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The Grand Banks Earthquake of November 18, 1929

BY

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ABSTRACT

The area over which the tremors were felt is outlined, as based on replies to questionnaires and collected newspaper reports. Reported damage from the resultant tidal waves which affected the southeastern shores of Newfoundland and some parts of Cape Breton is summarized. Four transatlantic cable companies suffered extensive loss due to a multiplicity of breaks in their lines crossing or approaching the disturbed zone of ocean floor. These are listed, giving the geographical coordinates of the point or points of breakage and the times at which the services were interrupted. Seismographic stations, representing a world-wide distribution of recording points, supplied seismograms, from the interpretation of which, data were obtained for the time of occurrence of the disturbance at its origin and also its epicentre as determined by the stereographic projection method. All the evidence at hand seems to indicate a subsidence of a section of the ocean floor between two fault planes with the vertical displacement progressively less toward the southern extremity of the disturbed zone.

The Grand Banks Earthquake of November 18, 1929, was comparable in intensity with that of the St. Lawrence shock of March 1, 1925, and considerably greater than that which caused so much damage at Santa Barbara on June 29, 1925. The origin was just beyond the continental shelf at approximately 44·5° N. latitude and 55·0° W. longitude and the time of occurrence $20^h31^m53^s$ Greenwich Mean Time. The tremors were felt throughout Newfoundland, the Maritime Provinces, Eastern Quebec, and the northern New England States. Records were obtained at practically all seismographic stations in operation at the time of the disturbance. The damage to land structures due directly to the earth tremors was of but a minor nature but telegraphic cable services were seriously affected, twelve of the transatlantic lines being broken. The resulting tidal wave took a toll of over a score of lives and caused considerable damage to shipping and to shore structures along the southeastern portion of Newfoundland and some seaboard sections of Cape Breton. The earthquake is outstanding in that this locality has been regarded as unusually free of major seismic activity.

Isoseismals

Canadian field data were collected through the medium of newspaper clippings and a questionnaire service covering Newfoundland, Nova Scotia, New Brunswick, Prince Edward Island, Quebec, and the eastern half of Ontario. A similar survey of the New England States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, and Delaware was conducted by the United States Coast and Geodetic Survey whose cooperation in this and also in other phases of the investigation is gratefully acknowledged. The combined canvass secured reports from 331 localities. With the exception of northern Quebec Province this brought returns from districts well distributed throughout the States and provinces named. The tremors were reported as

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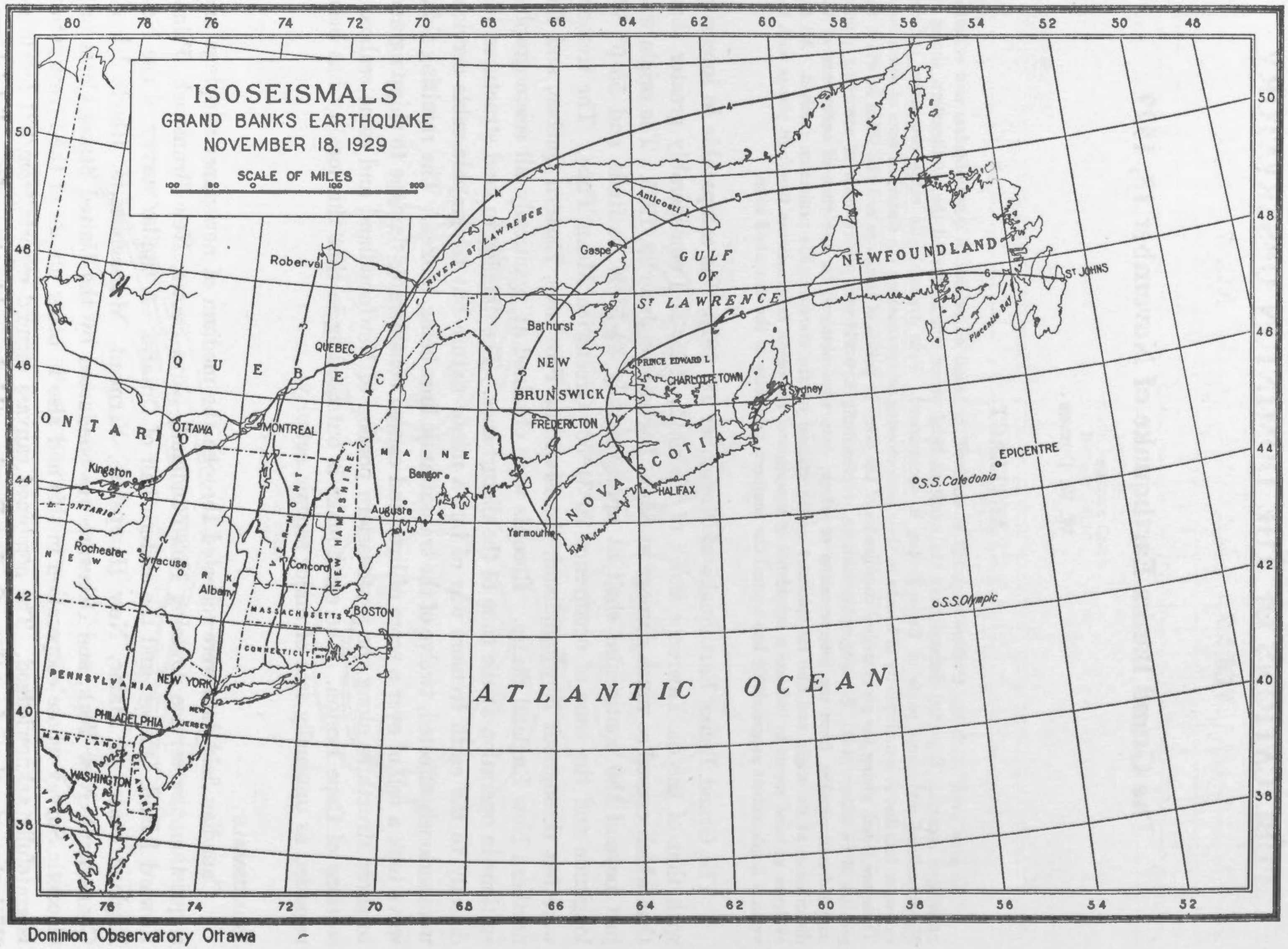

Isoseismal Map. Figure 1.

perceptible as far west as Ottawa, Ontario, and south to Claymont in the State of Delaware. With but very few exceptions the evidence of moving objects and accompanying sounds was found to be consistent, pointing to an epicentre south of Newfoundland, east of Quebec and the Maritimes, and north or northeast of the New England States. All reports received were classified according to the Rossi-Forel scale of intensities and the ratings thus obtained were used to draft the isoseismal map given in Figure 1. The submarine origin precluded the plotting of closed contours which would have served to determine the epicentre approximately. The map can, therefore, serve only to indicate the extent of land surface affected and the degree of severity of the shock within that area. The continental zone within which appreciable damage occurred was comparatively small, being restricted practically to Cape Breton Island. Within this area chimneys were overthrown or cracked, loose objects and stores dislodged from shelves and cupboards, and some highways blocked as the result of minor landslides. An early report that the railway bridge at Grand Narrows had been damaged proved erroneous as also did that regarding a fall at the mines in the Glace Bay district. Two ships at sea, the Caledonia and the Olympic, reported the tremors as severe and of about two minutes duration. The respective positions of these ships at the time of the earthquake are indicated on the isoseismal map as is also the epicentre as located from instrumental records.

Tsunami (Tidal Wave)

High tide was predicted and expected on the day on which the earthquake occurred: the fact that many places along the seaboard reported exceptionally high tides was probably as much due to the heavy gale at sea as to the tsunami which followed the earth shock. Damage resulting from the tidal wave was reported from some sections of Nova Scotia but principally from southeastern Newfoundland. Sweeping in from the Atlantic, it struck with greatest force on the west side of Placentia Bay at the lower end of Burin peninsula, taking a toll of twenty-seven lives and causing enormous loss of property. The following is the summary given in the Saint John's Free Press in the issue of November 26, 1929.

Lamaline

One man died of injuries. All stages and stores along the waterfront were swept away.

Point au Gaul

Eight lives lost; all fishing property, stages, stores, five cod traps, all provisions, about one hundred tons of coal, three dwelling houses, and seventy other buildings gone.

Taylor's Bay

Four lives lost and fifteen families homeless, all fishing property with provisions and coal swept away.

Lord's Cove

Four lives lost, all fishing property with provisions and coal swept away.

Lawn

No lives lost, all fishing properties with most of the boats, dories, provisions, and coal lost.

St. Lawrence

No lives lost, all flakes and stores on both sides of the harbour swept away with all provisions and coal.

Corbin

Swept clean, no lives lost.

Lance au Lean

One dwelling house and all fishing gear lost.

Great Burin

Swept but no lives lost.

Step-a-side

All waterside premises gone. No loss of life.

Kelly's Cove, Ship Cove, Burin North and Burin East

All waterside premises lost or damaged. No lives lost.

Port au Bras

Eight lives lost, eleven dwelling houses, fourteen small schooners, all dories and skiffs, provisions, and all waterside premises gone.

Mortur

No loss of life. Considerable damage to waterside premises.

Rock Harbour

Reported swept.

The French islands of St. Pierre and Miquelon escaped damage as did the western coast of the peninsula. To the east at Salmonier at the head of St. Mary's Bay the wave was reported as a six-foot wall of water which caused considerable damage to floating timber.

At Sydney and Glace Bay in Cape Breton and at Halifax Harbour abnormally high tides were reported, but no damage other than flooding was indicated. At Boston the tide was reported as considerably higher than normal with some flooding in a northern suburb. At Canso, Nova Scotia, a tidal wave about two feet in excess of Spring High tide was noticed at about 8 p.m. Atlantic Standard Time on November 18. The wave came in with great force damaging fishermen's wharves and carried ashore the schooner *Lena M* which was badly damaged and her cargo of produce a total loss.

A report* in the *Bermuda Gazette* and *Colonial Daily* states that on the evening of the earthquake a dredging plant at the Flatts was violently disturbed by what was thought to be a tidal wave. So great was the force of the disturbance that the mooring chains were broken and the dredger 70 feet long and 25 feet in depth was in danger of being dashed against the wharf. The time reported was 7.30 p.m. local time.

An article in the Montreal *Herald* of January 2, 1930, states that the wave was noted at 4.30 o'clock at the Azores on the morning following the earthquake.

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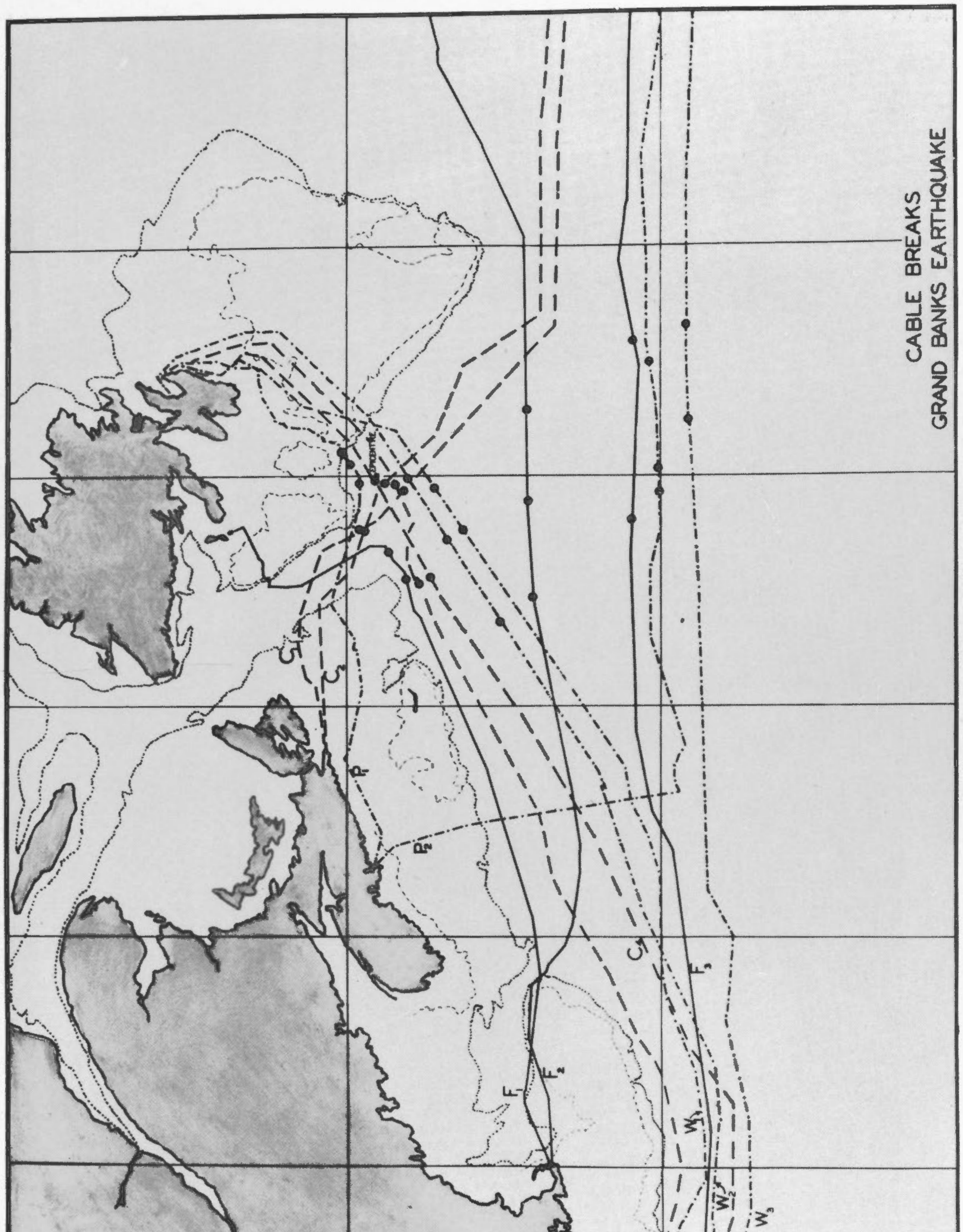
* Brought to our attention through the kindness of Dr. R. A. Daly of Harvard University.



Map of Cable Breaks. Figure 2.

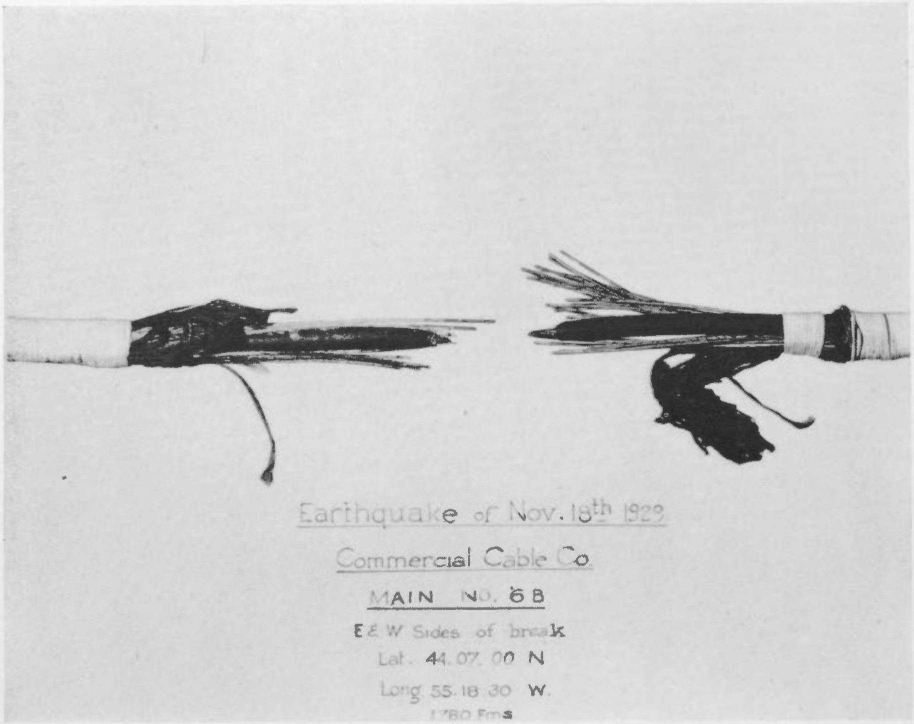


Figure 3.

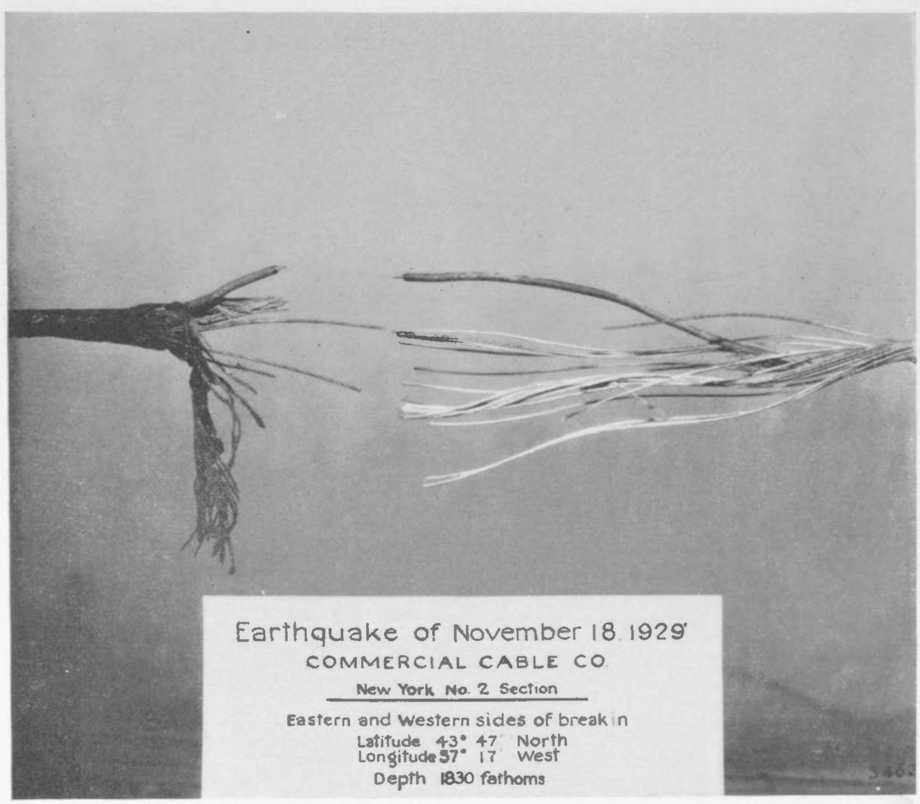


Figure 4.

The Bermuda report would indicate a travel speed of about 350 miles per hour while the Azores time of arrival would give a speed of approximately 250 miles per hour in the north Atlantic water. The arrival time at Burin is given as 7.15 p.m. local time which would indicate a velocity of only about 65 miles per hour, the lower rate of propagation for shallow water being confirmed by the Canso report which placed the time at approximately 8 p.m. which gives a wave velocity of about 80 miles per hour.

The Canadian Hydrographic Service of the Department of Marine supplied copies of tide gauge records as obtained at Halifax, Charlottetown, Saint John, N.B., Gaspe and Quebec. A study of these indicates that the disturbance at sea was not unusual except in the case of Halifax where tide surges were recorded at 7.30 p.m. and again at midnight, Atlantic Standard Time, on November 18.

The collected data indicate that the tidal wave of itself was not of major proportions, its effect being intensified by an exceptionally high tide and a high gale blowing in from the sea. Damage occurred only at places located at the heads of converging bays bounded by rocky walls.

Cable Breaks

No official statement has been obtained as to the monetary loss resulting from the twenty-eight cable breaks caused by the earthquake of November 18, 1929, but many miles of new cable were required to effect the repairs which in come cases were not completed until late in the summer of 1930. Of the twelve transatlantic cables damaged by the shock, three were the property of the Western Union Cable Company, three of the French Cable Company, four of the Commercial Cable Company and two of the Imperial Cable Company. These are shown in Figure 2, a composite map of cable breaks, on which Western Union breaks are indicated as W_1, W_2, W_3; French Cable by F_1, F_2, F_3; Commercial Cable by C_1, C_2, C_3, C_4; and Imperial Cable by P_1 and P_2.

The data as supplied by the respective Companies are given in the following summary:

CABLE BREAKS

Break No.	Lat. N.	Long. W.	Time	Date	Depth (fathoms)
Western Union Cable Company					
New York—Bay Roberts (W_1)					
1	43° 37′	55° 15′	4.31 p.m.	18/11/29	2,000
2	43° 15′	56° 07′	4.31 p.m.	18/11/29	2,200
New York—Bay Roberts (W_2)					
3	44° 02′	55° 02′	3.31·5 p.m.	18/11/29	1,800
4	43° 25′	56° 20′	3.32·5 p.m.	18/11/29	2,000
5	42° 42′	58° 10′	?	18/11/29	2,300

CABLE BREAKS—*Continued*

Break No.	Lat. N.	Long. W.	Time	Date	Depth (fathoms)
Western Union Cable Company—Concluded					
New York—Fayal (W_3)					
6	39° 35′	51° 41′	4.53 a.m.	19/11/29	2,800
7	39° 29′	53° 47′	4.49 a.m.	19/11/29	2,780
French Cable Company					
Saint Pierre—Cape Cod (F_1)					
8	44° 20′	56° 40′	3.46 p.m.	18/11/29	1,150
9	44° 03′	57° 12′	?	18/11/29	1,000
Cape Cod—Brest (F_2)					
10	42° 07′	53° 30′	?	18/11/29	2,600
11	42° 05′	55° 30′	6.35 p.m.	18/11/29	2,400
12	42° 00′	57° 36′	?	18/11/29	2,500
New York—Fayal (F_3)					
13	40° 28′	52° 06′	12.33 a.m.	19/11/29	2,800
14	40° 30′	55° 55′	12.33 a.m.	19/11/29	3,000
Commercial Cable Company					
Canso—Fayal (C_1)					
15	44° 07′	55° 18′	3.33 p.m.	18/11/29	1,780
16	44° 45′	56° 09′	3.33 p.m.	18/11/29	310
Canso—Fayal (C_2)					
17	44° 23′	55° 08′	3.33 p.m.	18/11/29	1,500
18	44° 43′	56° 10′	3.33 p.m.	18/11/29	220

CABLE BREAKS—*Concluded*

Break No.	Lat. N.	Long. W.	Time	Date	Depth (fathoms)
Commercial Cable Company (Continued)					
N.Y. 2 New York—Saint Johns (C_3)					
19	44° 12′	55° 10′	3.33 p.m.	18/11/29	1,820
20	43° 47′	57° 17′	3.33 p.m.	18/11/29	1,830
N.Y. 1 New York—Saint Johns (C_4)					
21	44° 32′	55° 04′	3.33 p.m.	18/11/29	1,450
22	43° 41′	57° 07′	?	18/11/29	1,890
Imperial Cable Company					
Halifax—Harbor Grace (P_1)					
23	45° 05′	54° 27′	3.33 p.m.	18/11/29	150
24	44° 55′	54° 45′	3.33 p.m.	18/11/29	700
25	44° 50′	55° 09′	3.32 p.m.	18/11/29	800
Halifax—Fayal (P_2)					
26	40° 13′	52° 30′	3.50 a.m.	19/11/29	2,800
27	40° 02′	54° 50′	1.50 a.m.	19/11/29	2,900
28	40° 00′	55° 20′	1.50 a.m.	19/11/29	3,190

The summary shows that each of the twelve lines was broken in at least two places, in the case of four of them there were triple breaks. It also makes evident the fact that the breaks range themselves into two groups whose east and west separation becomes greater as the progression extends southeast from the epicentral zone to about 39° north latitude. This evidence suggests a subsidence of the ocean floor between two fault planes each roughly parallel to the axis of the Cabot trench and extending from about 45° N. to approximately 39° N. The large number of cables grouped near the mouth of the Cabot trench accounts in a large measure for the concentration of breaks in that area. On the other hand, the fact that practically all of these occurred at the same time as the earthquake, while those to the south were later, some as late as 4.53 a.m., E.S.T., November 19, 1929, would indicate that the greatest displacement was in the northern section of the disturbed zone. That this area was violently disturbed is shown by an examination of the recovered cables which evidently had been subjected to a sharp and sudden strain at the point of fracture. The two photographs (Figures 3 and 4) supplied by the Commercial Cable Company indicate that these cables were literally pulled apart.

There is a possibility that the break in the French Cable Company's Cape Cod-Brest line which occurred at 6.35 p.m., E.S.T., November 18, 1929 may have resulted from the pronounced aftershock, the first tremors of which were recorded at the Halifax seismographic station at 6.04 p.m. of that date.

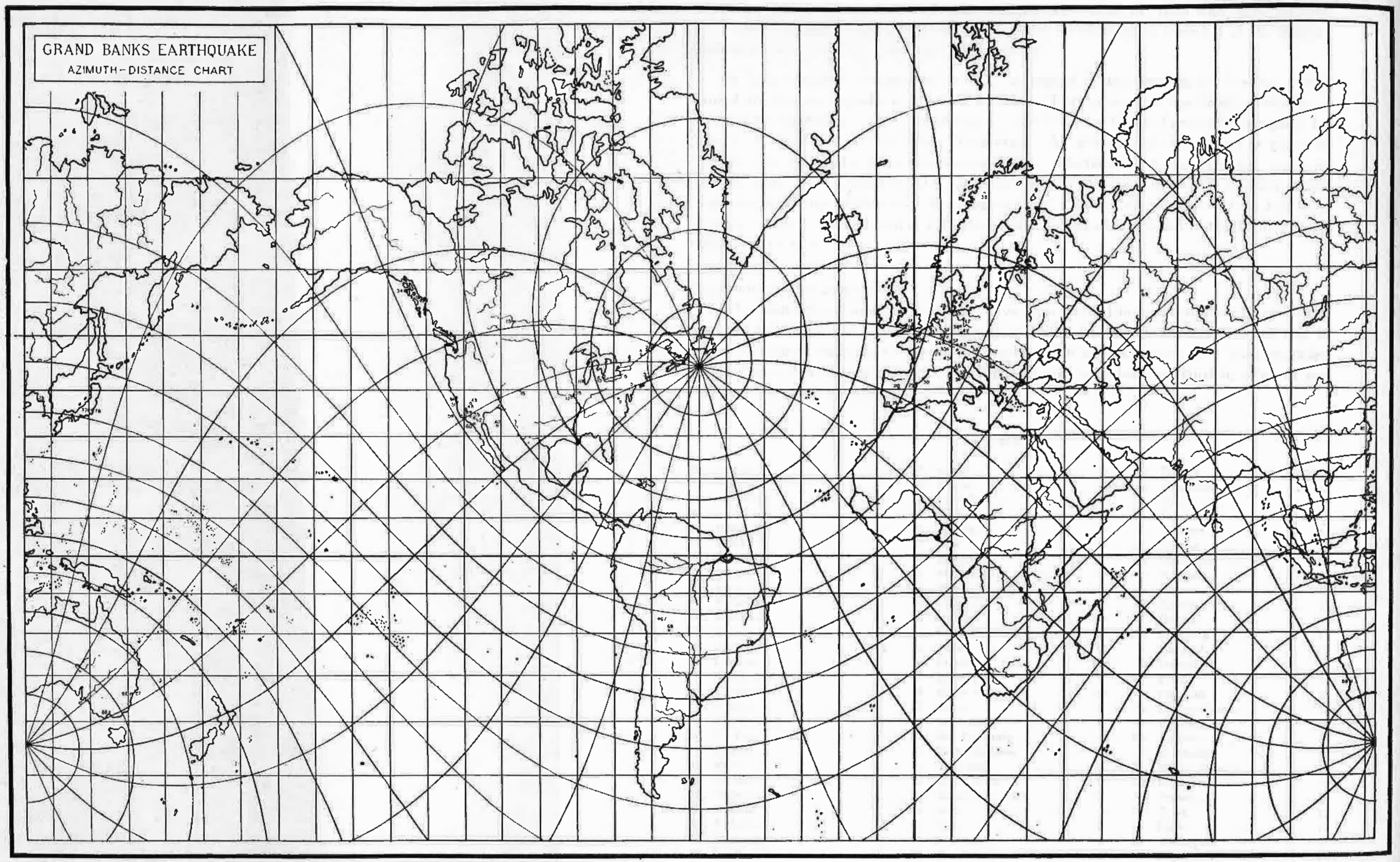
A very complete compilation of data in regard to the damage to Atlantic cables caused by this earthquake is given in a report "Earthquakes in the North Atlantic as Related to Submarine Cables" prepared for the Western Union Telegraph Company by Mr. V. P. de Smitt of their New York staff. An abstract of this report is given in *Transactions of the American Geophysical Union,* Thirteenth Annual Meeting, April 28 and 29, 1932, at Washington, D.C. published by the National Research Council of the National Academy of Sciences, Washington, D.C., June, 1932, pages 103 to 109 with 5 figures. Other papers dealing with this submarine shock are listed in the Bibliography following the text.

Seismogram Interpretations

The seismograms and reports which have been studied in connection with the Grand Banks Earthquake are listed alphabetically in Table 1 in which the letters O, C, and R indicate original, copy, and report respectively. The numbers serve as a position index to the Azimuth-Distance map given in Figure 5 and have been assigned in order of the relative epicentral distances.

TABLE 1

38	Abisko	O	72	Ksara	O	32	Taunus	O
41	Algiers	O	66	Kucino	R	49	Tinemaha	O
10	Ann Arbor	O	60	La Jolla	O	77	Tokyo	C
83	Apia	O	67	La Paz	C	20	Toledo	O
27	Balboa	O	39	Leipzig	O	7	Toronto	O
73	Baku	R	51	Lick	O	25	Tortosa	C
30	Barcelona	C	84	Manila	C	13	Florissant	O
85	Batavia	C	88	Melbourne	C	5	Fordham	O
64	Beograd	O	58	Mount Wilson	O	50	Graz	C
62	Berkeley	O	43	München	O	48	Haiwee	O
29	Besancon	O	6	Ottawa	O	1	Halifax	O
61	Budapest	O	17	Oxford	C	35	Hamburg	O
8	Buffalo	O	22	Paris	O	3	Harvard	O
26	Cartuja	C	55	Pasadena	O	31	Heidelberg	O
9	Charlottesville	O	87	River View	O	89	Perth	C
11	Chicago	O	56	Rocca di Papa	O	45	Piacenza	O
79	Colaba	C	53	Rome	O	14	Port-au-Prince	O
34	Copenhagen	C	12	Saint Louis	O	47	Potsdam	C
24	De Bilt	O	21	San Fernando	O	63	Pulkovo	C
18	Denver	O	59	Santa Barbara	O	19	Richmond	C
42	Eger	C	15	Saskatoon	O	71	Rio de Janeiro	C
46	Firenze	O	2	Seven Falls	O	52	Riverside	O
28	Helgoland	C	4	Shawinigan Falls	O	40	Tucson	O
70	Helwan	C	54	Sitka	O	76	Tyosi	C
37	Hohenheim	O	65	Sofia	O	23	Uccle	C
74	Honolulu	O	16	Stonyhurst	O	86	Wellington	C
44	Innsbruck	O	36	Strasbourg	O	57	Zagreb	O
75	Jinsen	O	68	Sucre	C	80	Zi-ka-wei	O
78	Kobe	C	69	Sverdlovsk	R	33	Zürich	O
81	Kodaikanal	C	82	Sydney	C			



Azimuth Distance Chart. Figure 5.

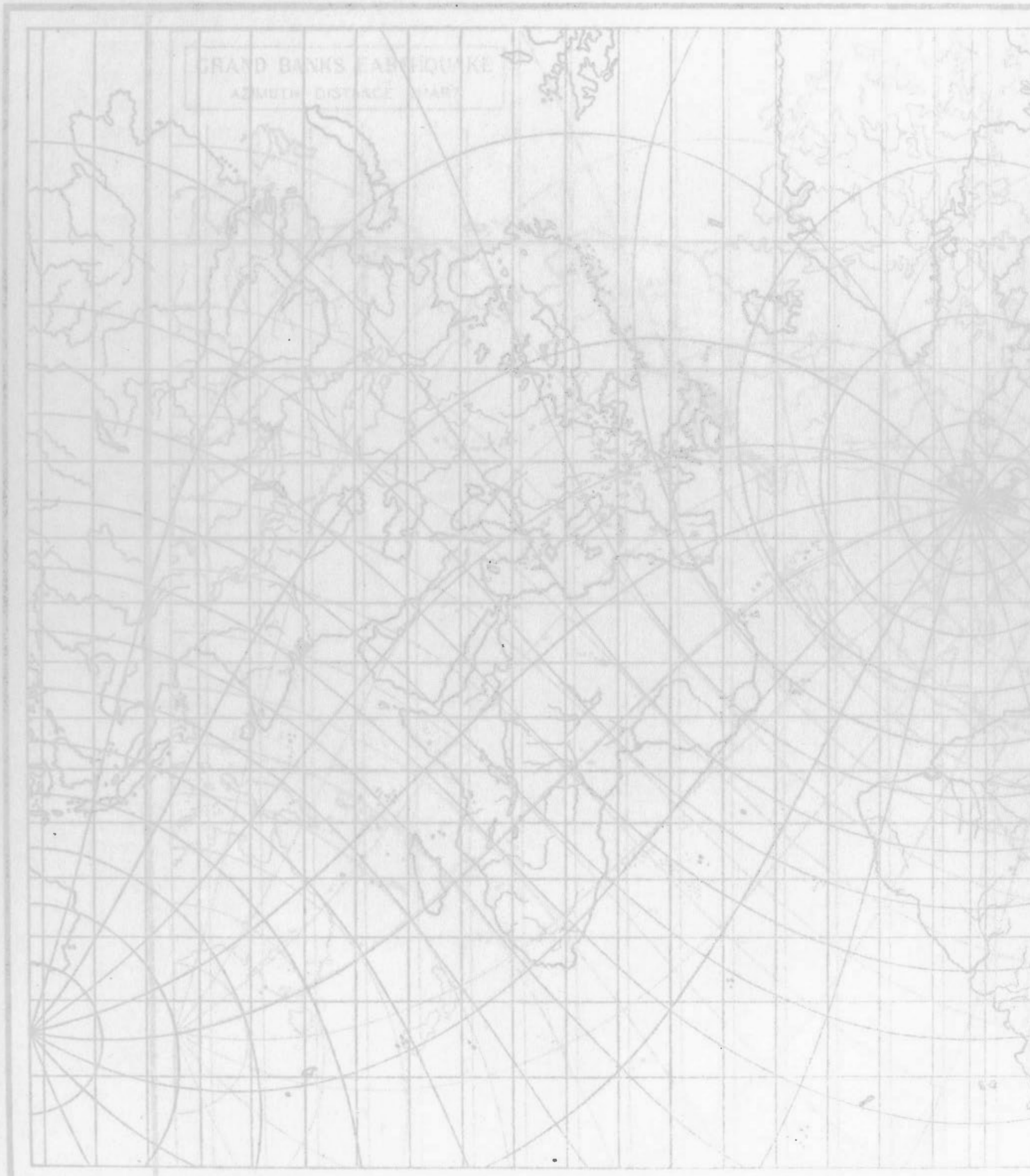


Figure 3.

The Azimuth Distance Chart shows the world-wide distribution of the eighty-nine stations listed in the above table. In all, two hundred and eleven component records were received for interpretation, the identification of the various phases being based on the travel times given in the Macelwane Tables. Some of the seismograms were incomplete but in the case of sixty-six of these stations, records were obtained on which the time of arrival of the compressional waves (P) and the shear waves (S) were definitely identified. For each of these stations the S-P time interval was used to determine the epicentral distance (△) and the Greenwich Mean Time (H) of the disturbance at its origin. These data are presented in summary form in Table II retaining the same station index numbers as were given in Table I.

TABLE II

	Station	P	S	H	△ (km.)
2	Seven Falls	$20^h34^m26^s$	$20^h36^m24^s$	$20^h31^m57^s$	1133
3	Harvard	20 34 32	20 36 40	20 31 51	1233
4	Shawinigan Falls	20 34 45	20 36 54	20 32 02	1244
5	Fordham	20 35 09	20 37 28	20 32 14	1344
6	Ottawa	20 35 13	20 37 43	20 32 06	1444
7	Toronto	20 35 52	20 38 55	20 32 04	1789
8	Buffalo	20 35 52	20 39 05	20 31 51	1900
9	Charlottesville	20 36 07	20 39 26	20 31 57	1978
10	Ann Arbor	20 36 34	20 40 19	20 31 47	2311
11	Chicago	20 37 04	20 41 17	20 31 34	2722
12	St. Louis	20 37 34	20 41 51	20 31 59	2778
15	Saskatoon	20 38 44	20 44 07	20 31 40	3800
16	Stonyhurst	20 38 57	20 44 29	20 31 43	3944
17	Oxford	20 39 10	20 44 45	20 31 53	3978
18	Denver	20 39 34	20 45 10	20 32 15	4000
19	Richmond	20 39 11	20 44 53	20 31 46	4089
20	Toledo	20 39 21	20 45 04	20 31 54	4111
21	San Fernando	20 39 21	20 45 10	20 31 46	4222
22	Paris	20 39 33	20 45 26	20 31 53	4278
23	Uccle	20 39 37	20 45 36	20 31 51	4378
24	De Bilt	20 39 39	20 45 43	20 31 47	4467
25	Tortosa	20 39 47	20 45 51	20 31 55	4467
26	Cartuja	20 39 36	20 45 41	20 31 43	4478
27	Balboa	20 40 06	20 46 16	20 32 08	4556
28	Helgoland	20 40 05	20 46 17	20 32 04	4589
29	Besancon	20 39 56	20 46 10	20 31 53	4622
31	Heidelberg	20 40 13	20 46 28	20 32 09	4644
32	Taunus	20 39 51	20 46 11	20 31 41	4722
33	Zürich	20 40 05	20 46 27	20 31 53	4756
34	Copenhagen	20 40 04	20 46 27	20 31 51	4778
35	Hamburg	20 39 57	20 46 20	20 31 44	4778
36	Strasbourg	20 39 59	20 46 23	20 31 45	4789
37	Hohenheim	20 40 05	20 46 31	20 31 50	4800
38	Abisko	20 40 09	20 46 38	20 31 48	4889
39	Leipzig	20 40 17	20 46 48	20 31 55	4911
40	Tucson	20 40 08	20 46 40	20 31 45	4922
41	Algiers	20 40 12	20 46 46	20 31 46	4967
42	Eger	20 40 18	20 46 55	20 31 48	5022
43	München	20 40 20	20 46 58	20 31 50	5033

TABLE II—*Concluded*

Station	P	S	H	△ (km.)
44 Innsbruck	$20^h40^m23^s$	$20^h47^m02^s$	$20^h31^m52^s$	5044
45 Piacenza	20 40 24	20 47 03	20 31 52	5056
46 Firenze	20 40 30	20 47 13	20 31 55	5111
48 Haiwee	20 40 32	20 47 23	20 31 47	5256
49 Tinemaha	20 40 30	20 47 22	20 31 44	5278
50 Graz	20 40 36	20 47 31	20 31 46	5333
52 Riverside	20 40 36	20 47 35	20 31 41	5411
53 Rome	20 40 45	20 47 44	20 31 50	5411
55 Pasadena	20 40 40	20 47 40	20 31 45	5422
56 Rocca di Papa	20 40 45	20 47 45	20 31 50	5422
57 Zagreb	20 40 50	20 47 50	20 31 55	5422
58 Mount Wilson	20 40 39	20 47 40	20 31 42	5444
59 Santa Barbara	20 40 46	20 47 50	20 31 47	5489
61 Budapest	20 40 56	20 48 05	20 31 51	5578
62 Berkeley	20 41 02	20 48 12	20 31 55	5600
63 Pulkovo	20 41 05	20 48 18	20 31 56	5644
64 Beograd	20 41 11	20 48 31	20 31 53	5778
65 Sofia	20 41 50	20 49 34	20 32 09	6178
66 Kucino	20 41 45	20 49 35	20 31 56	6300
67 La Paz	20 42 18	20 50 38	20 32 01	6800
68 Sucre	20 42 31	20 51 04	20 32 02	7011
69 Sverdlovsk	20 42 45	20 51 31	20 32 04	7244
70 Helwan	20 43 00	20 51 53	20 32 13	7356
71 Rio de Janeiro	20 43 00	20 52 00	20 32 07	7467
72 Ksara	20 43 01	20 52 06	20 32 03	7556
73 Baku	20 43 29	20 52 53	20 32 13	7900
74 Honolulu	20 44 27	20 54 27	20 32 09	9100

The arrangement of the above table shows, to a marked degree, the regular progression of arrival times of the P and S phases with increasing arcual distance. These sixty-six △ values were used to locate the position of the epicentre which was determined by means of the stereographic projection method. The point of intersection of the distance circles places the epicentre at approximately 44·5° N. and 55·0° W. which may be regarded as the section of greatest displacement within the disturbed zone. The time of the disturbance at the origin may be taken as the mean of the tabulated values which gives for H 20^h 31^m 53^s G.M.T. Secondary displacements resulted in at least two aftershocks, the first at approximately 23^h $02{\cdot}0^m$ G.M.T. on November 18 and the second at about 2^h $01{\cdot}5^m$ G.M.T. on the day following. The first of these was of the greater intensity and was recorded at Halifax, Seven Falls, Shawinigan Falls, Ottawa, Toronto, Fordham, Chicago, St. Louis, Tucson, Tinemaha, Copenhagen, and La Paz. The second shock had the same epicentral distance from the Shawinigan Falls and Seven Falls stations as the first and was recorded also at Halifax, Fordham, St. Louis, Ottawa, and Toronto stations.

The San Francisco earthquake of 1906 was the result of a horizontal displacement whose maximum did not exceed twenty-one feet. Several other major earthquakes have resulted from land movements much less than that which occurred at San Francisco. It is reasonable, therefore, to suppose that in the case of the Grand Banks earthquake the greatest vertical displacement was not in excess of the San Francisco maximum and that at the southern extremity of the disturbed zone the subsidence was in all probability very much less. Such a movement, however, would be sufficient to cause the severance of cable lines between two fault planes and would also account for the successively later times of breakage with increase of distance from the mouth of the Cabot trench. Displacements of the extent mentioned could hardly be detected by soundings taken in the deep waters of the Strait and such discrepancies as appear between old chartings and the soundings taken by the survey, made subsequent to this shock, are probably due to the inaccuracy of the former and also to the more intensive scope as well as the improved methods used for the latter.

The writer wishes to express his appreciation of the co-operation extended by the Directors of the various seismic stations for the loan of records; the Director of the United States Coast and Geodetic Survey for the use of field notes covering the New England States; cable company officials for detailed data regarding cable breaks; newspaper editors for press reports; and the many postmasters and individuals who responded to our questionnaire service.

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