
3. District K, or the various folds extending from the Balkans to the Himalayas.

The ratios of the numbers of disturbances which were noted in

P.92a
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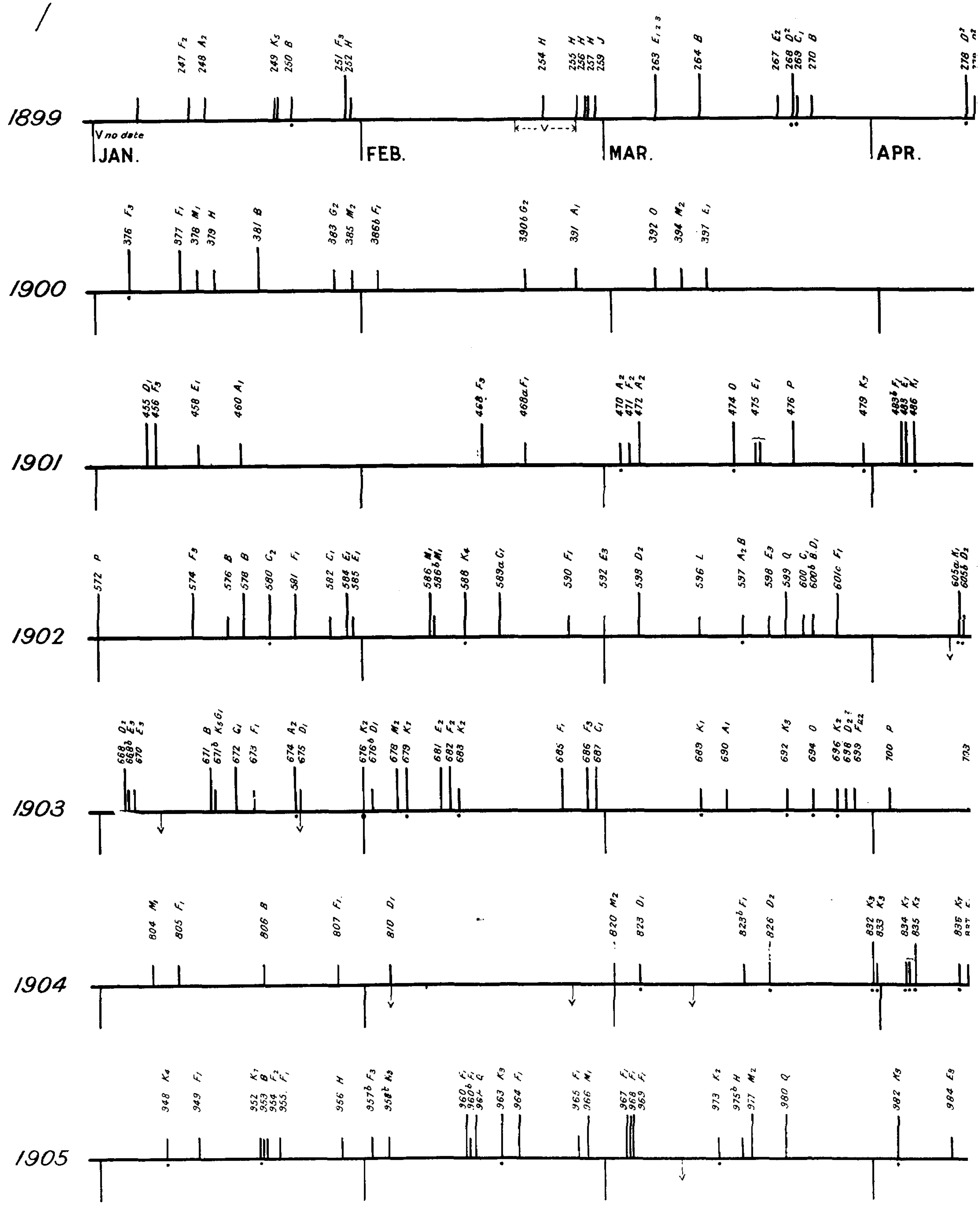
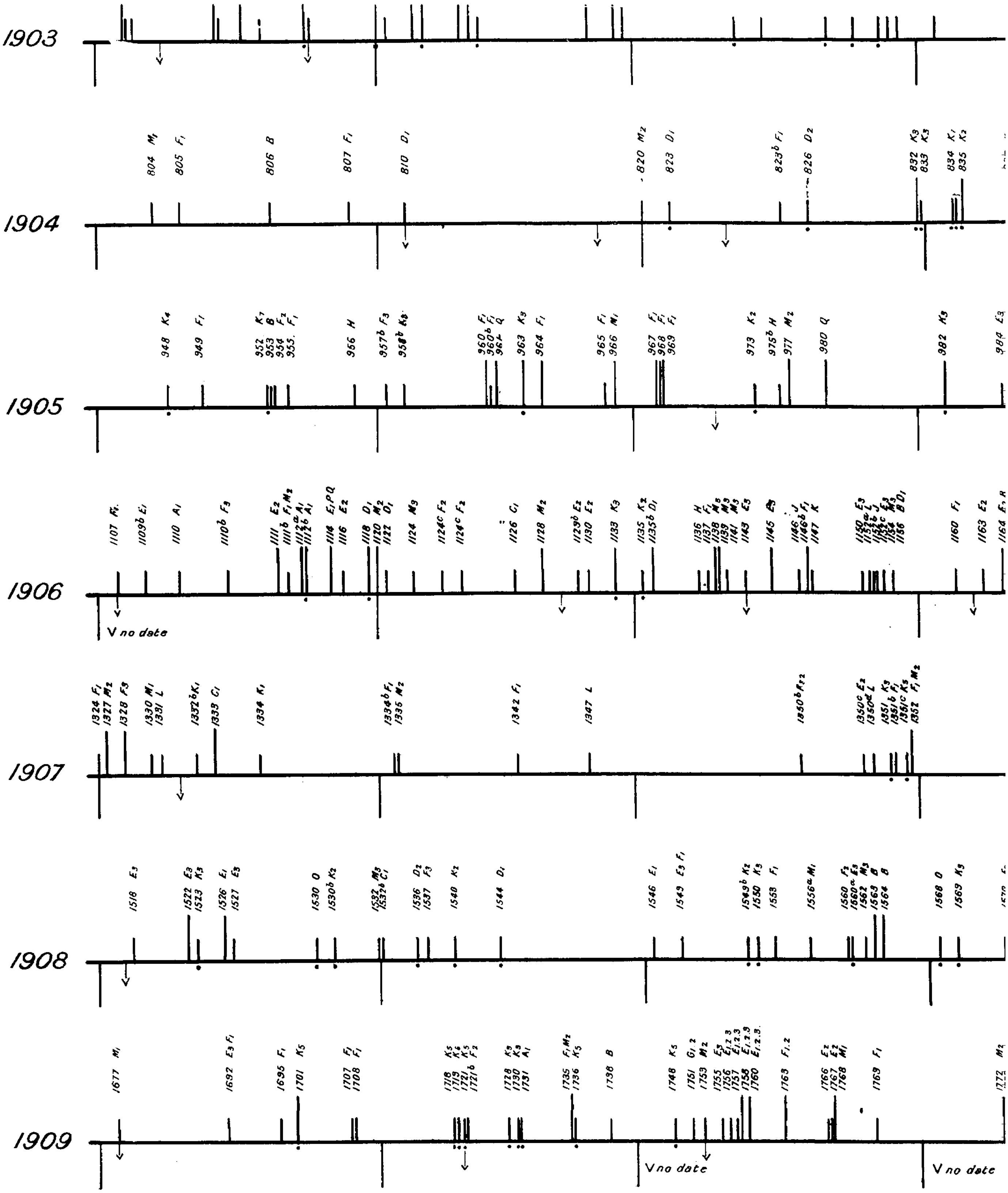

1899
1900
1901
1902
1903
1904
1905
JAN.
FEB.
MAR.
APR.
V no date
247 F2
248 A2
249 K5
250 B
251 F3
252 H
254 H
255 H
256 H
257 H
259 J
263 E1 2 3
264 B
267 E2
268 D2
269 C1
270 B
278 D2
376 F3
377 F1
378 M1
379 H
381 B
383 G2
385 M2
386b F1
390b G2
391 A1
392 O
394 M2
397 E1
455 D1
456 F3
458 E1
460 A1
468 F3
468a F1
470 A2
471 F2
472 A2
474 O
475 E1
476 P
479 K3
483b F1
485 E1
486 K1
572 P
574 F3
576 B
578 B
580 G2
581 F1
582 C1
584 E1
585 E1
586 M1
586b M1
588 K4
589a G1
590 F1
592 E3
593 D2
596 L
597 A2 B
598 E3
599 Q
600 C1
600b B D1
601c F1
605a K1
605b D2
668 D2
668b E3
670 E3
671 B
671b K5 G1
672 G1
673 F1
674 A2
675 D1
676 K2
676b D1
678 M2
679 K1
681 E2
682 F2
683 K2
685 F1
686 F3
687 C1
689 K1
690 A1
692 K3
694 O
696 K2
698 D2
699 F22
700 P
703
804 M1
805 F1
806 B
807 F1
810 D1
820 M2
823 D1
823b F1
826 D2
832 K3
833 K3
834 K1
835 K2
836 K1
948 K4
949 F1
952 K1
953 B
954 F2
955 F1
956 H
957b F3
958b K3
960 F1
960b F1
961 G
963 K3
964 F1
965 F1
966 M1
967 F1
968 F1
969 F1
973 K2
975b H
977 M2
980 Q
982 K3
984 E3

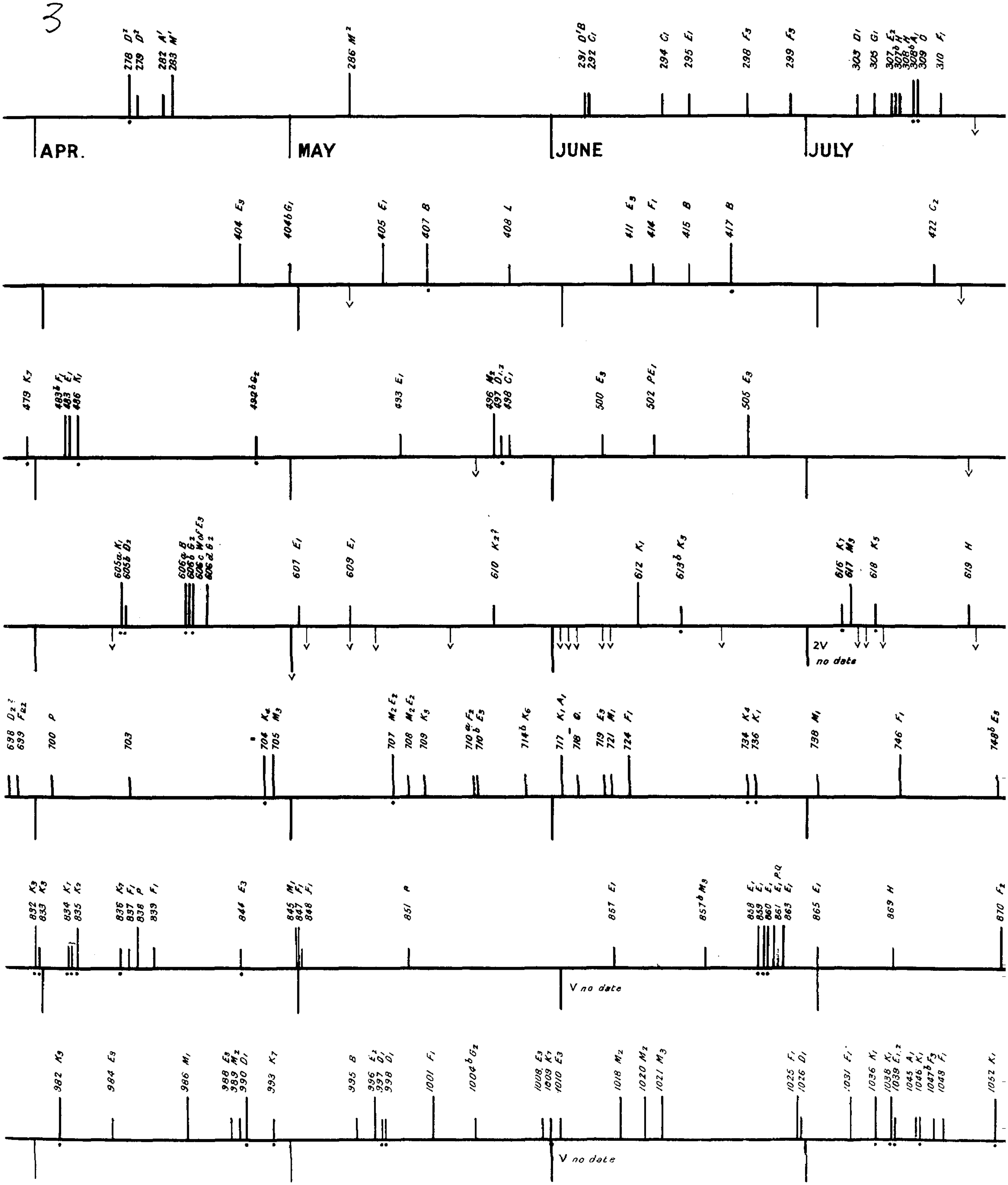

1903
1904
804 M1
805 F1
806 B
807 F1
810 D1
820 M2
823 D1
823b F1
826 D2
832 K3
833 K3
834 K1
835 K2
1905
948 K4
949 F1
952 K1
953 B
954 F2
955 F1
956 H
957b F3
958b K3
960 F1
960b F1
961 Q
963 K3
964 F1
965 F1
966 M1
967 F1
968 F1
969 F1
973 K2
975b H
977 M2
980 Q
982 K3
984 E3
1906
1107 F1
1109b E1
1110 A1
1110b F3
1111 E2
1111b F1 M2
1112a A1
1112b A1
1114 E1 PQ
1116 E2
1118 D1
1120 M2
1122 D1
1124 M3
1124c F2
1124c F2
1126 C1
1128 M2
1129b E2
1130 E2
1133 K3
1135 K2
1135b D1
1136 H
1137 F1
1138 M3
1139 M3
1141 M3
1143 E3
1145 E3
1146 J
1146b F1
1147 K
1150 E3
1152a L
1152b J
1152c E3
1154 M3
1156 B D1
1160 F1
1163 E2
1164 F1 R
V no date
1907
1324 F1
1327 M2
1328 F3
1330 M1
1331 L
1332b K1
1333 C1
1334 K1
1334b F1
1335 M2
1342 F1
1347 L
1350b F2
1350c E2
1350d L
1351 K3
1351b F1
1351c K3
1352 F1 M2
1908
1518 E3
1522 E3
1523 K3
1526 E1
1527 E3
1530 O
1530b K2
1532 M3
1532b C1
1536 D2
1537 F3
1540 K2
1544 D1
1546 E1
1549 E3 F1
1549b K2
1550 K3
1553 F1
1556a M1
1560 F1
1560a E3
1562 M3
1563 B
1564 B
1568 O
1569 K3
1909
1677 M1
1692 E3 F1
1695 F1
1701 K5
1707 F1
1708 F1
1718 K5
1719 K4
1721 K5
1721b F2
1728 K3
1730 K3
1731 A1
1735 F1 M2
1736 K5
1738 B
1748 K5
1751 G1,2
1753 M2
1755 E3
1756 E1,2,3
1757 E1,2,3
1758 E1,2,3
1760 E1,2,3
1763 F1,2
1766 E2
1767 E2
1768 M1
1769 F1
1772 M2
V no date
V no date

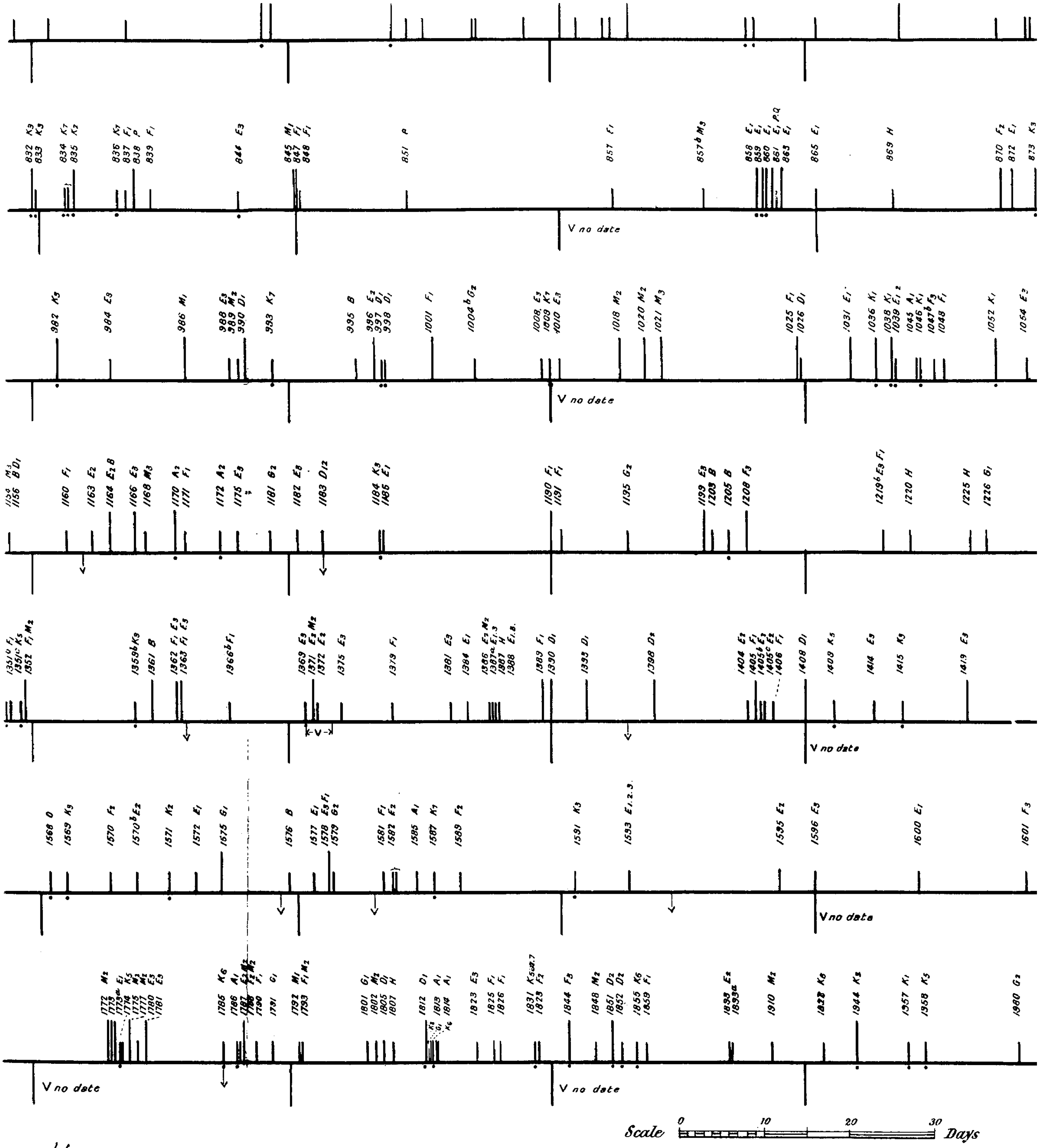
2

J. MILNE.

MEGASEISMS 1899-1

3





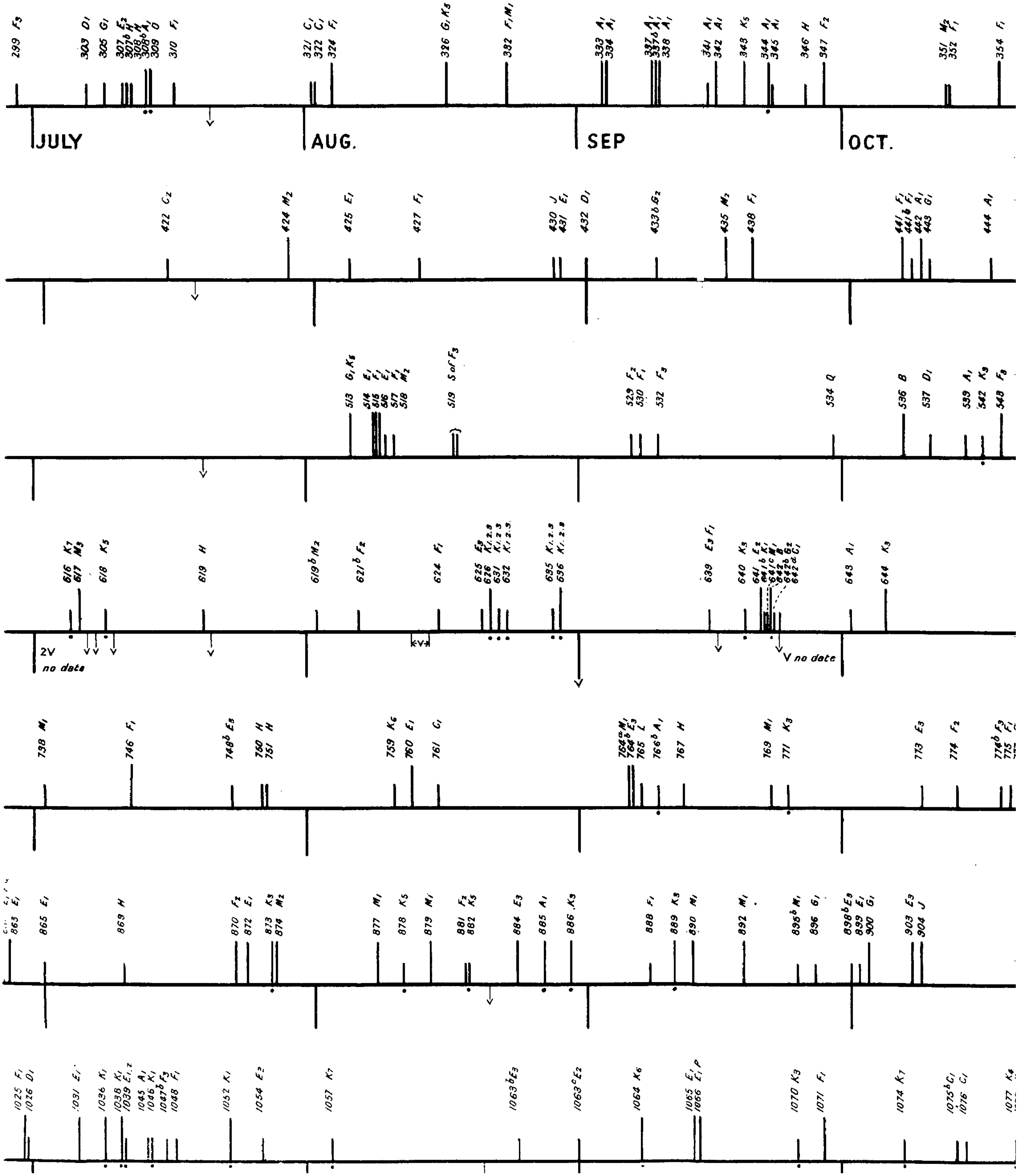
4

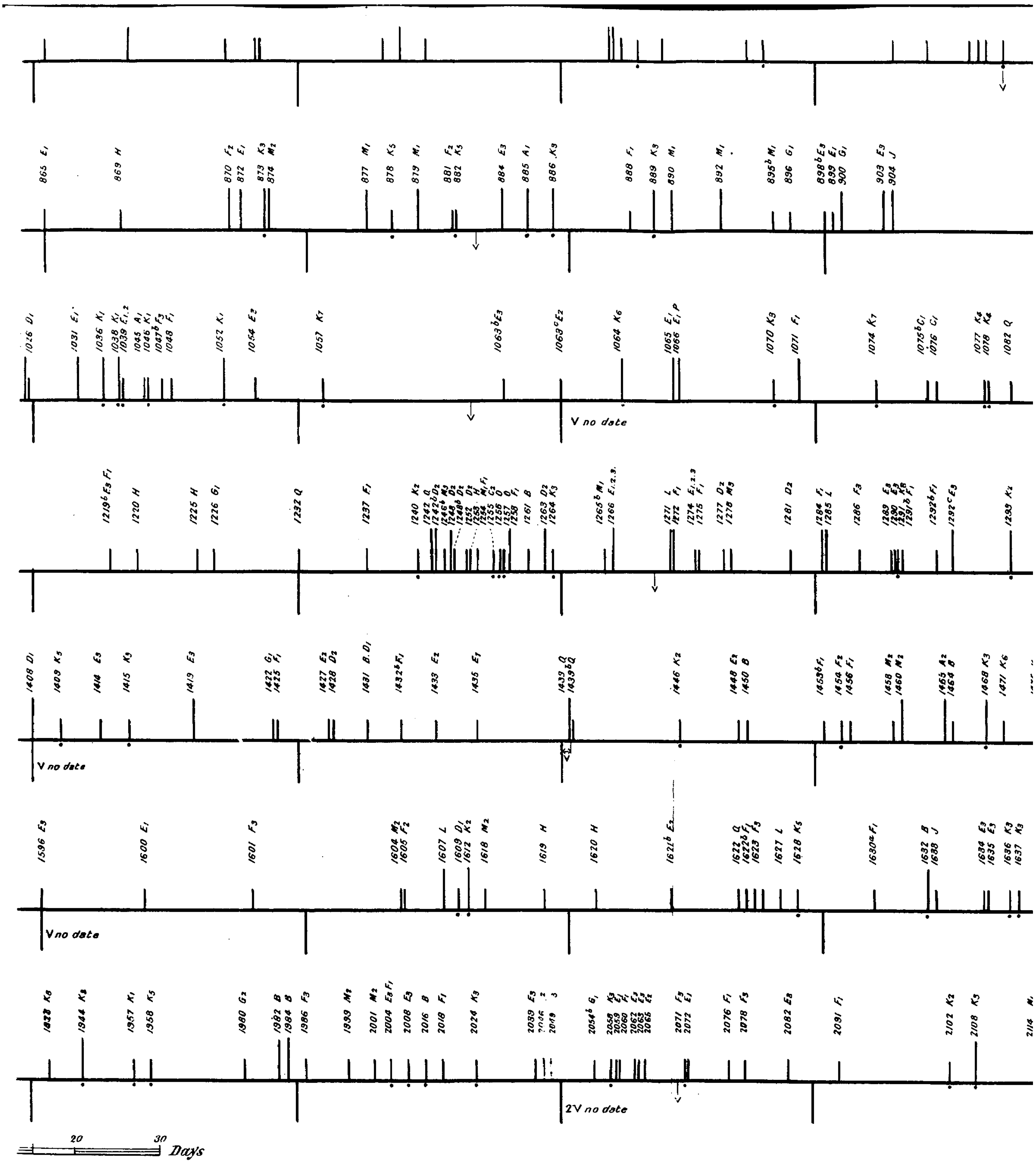
| Disturbed the Whole World. | Disturbed a

Originated on Land. v Volcanic Erupti

MS 1899-1909

5





6

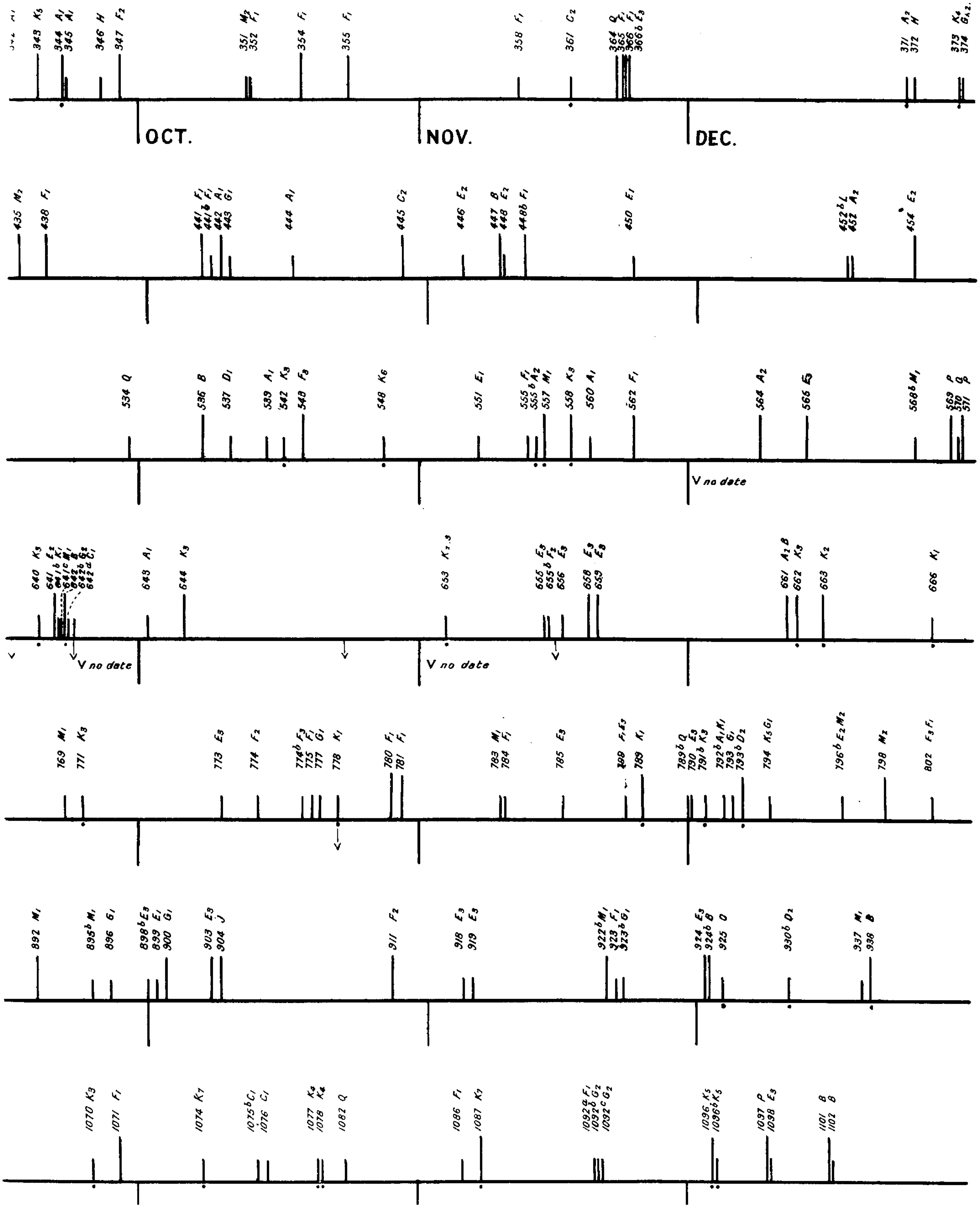
| Disturbed a Hemisphere.

Illustrating

v Volcanic Eruption, by L. Kelly.

Plate II.

7



343 K5
344 A1
345 A1
346 H
347 F2
351 M2
352 F1
354 F1
355 F1
358 F1
361 C2
364 Q
365 F1
366 F1
366b E3
371 A2
372 H
373 K4
374 GA2.
OCT.
NOV.
DEC.
435 M2
438 F1
441 F1
441b F1
442 A1
443 G1
444 A1
445 C2
446 E2
447 B
448 E2
448b F1
450 E1
452b L
452 A2
454 E2
534 Q
536 B
537 D1
539 A1
542 K3
543 F3
548 K6
551 E1
555 F1
555b A2
557 M1
558 K3
560 A1
562 F1
564 A2
566 E3
568b M1
569 P
570 Q
571 P
V no date
640 K3
641 E2
641b K1
641c M1
642 B
642b G2
642d C1
643 A1
644 K3
653 K2,3
655 E3
655b F2
656 E3
658 E3
659 E3
661 A2B
662 K3
663 K2
666 K1
V no date
V no date
769 M1
771 K3
773 E3
774 F2
774b F3
775 F1
777 G1
778 K1
780 F1
781 F1
783 M1
784 F1
785 E3
788 F1E3
789 K1
789b Q
790 E3
791b K3
792b A1M1
793 G1
793b D2
794 K5G1
796b E2M2
798 M2
802 F3F1
892 M1
895b M1
896 G1
898b E3
899 E1
900 G1
903 E3
904 J
911 F2
918 E3
919 E3
922b M1
923 F1
923b G1
924 E3
924b B
925 O
930b D2
937 M1
938 B
1070 K3
1071 F1
1074 K1
1075b C1
1076 C1
1077 K4
1078 K4
1082 Q
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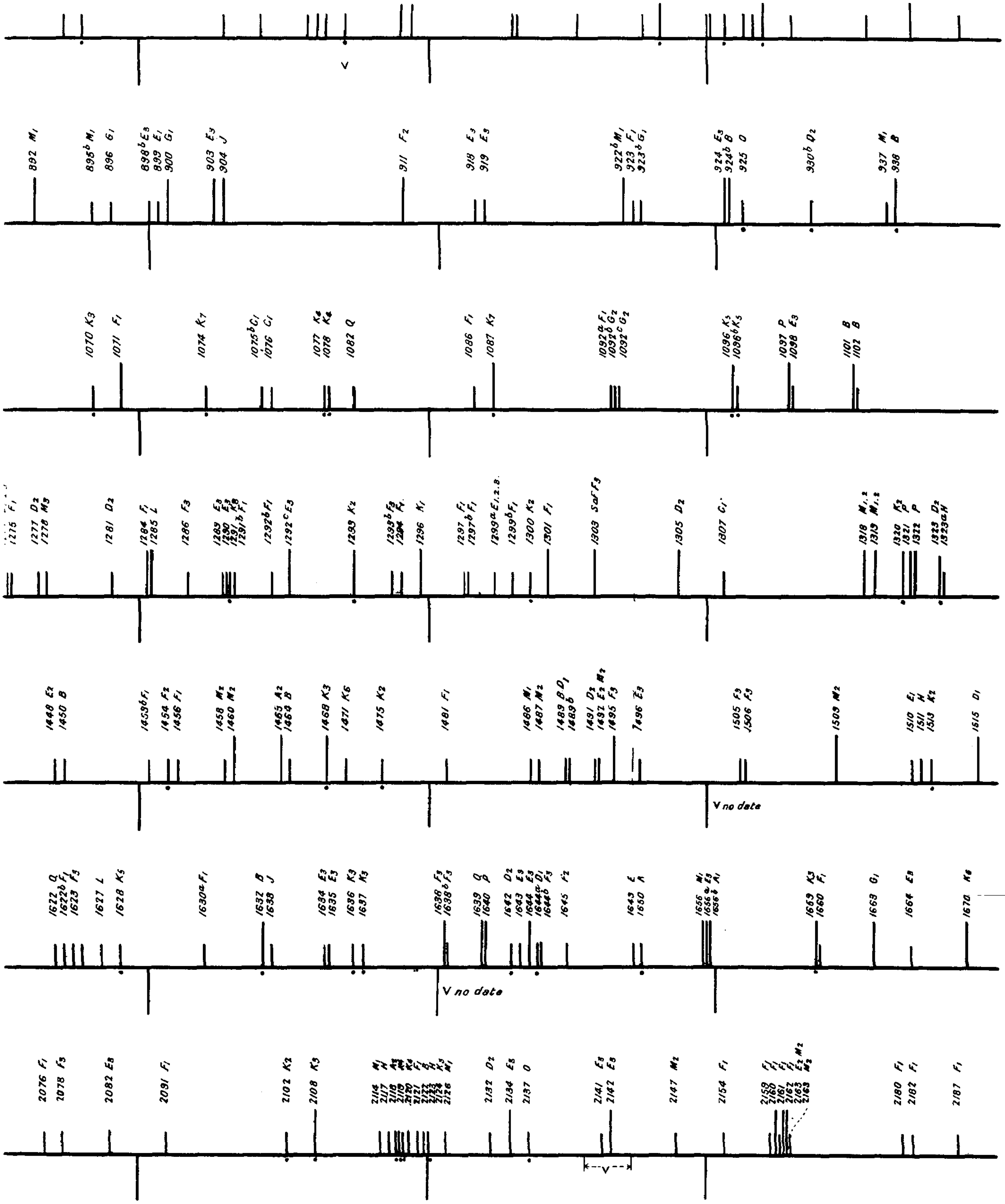
1098 E3
1101 B
1102 B



8

S. HIROTA.

Illustrating the Seventeenth Report on Seismological Investigations.

winter (October 31 to March 31) to those noted in summer in these three districts were respectively 1 to 0·55, 1 to 1·08, and 1 to 1·20.

In the following tables these comparisons are continued from the year 1906 to the year 1910:—

Districts		Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
A, B, C.	1906	3	1	2	3	0	2	1	1	0	0	0	0	13
	1907	1	0	0	1	0	0	0	1	1	2	0	0	6
	1908	0	1	0	0	1	0	0	0	0	1	1	0	4
	1909	0	0	0	1	2	0	2	1	0	1	0	0	7
	1910	0	1	2	1	2	2	1	1	1	0	0	1	12
	Total	4	3	4	6	5	4	4	4	2	4	1	1	42
E, F.	1906	5	3	6	6	2	4	1	3	5	8	6	0	49
	1907	3	1	4	3	8	4	3	4	1	1	3	3	38
	1908	3	1	4	2	3	2	2	1	1	3	8	2	32
	1909	5	5	7	7	7	5	0	6	8	2	3	8	63
	1910	4	3	0	7	11	12	7	3	5	5	4	14	75
	Total	20	13	21	25	31	27	13	17	20	19	14	27	257
K.	1906	0	1	2	1	1	0	0	2	0	3	1	1	12
	1907	1	0	1	1	0	0	2	0	1	3	0	1	10
	1908	1	0	3	2	1	1	1	3	1	2	0	3	18
	1909	3	5	2	3	2	1	5	3	1	5	1	0	31
	1910	1	1	0	1	3	5	4	11	3	1	1	2	33
	Total	6	7	8	8	7	7	12	19	6	14	3	7	104

	Earthquakes in Winter	Earthquakes in Summer	Ratio
Districts A, B, C.	17	25	1 to 1·47
,, E, F.	124	133	1 to 1·07
District K.	45	59	1 to 1·31

These results suggest that the greater number of large earthquakes, whether they originate beneath an ocean or beneath a continent, occur in summer, and a similar result is arrived at if we assume that summer commences on May 1 rather than on April 1.

It must, however, be noted that for A, B, C between 1899 and 1905 the greater frequency was found in the winter months. With this exception the results here given accord with those obtained previously.

If we combine these three districts for the twelve years ending 1910 we find that 365 earthquakes have taken place in the summer and 349 in winter, the winter to the summer ratio therefore being 1 to 1·04.

This close correspondence between winter and summer frequency suggests that megaseismic frequency is but little influenced by epigenic phenomena which follow the six-monthly changes in climate. The observation that between 1899 and 1905 the greater frequency was in winter, while subsequently it was in summer, also suggests that megaseismic frequency is not related to our seasons, and if there is a seismic periodicity it must be sought for outside seasonal recurrences.

Frequency in the World, 1899 *to* 1909.—In eleven years, or 4,018 days, there were 976 megaseisms, or on the average one every 4·1 days. Of these 117 at least originated on land, and the remaining 859 beneath oceans. The suboceanic activity was therefore seven times that on land. The average for the latter was one megaseism for every thirty-four days, but beneath the ocean one every 4·6 days.

Frequency in Districts F_1, F_2 and F_3 (East Indies).—These districts are taken collectively for five years, 1889 to 1893. I select these three overlapping areas because at the present time they are more active than any other. In the time considered, 1,826 days, sixty megaseisms originated in them. The average frequency was therefore one disturbance in thirty days. If we regard those disturbances which occurred within an interval of less than five days of each other as being parts of one effort, the number sixty is reduced to forty-eight, and the average frequency becomes one disturbance in thirty-eight days. The time intervals between these forty-eight efforts expressed in days were as follow:—

6	8	8	10	11	11	11	12	12	13	—	—	15
18	18	18	18	18	19	20	20	22	23	23	23	25
30	31	31	31	31	32	33	34	36	37	39	42	
47	47	54	57	60	62	65	93	124	129	132		

One inference which may be drawn from these figures is that in these districts the time taken to bring about conditions of seismic instability lies between eighteen and thirty-one days.

Frequency in Districts E_1 and E_3 (East of Japan).—In the five years 1889 to 1893 forty-one megaseisms originated in these districts. The average frequency was therefore one disturbance in forty-four days. Four of these disturbances may however be regarded as parts of single efforts. With this assumption, the average frequency becomes one disturbance in forty-nine days.

The time intervals between these efforts expressed in days are as follow:—

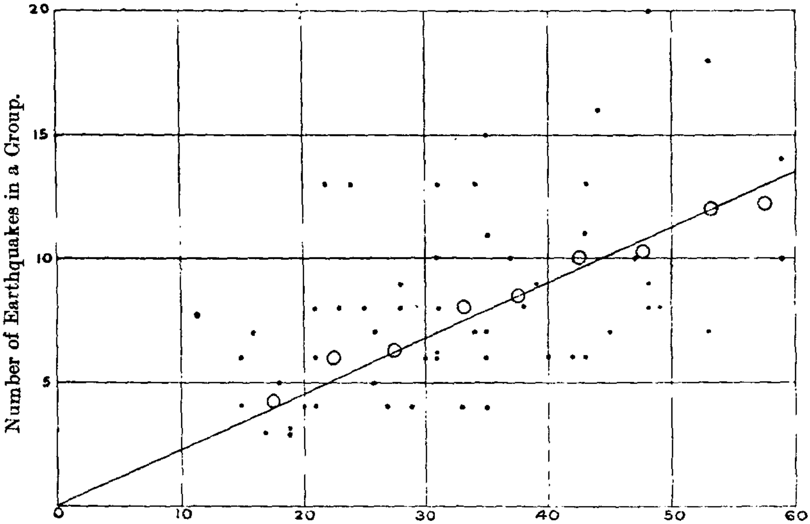
6	6	7	7	11	14	15	17	18	19	24	24	26	27	29
30	32	36	38	39	43	43	46	46	46	47	50			
57	60	64	87	91	102	105	109	138	160					

The time interval required to bring about seismic instability may lie between thirty-six and forty-seven days, but it is not so well marked as it is in the East Indies.

VIII. *Earthquake Periodicity.*

If we plot the megaseisms which have been recorded since 1889 on a sheet of paper ruled to show the days of the year (see Plate II.), it is seen that these disturbances have occurred in groups separated by periods of rest. The number of groups in a year have varied from eight to seventeen. Between November 23 and December 24, 1889, there was a period of quiescence extending over thirty-one days. If we start on December 14, which is in the middle of this period, we find that every successive 443 days we arrive at other periods of rest. These are met with on the following dates: February 28, 1901, May 17, 1902, August 4, 1903, October 22, 1904, January 17, 1906, April 1, 1907, June 17, 1908, September 3, 1909. The last date, however, only represents a period of partial quiescence.

The next section of this Report, drawn up by Professor H. H. Turner, shows that my determination of 443 days is somewhat too small. It should be about 452 days.



Intervals in days between centres of groups. Mean position of groups are indicated by circles. 1899–1908.

Another series of periods of rest is separated by intervals of 402 days. It contains the following dates: December 23, 1899, January 30, 1901, March 8, 1902, April 14, 1903, May 20, 1904, June 28, 1905, August 4, 1906, September 10, 1907, October 16, 1908, November 23, 1909.

IX. *On a New Periodicity in Earthquake Frequency.*

By Professor H. H. Turner.

The publication of the ' Catalogue of Destructive Earthquakes, A.D. 7 to A.D. 1899, ' made it possible to inquire into possible periodicities; and I therefore instituted such an inquiry for periodicities near fourteen months, the period of the free oscillation of the earth's axis. It was soon noticed that there was a marked period near fifteen months, the best value for which is 104/7 months: so that twenty-one periods occupy twenty-six years very closely. The material used in the first instance was from 1899 back to 1750, before which the records become very scanty; but more modern material subsequent to 1899 confirmed the result, and the old records from 1750 back to 1350, broken and incomplete though they are, still show the periodicity.

The following table shows the values of the calculated coefficients for cos θ and sin θ, expressed as *percentages* of the total number of earthquakes per month, with the adopted period 104/7 months. The grouping is easily effected by repeating the value for a single month at the end of seven periods of fifteen months. Thus, what would usually be a $7 \times 15 = 105$ months interval is reduced effectively to 104. The time is reckoned *backwards*, as it seemed best to begin with more modern observations.

Initial Date	Total No. of Earthquakes	Coefficients of		Maximum	Deviation from Mean
		Cos θ	Sin θ		
June 1909	409	− 9·0	+ 6·4	145°	+195°
Oct. 1905	530	+ 7·6	− 3·4	− 24	+26
Feb. 1897	809	+ 5·8	− 6·0	− 48	+ 2
Feb. 1871	779	+ 6·7	− 2·2	− 19	+31
Feb. 1845	315	− 3·3	− 7·7	−113	−63
Feb. 1819	191	+18·1	−13·1	− 36	+14
Feb. 1793	201	+12·9	− 4·8	− 20	+30
Feb. 1767	386	− 7·8	− 4·7	−149	−99
Feb. 1689	262	− 8·3	−15·3	−118	−68
Feb. 1611	159	+ 2·4	− 1·0	− 23	+37
Feb. 1533	161	+11·5	+ 2·0	+ 10	+60
Feb. 1455	78	+ 7·7	−14·4	− 62	−12
Feb. 1377	92	+ 5·0	− 1·1	− 13	+63
Mean . . .		+ 4·9	− 5·8	− 50	

Each group extends from the initial date given in the first column to the next initial date. The first group is thus from June 1909 to October 1905, and contains three periods only: and it is directly discordant. This anomaly is under investigation, and for the present we will omit the group. The mean formula is then:

$$+ 4{\cdot}9 \cos \theta - 5{\cdot}8 \sin \theta = 7{\cdot}6 \cos (\theta - 50^\circ),$$

the maximum occurring in December 1905, April 1897, &c., two months *later* than the initial date.

But a simple harmonic scarcely does justice to the facts. If we add together the results for corresponding months for the period of best observations, *i.e.*, February 1793 to October 1905 (it will be seen how broken is the record in the earlier centuries), and divide by ten so as to get simpler numbers, we get the following sequence, counting the time now forwards in the usual direction.

$$\underbrace{22\ 20\ 22}_{64} \qquad \underbrace{21\ 18\ 21}_{60} \qquad \underbrace{18\ 18\ 20}_{56} \qquad \underbrace{17\ 18\ 17}_{52} \qquad \underbrace{19\ 16\ 17}_{52}$$

The starting-point has of course been selected to bring out the main feature, which is an almost steady fall, followed by a very rapid rise when we return to the beginning. The idea suggested is that of accumulation. The outward manifestations of stress (earthquakes) fall off in number steadily, but this means that stress is accumulating, and ultimately there is an outburst of numerous earthquakes again. If this is the explanation, it may be that the inequality is only quasi-periodic, as in the illustration (quoted first by Dr. Johnstone Stoney) of a pot boiling over and damping the fire, which would tend to recur roughly after a given interval, but not by any means exactly. The period found can then only be regarded as an average period, and the deviations in the table are intelligible. But it is noteworthy that Mr. Chandler detected a fifteen-month period in the Latitude Variation,[2] though the coefficient is extremely small (only $0''.03$): and some preliminary calculations seem to show that the level error of the Greenwich transit circle also has an inequality of this period. These matters are being further investigated.

X. *Intervals in Days from the Commencement of one Group to the Commencement of another.*

1899 . . .	47	21	24	21	28	32	25	33	39	41	33						
1900 . . .	58	13	27	69	79	40	33	39									
1901 . . .	20	38	18	13	19	51	73	32	31	31	28	20					
1902 . . .	17	28	16	20	21	11	54	24	28	19	30	60	28				
1903 . . .	22	11	18	23	26	37	15	20	22	30	19	24	46	43	22		
1904 . . .	13	58	15	15	31	55	29	16	16	15	16	14	17	11	16	11	17
1905 . . .	32	29	19	10	41	15	22	30	24	33	20	48	20	14	6	7	
1906 . . .	37	33	18	18	10	75	21	10	26	29	15	12	14	12	43		
1907 . . .	15	33	51	18	20	22	30	35	7	28	20	10	41	23	18		
1908 . . .	19	16	32	10	21	7	22	11	93	40	22	20	28	12			
1909 . . .	15	37	24	16	19	15	15	7	17	19	35	34	7	52	42		

A table of the above intervals shows that those of from fifteen to twenty-two days recur no less than fifty-five times, whilst those between eighteen and thirty-three days are repeated twenty-seven times. Intervals of seven, ten, eleven and twenty-four days are each repeated five times; the remaining intervals only occur or recur once, with the exception of the intervals thirty-seven and forty-one days, which recur twice.

The inference is that for the world as a whole seismic strain usually finds relief every fifteen or thirty days. In other words there is frequently a rough regularity in the recurrence of megaseismic groups.

XI.—*Intervals and Days between Successive Megaseisms in Particular Districts.*

In the eleven years 1899 to 1909, off the East Coast of Japan to the North of Tokio, I find that thirty-two megaseisms were recorded. Twelve of these were separated by intervals lying between fifty-seven and ninety-five days.

To the South of the Philippines round the Celebes and to the West of N.-W. New Guinea during the same period forty-two large earthquakes originated; fifteen of these are separated by intervals which lie between fifty-six and ninety-two days.

XII.—*Geographical Distribution of Megaseisms and Thermometric Gradients.*

For the five years 1899-1903 we have a list of 313 megaseisms, the origins of which are known; of these, sixty-one originated on continental areas, and 252 originated along the lines of troughs or 'deeps,' beneath

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[2] *Astr. Journal,* No. 523, p. 152.

oceans. It appears from this that for this particular period there was four times as much seismic activity beneath the cold waters of particular parts of our oceans as there was beneath continental areas. This activity is represented by megaseisms, which usually occur in groups, and the periods of rest which follow the groups are found to be roughly proportional to the intensity of the groups by which they are preceded. This suggests that the strain which finds relief in world-shaking disturbances accumulates uniformly, and it may therefore be associated with uniformity in the rate of earth-cooling.[3] Should such a relationship exist, it seems likely that sub-oceanic thermometric gradients may be considerably steeper than those which exist beneath continental areas. This led me to examine such material as we have at our disposal relating to heat gradients in different parts of the world. In 1882, in the Fifteenth Report of the Underground Temperature Committee of the British Association, the late Professor Everett gives a summary of the results of their investigations. From a list of thirty-one localities in various parts of the world where observations have been made the conclusion is that the thermometric gradient is on the average 1° F. for 64 feet of descent, or 0·000285° C. per cm. of depth, which, with a rock conductivity of 0·0058, means an average escape of heat annually from each square centimetre of the surface of our world of 41·4 gramme-degrees of heat. Sufficient materials to make a complete map of the world, showing the heat gradients, do not exist, but Professor Everett's table may be split into two parts, one of which refers to highlands and the interior of continents, and the other to lowlands or localities which are near the sea. In the former we find the following seven localities, viz.: Przibram, in Bohemia, St. Gothard Tunnel, Mont Cenis Tunnel, Schemnitz, in Hungary, Manegaon, in India, Yakutsk, in Siberia, and Sperenberg, near Berlin. The average gradient for these I find to be 1° F. for 75 feet of descent, or 0·000239° C. per cm. of depth. For the remaining twenty-four districts, which are comparatively near to the sea, the average gradient is 1° F. for 60 feet of descent, or 0·000303° C. per cm. of depth. With the latter gradient the number of gramme-degrees of heat which escape annually through each square cm. of the earth's crust would be 42·4, but with the gradient for the highlands this number becomes 35·5. This means that from the lowlands one-fifth, or 20 per cent., more heat escapes than that which escapes from the inland highlands.

I next turned to the tables of the late Professor Prestwich, published in 1886.[4] In this register I found 329 sets of observations. Of these, 283 referred to Great Britain and Ireland, France, Holland, Belgium, Italy, St. Petersburg, Algeria, and Buenos Aires. These I regarded as countries and places near to the sea. Out of this group, 217 have gradients below 1° in 64 feet, which is Professor Everett's average, while the remaining sixty-six have gradients above 64 feet. The latter, which are gentle gradients, are to the former, which are steep, in the ratio of 1 to 3·3.

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[3] See *Brit. Assoc. Report*, 1910, p. 54.

[4] See *Proc. of the Royal Soc.*, vol. xli., 1886.

For Switzerland, Germany, Austria, Central North America, which are distant from the sea, the number of gradients below 1° in 64 feet is 32, while of those above 64 feet the number is twelve. In this case the ratio of the gentle gradients to those which are steep is as 1 to 2·6. Here again the inference is that steep gradients increase in frequency as we approach the seaboard. In this latter catalogue I find no less than twenty localities where the gradients are 33 feet or less. The steepest of this group is at the Dolcoath Mine, in Cornwall, where we have an increase of 1° F. for 18 feet of depth. For five mines beneath the sea the average gradient is 1° for 38 feet of depth.

The only other materials bearing upon this subject with which I am acquainted are lists of heat gradients drawn up by Messrs. Koenigsberger and Mühlberg.[5] When these are combined with those given by Professors Prestwich and Everett, the following two tables are obtained:

TABLE I.

This gives the average heat gradients in feet per 1° F. for inland districts and highlands together with the number of stations at which observations have been made.

—	No. of Stations	Average Gradient
S.E. Lancashire, S. Yorkshire, Nottinghamshire .	9	65
Wales, Inland	2	70
S. Germany, Bohemia, Austria	12	62
Central France	6	51
Victoria and New South Wales	2	78
Central United States and Central Canada . .	13	92 or 79
Witwatersrand, high ground	1	207
South America, high ground	5	113

The average gradient deduced from these figures is 1° F. for 75 feet descent. From Everett's tables the estimate was also 1° F. in 75 feet.

TABLE II.

For low ground, and localities near the sea, the gradients run as follows :—

—	Stations	Gradient
Newcastle and Durham District	10	52
West Cumberland	2	43
S. Wales, near the coast	2	49
Cornwall and Devon	14	44
Between Glasgow and Edinburgh	4	48
N. Germany	4	52
West France	4	50
N. France and Belgium	8	47
Africa, the Sahara	3	45
N. America, E. Coast	3	59
Mexico, Central	2	50

From these figures it would appear that the average gradient of these localities is an increase of 1° F. for 52 feet of descent. From Everett's tables this becomes 1° F. in 60 feet of descent.

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[5] See *Trans. Institute Mining Engineers*, vol. 39, 1909-10, p. 617.

The general result of these examinations indicates that heat gradients beneath high grounds and continental areas are markedly less than those beneath low grounds and the oceans. Because seismic activity beneath certain portions of ocean beds is, as I have already said, at least four times greater than it is along shore lines or well inland, and if the gradient beneath continental surfaces is 1° in 75 feet, we might expect a gradient beneath the deeper parts of oceans of about 1 in 19.

Another method by which an approximate estimate may be made of suboceanic thermometric gradients is to assume that the steepness of these increases as we descend from a shore line to a sea-bed at the same rate as they increase as we descend from a high level to a shore line. In the tables given by Professor Prestwich I find seventeen entries which refer to gradients obtained at elevations lying between 1,017 and 9,529 feet above sea-level. Ten of these observations were made at metal mines, six at coal mines, and one in a borehole. The mean height of these stations is 2,723 feet. The mean of the gradients is 1° F. for 68 feet of descent, which, it will be observed, is somewhat less than the average gradient given by Professor Everett. The mean gradient from low-lying stations is about 1° F. for 60 feet descent. The difference between these gradients is therefore 8 feet, and if this difference steadily increases as we descend beneath sea-level, at a depth of 12,000 feet we should expect to find a gradient of 1° F. for 25 feet descent. This value and the gradient of 1° in 19 feet already suggested, considering what has been observed in mines under the sea, may be rough approximations to thermometric gradients beneath deep oceans. With rock conductivity constant, the rate at which heat is lost beneath our ocean would therefore be about three and a half times that at which it escapes from continental surfaces. If this is so, we may assume that the suboceanic crust of the world is either thinner or a better conductor of heat than that beneath the land. The plumb-line and observations made with pendulums show that high ground and mountain ranges have a deficiency in their gravitational attraction. To account for this Sir G. B. Airy advanced the hypothesis that materials of which they are constituted bulged downwards into a heated denser nucleus beneath. This, and the fact that the value of gravity increases as we approach the seaboard, means that the superficial covering of our earth beneath mountains is not only thicker, but it is also less dense than it is beneath lowlands and near the sea.

It may also be added that rocks which are heavy and those which are metamorphic or crystalline have a slightly higher conductivity for heat than many other stratified rocks which are comparatively light. The crust of our earth beneath a suboceanic depression, partly, perhaps, because it is continually bathed by an oceanic circulation of cold water, is therefore a region where we should expect to find the greatest flow of heat, and consequently it is one where *sudden* contractions which accompany solidification should most frequently occur.

Diabase, which is a volcanic rock, when it passes from the fluid to the glassy state contracts about 14 per cent., but at the time of solidification, which takes place at a temperature of about 2,000° F., there is a *sudden* contraction of from 3 to 4 per cent. Beneath an ocean bed with a gradient of 1° F. in 20 feet we should expect this to take place at a depth of about eight miles, but beneath a continent with a gradient of 1° in 60 feet at a depth of about twenty-four miles.

XIII. *A Possible Cause of Megaseismic Activity.*

That earth rest after megaseismic activity is roughly proportional to that activity as measured by the number of large earthquakes in a group (p. 24), and that activity in the world is most frequently repeated after fifteen or thirty days of rest (p. 24), suggests that the cause which brings large earthquakes into being which cannot be traced to epigenic influences may be due to the steady dissipation of earth heat. In the first place, this view finds strong support in the fact that the regions where geothermic gradients are steepest are those from which megaseisms most frequently radiate.

Volcanic rock, when passing from the fluid state to the solid, contracts suddenly (see p. 32), and something similar happens when molten slag solidifies. Information bearing on this subject was very kindly obtained for me by Mr. J. J. Shaw, of West Bromwich. To get rid of the slag from an iron furnace it is run into moulds or holders. As it mounts upwards in one of these, its outer edges are seen to contract or curve inwards, leaving a small space between the side of the holder and the hot 'metal.' The hot stream, as it continues to pour, fills up this space. When, however, it has reached a height of one and a half or two inches more in the holder, a second contraction occurs. This intermittent contraction and filling up the space it has left goes on until the holder is full. 'When the block is turned out it shows striæ round its sides which correspond to the intermittent solidifications. Although the conditions of a cooling block of slag are different from those of a cooling globe, they suggest a series of spasmodic contractions at regular intervals rather than a contraction that is uniform,' a phenomenon which is roughly illustrated in the successive sequence of large earthquakes.

When the block cools it frequently cracks, and hot material is exuded. This is due, as pointed out by Mallet, to the grip of the contracting outside shell upon the hot interior.

The huge dykes filled with volcanic rock which traverse many countries, together with the fissure eruptions which have buried many thousands of square miles to depths of from 2,000 to 6,000 feet of lava, correspond, but on a gigantic scale, to the phenomena observed on the surface of the cooling slag.

With each sudden yielding vibrations or waves would be generated on the surface of the viscous mass, and if it is assumed that this is homogeneous, these would be propagated beneath the crust at a uniform velocity, which is the case with the large waves of earthquakes.

The suggestion here made is the reverse of the old idea. It is not a nucleus that contracts to leave a shell to follow downwards, but a

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See *Bulletin of the U.S. Geolog. Survey*, No. 103, 'Igneous Fusion and Ebullition,' by Carl Barus.

forming shell that contracts, which, by its sudden grip on the unshrinking nucleus, fractures itself.[7]

XIV. *Seismic and Volcanic Activity.*

From the 'Catalogue of Destructive Earthquakes' published in the British Association Reports for 1911 a list was constructed which gave the number of earthquakes which had occurred in the year 1800 and each following year up to 1900. A second list, based on information found in 'Die vulkanischen Erscheinungen der Erde,' by Dr. Karl Schneider, gave the number of volcanic eruptions in each of these years. An inspection of these lists showed that from year to year seismic and volcanic activity seldom remained constant, but rose or fell. When all the entries in the 'Catalogue' were considered it was seen that in forty-nine instances seismic and volcanic activity increased or decreased at the same time, but in the remaining fifty-one years one of these activities became greater whilst the other became less. If only the very large earthquakes having an intensity of II. or III. were considered, these numbers became respectively 52 and 47.

Although we know that a megaseism may shake a dormant volcano into activity,[8] the figures here given suggest that volcanic and seismic activities of the world increase or decrease independently of each other.

A stricter and therefore more satisfactory comparison of these activities may be obtained by reference to the chart which shows the chronological sequence of megaseisms between 1899 and 1910, together with the volcanic eruptions which have been recorded during the same period. The number of the latter, with fixed dates, was fifty-eight, and of the former 976. Eruptions and megaseisms have only occurred on the same day seventeen times.

XV. *On the Mitigation of Air Tremors at Cardiff.*

Mr. Thomas Chant writes me from Cardiff as follows:—

'The air tremors recorded by our seismograph, which have now been reduced, appear to have been caused by movements of the air within the covering case, set up by changes of temperature, and by currents of air moving in the room.

'In the first place it was thought that the heat from the small lamp changed the temperature in that part of the case near where it stands. To overcome this the lamp is now placed on two strips of asbestos fastened with seccotine to the movable top of the clock box, and two strips of asbestos have been fastened to the ends of the case (bridge). On these latter strips a piece of sheet tin has been fastened. Air now passes under the lamp and between the tin and the end of the bridge, thus preventing the case from becoming warm.

'Secondly, movements of air within the case have been partially prevented in the following way: Pieces of thin mica have been fastened to the interior of the case across each end of the bridge, and the boom

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[7] See "Bedrock," No. 2, 1912.

[8] See *Brit. Assoc. Report,* 1902, p. 72, and 1906, p. 97.

now passes through two horizontal slits in these pieces of mica. A slit has also been made for the silk thread. These narrow strips of mica fixed to narrow cubes of wood, almost making a triangle, rest on the top of the clock box under the movable cover. The intention is to reduce the space to which the pendulum swings, and to prevent air movements as far as possible from acting on it.

'A small glass slide (microscope cover glass) has been fixed over the slit in the top of the clock box, under the blackened shield at the end of the boom, and a piece of glass fixed to the underside of the movable cover.

'Screens made of wood and American cloth have been temporarily placed round the seismograph. We intend having a large screen with a cover made to go round and over the instrument, so that the seismograph will be practically enclosed in an American cloth cabinet.

'The pieces of mica and asbestos were used first, and these reduced the tremors. When the screens were placed round the seismograph the tremors were further reduced, and when we obtain a new screen I am hoping things will be better still.'