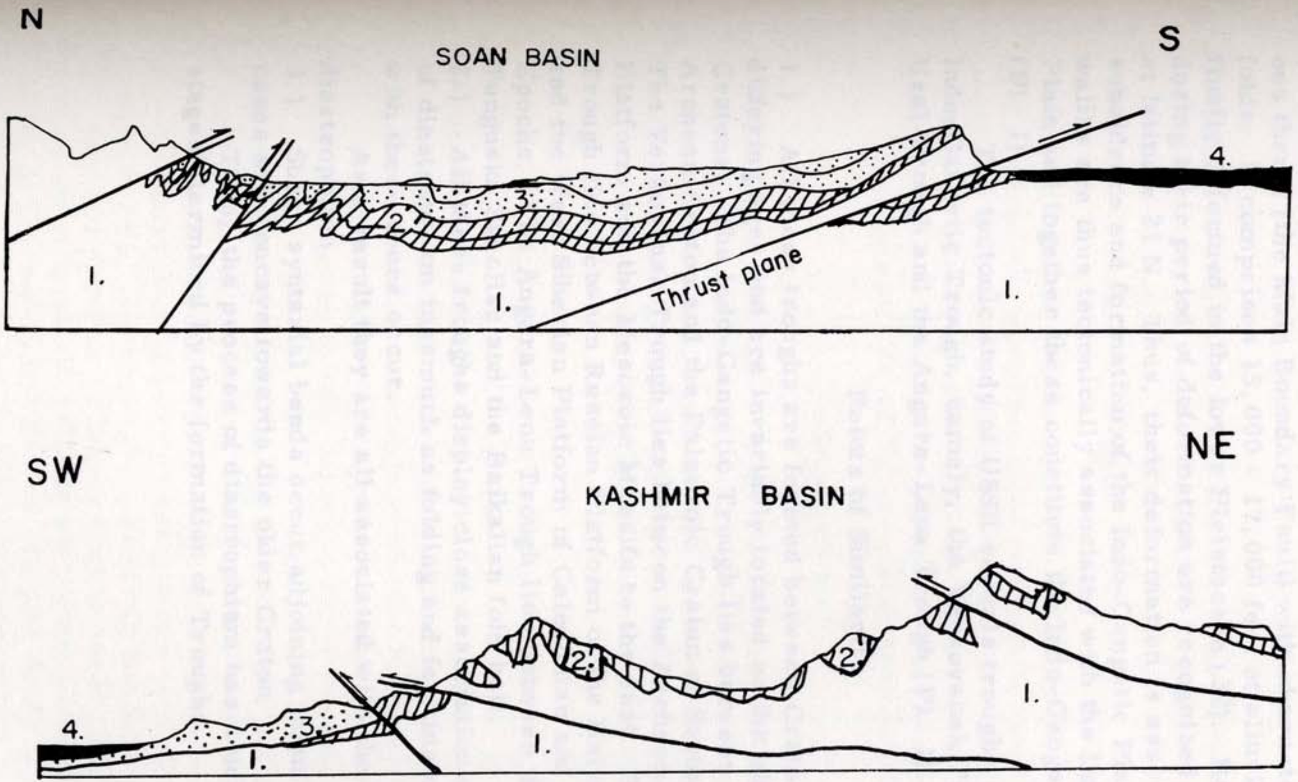

FIG. 7. STRUCTURAL (SKETCH) SECTIONS OF THE OVERTHRUST SOAN AND KASHMIR BASINS (After Wadia G.S.I.)

1. Paleozoic and Pre-Cambrian
2. Paleogene
3. Siwalik
4. Recent

East Asian Troughs

Adjoining the Indo-Gangetic Plain to the north is the autochthonous Siwalik System which is associated with a continuous thrust (the Main Boundary Fault) with characteristic reverse folds. It comprises 15,000 - 17,000 feet of alluvium which were finally deformed in the lower Pleistocene (32). Regional uplifts during their period of deformation are recognized (33) in Bihar at latitude 23 N. Thus, their deformation is associated with the subsidence and formation of the Indo-Gangetic Plain. The Siwaliks are thus tectonically associated with the Indo-Gangetic Plain and together these constitute the Indo-Gangetic Trough (Pl. 1).

The tectonic study of USSR reveals troughs similar to the Indo-Gangetic Trough, namely, the Verkoyansk Trough, The Ural Trough and the Angara-Lena Trough (Pl. 1).

Points of Similarity

1.) All these troughs are formed between Cratons of highly differing ages and are invariably located on the older of the Cratons. The Indo-Gangetic Trough lies between the Indian Archean Craton and the Paleozoic Craton of Southern Russia. The Verkoyansk Trough lies between the Archean Siberian Platform and the Mesozoic Massifs to the east. The Ural Trough lies between Russian Platform of the Baikalian Epoch and the West Siberian Platform of Caledonian and Hercynian Epochs. The Angara-Lena Trough lies between the Archean Tunguska Synclise and the Baikalian fold belt.

2.) All these troughs display close association with the zones of diastrophism inasmuch as folding and faulting of their contact with these zones occur.

As a result they are all associated with the last stages of diastrophism.

3.) Sharp syntaxial bends occur adjoining them and in all cases are concave towards the older Craton.

Thus, the process of diastrophism has a unique final stage determined by the formation of Troughs.

CHAPTER V

CONCLUSIONS

Restatement of the Problem

The problem reduces to correlation between proposed hypotheses and phenomena recorded at all scales of observation.

Umbgrove's Hypothesis

Intensive study and careful correlation of Island Arcs (particularly those of Eastern Asia) constitute the basis of the hypothesis in which crustal waves advance towards a continent. (34) Convection current in the mantle are proposed as a mechanism to explain the crustal wave formation. (Fig. 8) These depend entirely on heat processes in the mantle and core.

Heat Processes

Comparative observations have, for practical purposes, been limited to the vicinity of the earth's surface. The observed heat flow in the oceans are in the same order as the continents (10^{-6} cal. /cm.^{2}) however, the Pacific ocean bottom shows generally lower values except in certain restricted sections. (35)

Van Bemmelen's Hypothesis

The monumental study of the East Indies by Van Bemmelen (36) enables this author to propose the Undation Theory. The hypothesis suggests the development of a central volcanic zone in a wide diastrophic area between continental nuclei (Cratons). Migration of the volcanic zone is recognized by this author towards the cratons.

The mechanism theorized to explain the process implies the existence of a world encircling "Salismatic" layer in the mantle. This layer is subject to cosmic cooling under the wide diastrophic area causing the "hypo-differentiation" of this layer into acid and ultrabasic segregations. The re-establishment of this layer causes rock flow at depth towards the center of the area producing smaller diastrophic zones (eugeosynclines) which migrate in both directions. (Fig. 9) The mechanism is dependent entirely on the physico-chemical behaviour of the Salismatic layer.

It is interesting to note that this author associates mi-

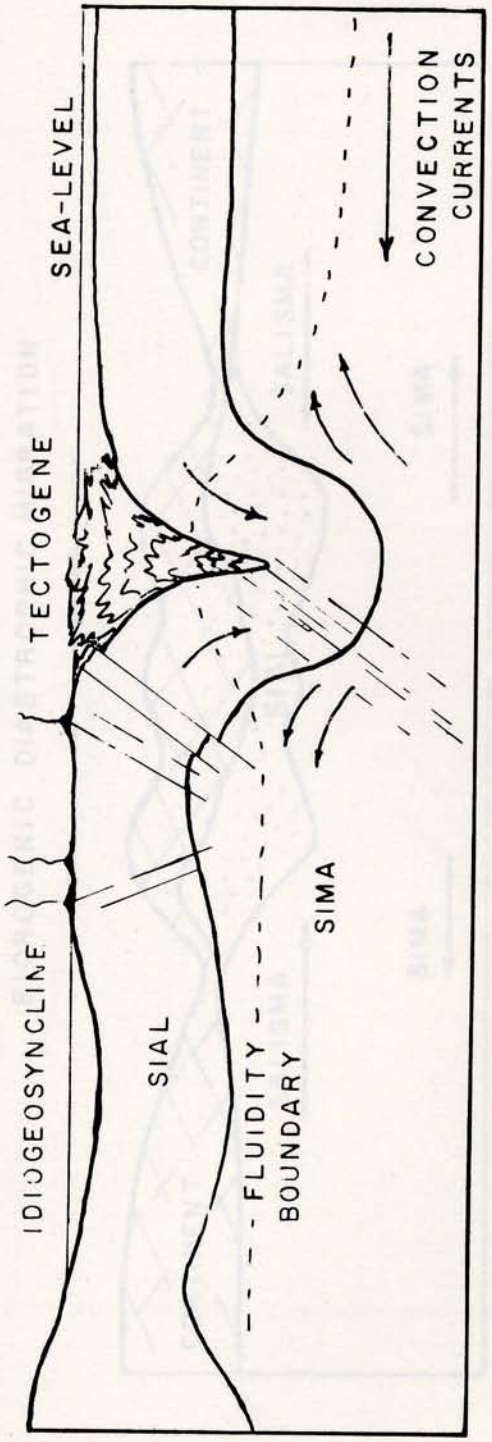

FIG. 8 SKETCH ILLUSTRATING UMBGROVE'S CONCEPT

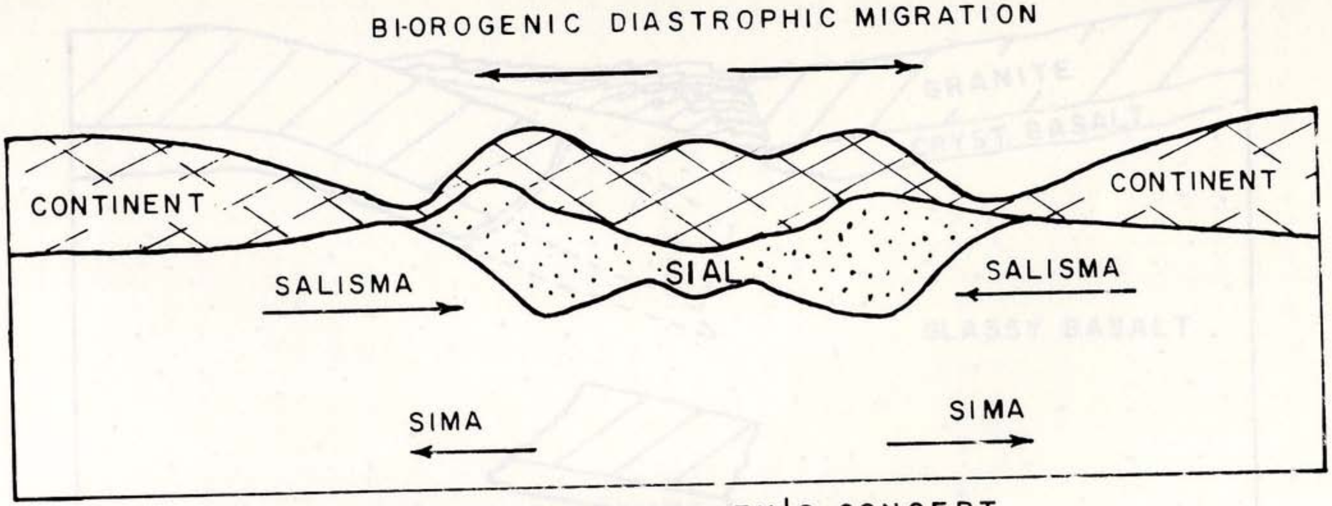

FIG. 9 SKETCH MAP OF VAN BEMMELEN'S CONCEPT

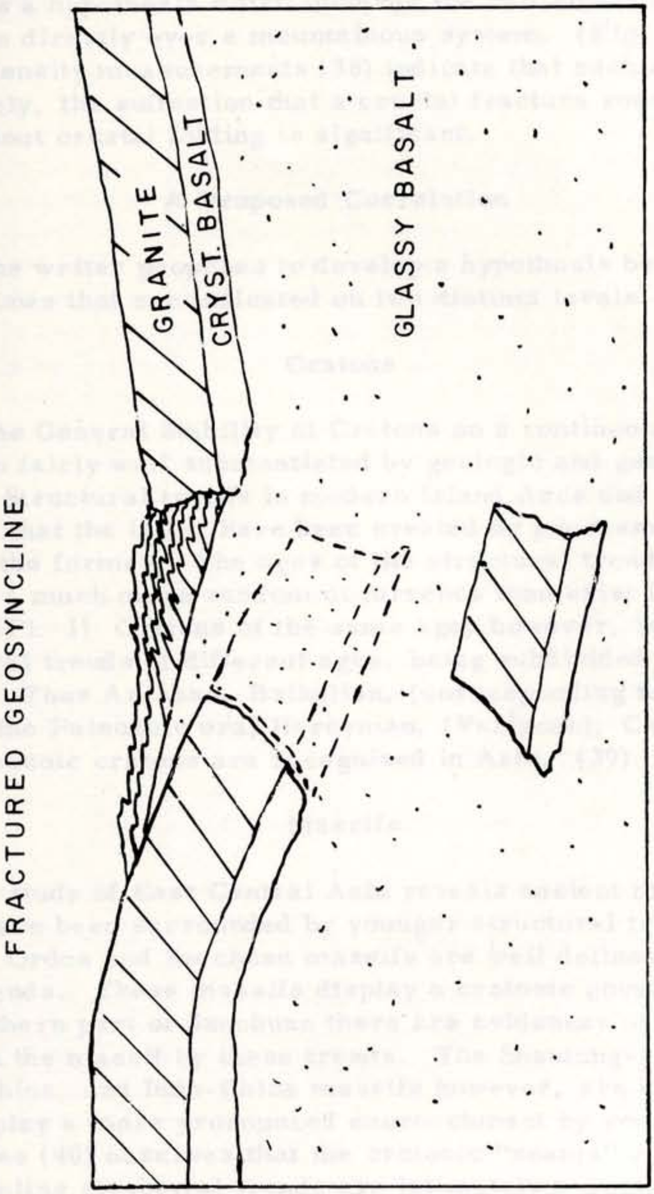

FIG.10 SKETCH ILLUSTRATING DALY'S CONCEPT

gration with diastrophism rather than with cratons.

Daly's Hypothesis

With regard to the strength of the earth's crust Daly (37) proposes a hypothesis which involves the settlement of a graben-like zone directly over a mountainous system. (Fig. 10) Even though density measurements (38) indicate that such a situation is unlikely, the suffestion that a crustal fracture zone may occur without crustal folding is significant.

A Proposed Correlation

The writer proposes to develop a hypothesis by combining the laws that are indicated on two distinct levels.

Cratons

The General Stability of Cratons on a continental scale has been fairly well substantiated by geologic and geodetic evidence. Structural trends in modern Island Arcs and Cratons indicate that the latter have been created by processes associated with the former. The ages of the structural trends however suggest a much more random occurrence than exist in modern Arcs. (Pl. 1) Cratons of the same age, however, include structural trends of different ages, being subdivided by wider epochs. Thus Archean, Baikalian, (corresponding to the beginning of the Paleozoic era) Hercynian, (Variscan), Caledonian and Mesozoic cratons are recognized in Asia. (39)

Massifs

A study of East Central Asia reveals ancient massifs which have been surrounded by younger structural trends. The Tarim, Ordos and Szechuan massifs are well delineated by such trends. These massifs display a cratonic cover, but in the southern part of Szechuan there are evidences of encroachment on the massif by these trends. The Shantung-Liaotung, South China, and Indo-China massifs however, are exposed, and display a more pronounced encroachment by younger trends.

Lee (40) observes that the cratonic "seams" of the Inshan and Tsinling structural trends are intimately associated with the conjunctions of the Japanese arc with the Kurile and Riu-Kiu Arcs. (Pl. 1) The recent (1957) major earth-quake in the Bogdo structural trend (an apparent continuation of the Inshan trend) indicates activity contemporaneous with the East Asian

Arc System.

Hypothesis on a Cratonic Level

These observations suggest the gross outline of the hypothesis. Whereas Island Arcs compose Cratons, Cratons govern the formation of Island Arcs.

Island Arcs

On a smaller scale of observation the zones of diastrophism appear to occur between cratons of different ages. From present activity, these zones are intimately associated with Island Arcs. The modern Island Arc is recognized to have geotectonic factors (41) in a very definite zonal sequence. (Fig. 11) (A) An oceanic trench; (B) Shallow earth-quakes and maximum negative gravity anomalies; (C) Maximum positive anomalies, occasional non-volcanic islands and foci at depths near 60 km; (D) A principal arc of active or recently extinct volcanoes and foci at depths of 100 km; (E) A second structural arc of older volcanics; (F) Foci at depths of 200-300 km and (G) A gentle depression with foci at depths of 300-700 km. Not all these factors are found in modern Arcs, but nonetheless, the order of sequence is invariably preserved.

The Burmese and Pamir arcs display this same property (Fig. 3A and 3B) whereas indications of seismicity (in comparison with modern Arcs) suggest that diastrophism is waning in these zones. (42) This decrease is further associated with a diminishing depth to the "seismic limit."

The Hypothesis at an Arcuate Level

When the invariable order of sequence in these zones is compared, three factors appear to be preserved. This suggests the second stage of the hypothesis.

The sequence of (A) trench (eugeosyncline), the fracture zone (delineated by foci and surface faults) and (D) active plutovolcanism, migrates in the direction of factor (D) to factor (A).

The hypothesis identifies the non-volcanic islands (C) and the second structural arc of older volcanics (E) as former locations of factor (A) and factor (D) described above.

Application of the Hypothesis

According to the hypothesis the Shan Plateau and Himalayan complex (and syntax) are left in the "Wake" of the migration

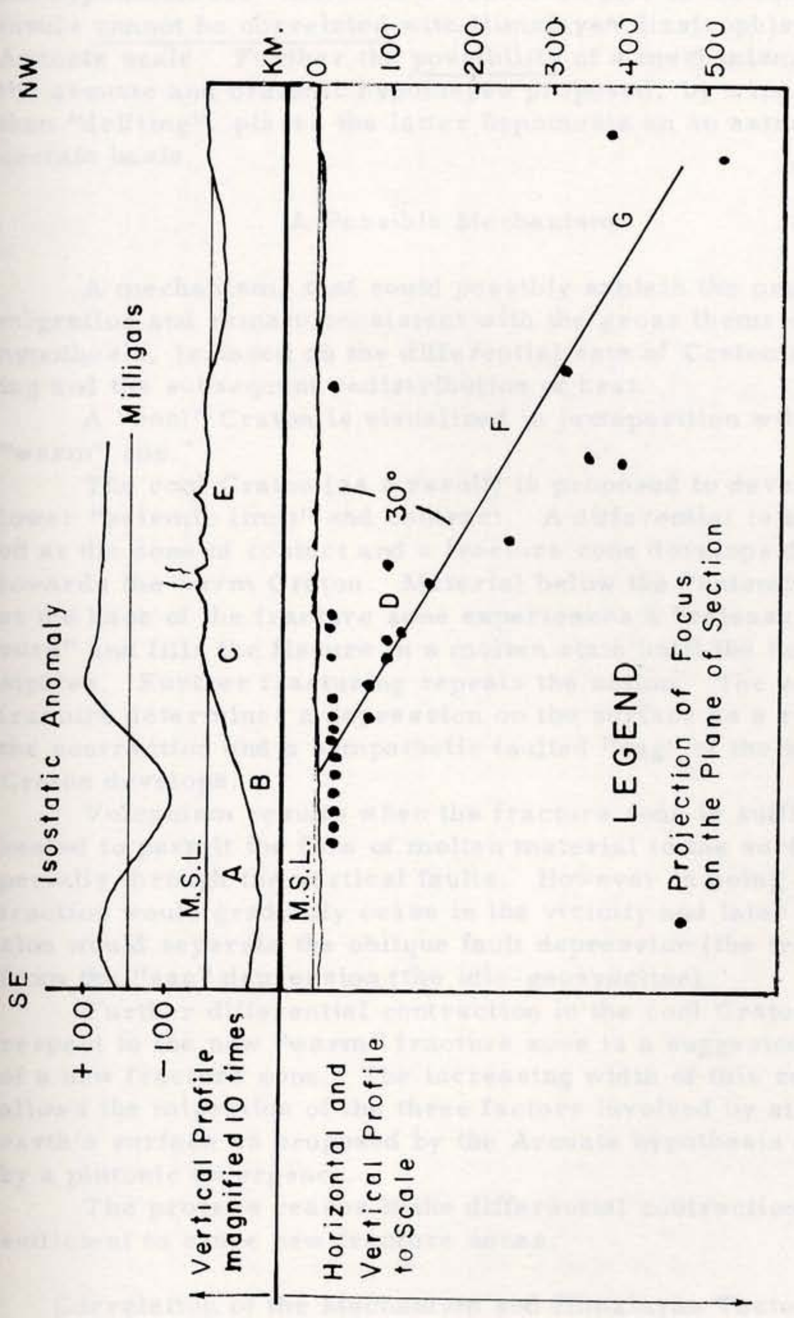

FIG. 11 TECTONIC PROFILE OF NORTH JAPAN
(After Gutenberg & Richter, 1941.)

of the Burmese and Pamir Arcs.

The direction of migration by the Arcs (Pl. 1) precludes any consistent movement of the Indian Craton as a unit. Thus the hypothesis for "drift" on a Cratonic scale of the Indian Peninsula cannot be correlated with Himalayan diastrophism on an Arcuate scale. Further the possibility of a mechanism relating the arcuate and cratonic hypotheses proposed, by a means other than "drifting", places the latter hypothesis on an extremely uncertain basis.

A Possible Mechanism

A mechanism, that could possibly explain the proposed migration and remain consistent with the gross theme of the hypothesis, is based on the differential rate of Cratonic cooling and the subsequent redistribution of heat.

A "cool" Craton is visualized in juxtaposition with a "warm" one.

The cool Craton (as a result) is proposed to develop a lower "seismic limit" and contract. A differential is established at the zone of contact and a fracture zone develops dipping towards the warm Craton. Material below the "seismic limit" at the base of the fracture zone experiences a "release in pressure" and fills the fissure in a molten state until the heat dissipates. Further fracturing repeats the action. The zone of fracture determines a depression on the surface as a result of the contraction and a sympathetic faulted "sag" of the warm Craton develops.

Volcanism results when the fracture zone is sufficiently heated to permit the flow of molten material to the surface, especially through the vertical faults. However in doing so contraction would gradually cease in the vicinity and later expansion would separate the oblique fault depression (the trench) from the "sag" depression (the idio-geosyncline).

Further differential contraction in the cool Craton with respect to the now "warm" fracture zone is a suggested cause of a new fracture zone. The increasing width of this zone allows the migration of the three factors involved by at the earth's surface as proposed by the Arcuate hypothesis followed by a plutonic emergence.

The process ceases if the differential contraction is insufficient to cause new fracture zones.

Correlation of the Mechanism and Himalayan Tectonics

According to the mechanism, the upper edge of the Indo-

Gangetic Trough represents the initial fracture zone. The crystalline axis of the Great Himalaya represents the expansion and emergence of the pluto-volcanic zone, along with the "seismic limit".

Gravitational sliding of the sediments above this emergence, towards the Indian Craton, is a possible explanation for the overthrust zone.

Finally, the presence of Archean rock within the Himalayan zone (Pl. 2) is possibly explained by a removal of the northern "basal edge" of the Indian Craton, in a pluton, rising along a fractured zone. In this event, the isostasy of the northern edge of Craton is disturbed causing subsidence along the Indo-Gangetic Trough.

After examining the various hypotheses proposed the writer is of the opinion, that the mechanism of a migrating fault zone as described above, accounts best for the geological observations made in the Himalayas.

SHALLOW EARTH-QUAKES
(1904-1954)

No.	Date.	Time.	Location.	M	D(km.)
1	1931, Nov. 30	17:01:36	15. 5 N 92. 5 E	d	
2	1930, May 5	13:45:57	17 N 96. 5 E	7. 3	
3	1930, Dec. 3	18:51:44	18 N 96. 5 E	7. 3	
4	1931, Sept. 6	05:38:07	18. 5 N 96 E	d	
5	1933, July 3	15:09:05	19 N 97 E	d	
6	1912, May 23	02:24:10	21 N 97 E	8. 0	
7	1936, Feb. 21	06:20:40	23 N 96 E	d	
8	1939, June 19	21:56:40	23. 5 N 94 E	d	
9	1938, Aug. 16	04:27:50	23. 5 N 94. 3 E	7. 2	
10	1918, July 8	10:22:07	24. 5 N 91 E	7. 6	
11	1932, March 27	08:44:40	24. 5 N 92 E	d	
12	1946, Sept. 12	15:17:15	23. 5 N 96 E	7. 5	
13	1946, Sept. 12	15:20:20	23. 5 N 96 E	7. 8	
14	1933, Aug. 11	08:54:01	25. 5 N 98. 5 E	6. 5	
15	1931, May 27	00:43:29	27. 5 N 98. 5 E	d	
16	1934, Jan. 19	12:33:07	25. 5 N 98. 25 E	6	
17	1933, Nov. 19	09:08:29	25 N 98 E	d	
18	1931, Oct. 18	07:06:40	26 N 98 E	d	
19	1908, Dec. 12	12:54:90	26. 5 N 97 E	7. 5	
20	1931, Jan. 27	20:09:13	25. 6 N 96. 8 E	7. 6	
21	1931, Feb. 10	01:22:54	25. 5 N 96 E	d	
22	1929, March 25	03:47:04	29 N 94. 5 E	d	
23	1930, Sept. 22	14:19:11	25 N 94 E	6. 3	
24	1943, Oct. 23	17:23:16	26 N 93 E	7. 2	
25	1941, May 22	01:00:32	27. 5 N 93 E	d	
26	1950, Aug. 15	14:09:30	28. 5 N 96. 5 E	8. 6	
27	1938, Nov. 21	01:11:28	30 N 95 E	6	
28	1947, July 29	13:43:22	28. 5 N 94 E	7. 7	
29	1932, March	00:17:56	25. 5 N 92. 5 E	d	
30	1934, June 23	95:19:53	33 N 92. 5 E	6	
31	1932, Nov. 9	18:30:09	26. 5 N 92 E	d	
32	1940, Sept. 3	14:40:32	31 N 91. 5 E	d	
33	1923, Sept. 9	22:03:43	25. 3 N 91 E	7. 1	
34	1933, March 6	13:05:35	26 N 90. 5 E	d	
35	1932, March 24	16:08:36	25 N 90 E	d	
36	1930, July 2	21:03:42	25. 5 N 90 E	7. 1	
37	1924, Aug. 13	23:57:50	29. 5 N 90 E	d	
38	1924, Oct. 8	20:32:57	30 N 90 E	6. 5	
39	1934, Dec. 15	01:57:37	31. 3 N 89. 3 E	7. 1	
40	1936, Feb. 18	14:30:32	31 N 89 E	d	
41	1935, Jan. 3	01:50:08	30. 5 N 88	6. 5	
42	1936, Feb. 11	04:48:00	27. 5 N 87 E	d	50
43	1934, Jan. 15	08:43:18	26. 5 N 86. 5 E	8. 3	

TABLE 1 (contd.)

No.	Date.	Time.	Location	M	D(km.)
44	1931, June 18	12:58:29	30. 5 N 84 E	d	
45	1936, May 27	06:19:19	29. 5 N 83. 5 E	7. 0	
46	1944, Oct. 17	18:36:54	31. 5 N 83. 5 E	6. 8	
47	1944, Oct. 29	00:11:32	31. 5 N 83. 5 E	6. 8	
48	1913, March 6	02:09:00	30 N 83 E	6. 2	
49	1913, March 6	11:04:00	30 N 83 E	6. 4	
50	1934, Oct. 19	20:58:16	34 N 82 E	d	
51	1916, Aug. 28	06:39:42	30 N 81 E	7. 5	
52	1932, March 4	23:20:48	33. 5 N 81 E	d	
53	1911, Oct. 14	23:24:00	31 N 80. 5 E	6. 8	
54	1935, March 5	22:15:53	29. 8 N 80. 3 E	6	
55	1945, June 4	12:09:06	30 N 80 E	6. 5	60
56	1905, April 4	00:50:00	33 N 76 E	8	
57	1945, June 22	18:00:57	32. 5 N 76 E	6. 5	60
58	1940, Oct. 31	10:43:56	24. 5 N 70. 3 E	d	
59	1934, May 1	03:40:40	27 N 69 E	d	
60	1931, Aug. 26	19:29:20	28 N 69 E	d	
61	1931, Sept. 30	11:14:45	28. 5 N 69 E	d	
62	1930, Sept. 29	13:29:00	27. 5 N 68. 5 E	d	
63	1928, Sept. 1	06:09:00	29 N 68. 5 E	6. 3	
64	1935, May 15	02:01:24	28 N 68 E	6	
65	1909, Oct. 20	23:41:12	30 N 68 E	7. 2	
66	1931, Aug. 24	21:35:22	30. 5 N 67. 8 E	7. 0	
67	1928, Oct. 15	14:19:41	28. 5 N 67. 5	6. 8	
68	1931, Aug. 27	15:27:17	29. 8 N 67. 3 E	7. 4	
69	1933, Oct. 16	04:34:44	33 N 67 E	d	
70	1935, May 30	21:32:46	29. 5 N 66. 8 E	7. 5	
71	1935, June 2	09:16:25	30 N 66. 8 E	6	
72	1934, April 19	23:27:00	24 N 65 E	d	
73	1944, Sept. 27	16:25:02	39 N 73. 5 E	7. 0	40
74	1924, July 6	18:31:49	40. 5 N 73. 5 E	6. 5	
75	1924, July 12	15:12:34	40. 5 N 73. 5 E	6. 8	
76	1911, Feb. 18	18:41:03	40 N 73 E	7. 8	
77	1932, Oct. 29	11:08:49	39. 5 N 72 E	6	
78	1934, Nov. 15	23:14:42	36. 5 N 71 E	d	
79	1936, Aug. 20	23:32:33	36. 5 N 71 E	d	
80	1939, June 19	00:42:40	36. 5 N 71 E	d	
81	1934, Sept. 8	06:44:56	38. 5 N 71 E	d	
82	1934, Aug. 31	14:57:41	38. 8 N 71 E	6. 5	
83	1939, May 30	10:07:04	39 N 71 E	d	
84	1924, Sept. 16	02:36:00	39 N 70. 5 E	6. 3	
85	1941, April 20	17:38:30	39 N 70. 5 E	6. 5	
86	1941, April 26	23:11:01	39 N 70. 5 E	d	
87	1941, May 6	16:55:36	39 N 70. 5 E	6	60
88	1940, March 19	04:35:50	35. 8 N 70 E	6	50

TABLE 1 (contd.)

No.	Date.	Time.	Location.	M	D(km.)
89	1926, March 22	16:24:10	36 N 70 E	d	
90	1933, Dec. 2	02:15:16	36. 5 N 69. 5 E	d	
91	1933, Dec. 9	07:52:10	36. 5 N 69. 5 E	d	
92	1907, Oct. 21	04:23:36	38 N 69 E	8. 0	
93	1923, Dec. 28	22:24:52	39. 5 N 68 E	6	
94	1935, July 5	17:53:01	38 N 67. 5 E	6	
95	1928, Feb. 25	17:23:58	37. 5 N 67 E	d	
96	1911, Jan. 1	10:18:00	38 N 66 E	7. 2	50
97	1949, July 10	03:53:36	39 N 70. 5 E	7. 6	
98	1938, Aug. 23	08:16:03	32. 3 N 92. 8 E	5. 5	
99	1940, Aug. 4	04:35:52	30 N 92 E	6	
100	1952, Aug. 17	16:02:07	30. 5 N 91. 5 E	7. 5	
101	1951, Nov. 18	09:35:47	30. 5 N 91 E	8. 0	
102	1938, Jan. 29	04:13:08	27. 5 N 87 E	5. 5	
103	1941, Aug. 1	03:48:00	33 N 85. 3 E	d	
104	1937, Oct. 20	01:23:43	31 N 78 E	5. 5	
105	1947, July 10	10:19:27	33 N 77 E	6	60

TABLE 2

INTERMEDIATE EARTH-QUAKES OF THE NORTH INDIAN REGION (1904-1954)

No.	Date.	Time.	Location.	M	D(km.)
1	1938, April 14	01:16:35	23.5 N 95 E	6.8	130
2	1940, May 11	21:00:20	23.8 N 94.3 E	6.5	80
3	1935, April 23	16:45:41	24 N 94.8 E	6.3	110
4	1927, March 15	16:56:32	24.5 N 95 E	6.5	130
5	1934, June 2	05:54:29	24.5 N 95 E	6.5	130
6	1939, May 6	03:41:08	24.5 N 95 E	5.8	100
7	1939, May 27	03:45:44	24.5 N 94 E	6.8	75
8	1926, May 10	08:19:10	26 N 97 E	6.3	80
9	1906, Aug. 31	14:57:30	27 N 97 E	7	100
10	1941, Feb. 23	09:56:40	28 N 96 E	5.5	90
11	1932, Aug. 14	04:39:32	26 N 95.5 E	7.0	120
12	1941, Jan. 27	02:30:16	26.5 N 92.5 E	6.5	180
13	1941, Jan. 21	12:41:48	27 N 92 E	6.8	100
14	1935, March 21	00:04:02	24.3 N 89.5 E	6.3	80
15	1935, May 21	04:22:31	28.8 N 89.3 E	6.3	140
16	1937, Nov. 15	21:37:34	35 N 78 E	6.5	100
17	1925, March 8	11:27:47	34 N 67 E	5.8	200
18	1907, April 13	17:57:18	36.5 N 70.5 E	7.0	260
19	1907, Dec. 25	22:36:00	36.5 N 70.5 E	6.8	240
20	1908, March 12	19:24:24	36.5 N 70.5 E	6.5	200
21	1908, April 16	17:38:48	36.5 N 70.5 E	6.8	220
22	1908, Oct. 23	20:14:06	36.5 N 70.5 E	7.0	220
23	1908, Oct. 24	21:16:36	36.5 N 70.5 E	7.0	220
24	1909, July 7	21:37:50	36.5 N 70.5 E	7.8	230
25	1912, April 25	10:27:48	36.5 N 70.5 E	6.8	220
26	1912, May 22	23:08:18	36.5 N 70.5 E	6.3	220
27	1912, June 1	00:31:18	36.5 N 70.5 E	6	200
28	1912, Aug. 23	21:14:30	36.5 N 70.5 E	6.8	200
29	1912, Nov. 28	20:55:06	36.5 N 70.5 E	6.5	230
30	1915, June 3	08:08:36	36.5 N 70.5 E	5.8	200
31	1916, April 21	13:56:22	36.5 N 70.5 E	6.3	220
32	1921, Nov. 15	20:36:38	36.5 N 70.5 E	7.8	215
33	1922, Dec. 6	13:55:36	36.5 N 70.5 E	7.5	230
34	1922, Dec. 17	00:51:20	36.5 N 70.5 E	6.3	210
35	1927, July 15	03:46:43	36.5 N 70.5 E	5.8	250
36	1928, Aug. 10	15:33:48	36.5 N 70.5 E	6.8	230
37	1929, Feb. 1	17:14:26	36.5 N 70.5 E	7.1	220
38	1930, Sept. 11	17:20:16	36.5 N 70.5 E	5.8	250
39	1931, Aug. 15	04:01:08	36.5 N 70.5 E	6	240
40	1931, Sept. 14	03:32:16	36.5 N 70.5 E	5.8	220
41	1931, Oct. 5	22:31:27	36.5 N 70.5 E	6.8	220
42	1932, Feb. 9	02:19:44	36.5 N 70.5 E	5.3	220
43	1933, Jan. 9	02:01:43	36.5 N 70.5 E	6.5	230
44	1933, Jan. 20	12:12:12	36.5 N 70.5 E	5.5	230
45	1933, May 21	17:53:43	36.5 N 70.5 E	5.5	220
46	1934, July 22	19:56:57	36.5 N 70.5 E	6.8	240
47	1934, Nov. 18	03:21:24	36.5 N 70.5 E	6.5	220
48	1935, Feb. 3	02:10:47	36.5 N 70.5 E	6	230
49	1935, April 3	11:11:59	36.5 N 70.5 E	6.3	250
50	1935, Oct. 11	04:20:18	36.5 N 70.5 E	5.8	230
51	1935, Dec. 19	23:10:45	36.5 N 70.5 E	5.5	230
52	1937, Oct. 29	07:26:30	36.5 N 70.5 E	6.3	230
53	1937, Nov. 14	10:58:12	36.5 N 70.5 E	7.2	240
54	1938, Jan. 18	09:29:02	36.5 N 70.5 E	5.8	250
55	1938, Jan. 26	10:48:12	36.5 N 70.5 E	5.3	250
56	1938, April 6	01:14:30	36.5 N 70.5 E	5.3	240
57	1939, Nov. 21	11:01:50	36.5 N 70.5 E	6.9	220
58	1940, Sept. 21	13:49:03	36.5 N 70.5 E	6.3	250
59	1941, May 17	21:29:34	36.5 N 70.5 E	5.8	250
60	1941, Nov. 28	12:23:23	36.5 N 70.5 E	5.8	220
61	1942, May 15	16:55:30	36.5 N 70.5 E	5.5	250
62	1942, Nov. 16	21:26:17	36.5 N 70.5 E	5.5	230
63	1943, Feb. 28	12:54:33	36.5 N 70.5 E	7.0	210
64	1943, Sept. 9	04:06:10	36.5 N 70.5 E	6.3	200
65	1944, Nov. 14	23:18:10	36.5 N 70.5 E	5.5	200
66	1939, Dec. 19	00:02:31	36.5 N 70.5 E	5.5±	220
67	1940, Feb. 8	15:15:20	36.5 N 70.5 E	5.8	220
68	1940, Dec. 25	23:07:33	36.5 N 70.5 E	5.5±	250
69	1947, Jan. 30	12:32:42	36.5 N 70.5 E	5.8±	200
70	1949, March 4	10:19:25	36 N 70.5 E	7.5	230
71	1911, July 4	13:33:26	36 N 70.5 E	7.6	190
72	1921, May 20	00:43:20	36 N 70.5 E	6.8	220
73	1924, Oct. 13	16:17:45	36 N 70.5 E	7.3	220
74	1928, June 24	04:34:38	36 N 70.5 E	6.5	120
75	1940, Nov. 20	17:59:59	36 N 70.5 E	5.8	200
76	1943, Dec. 12	15:54:21	36 N 70.5 E	5.5	230
77	1917, April 21	00:49:49	37 N 70.5 E	7.0	220
78	1933, May 27	22:41:58	37 N 70.5 E	5.8	230
79	1925, June 20	13:04:15	36.5 N 71.5 E	6.5	230
80	1931, Jan. 20	09:27:22	36.5 N 71.5 E	6.5	220
81	1925, Dec. 18	18:10:25	36.5 N 71 E	6	230
82	1929, March 3	03:11:02	36.5 N 71 E	6.3	250
83	1931, Jan. 7	03:49:42	36.5 N 71 E	5.5	200
84	1936, June 29	14:30:10	36.5 N 71 E	6.8	230
85	1941, March 11	21:48:55	36.5 N 71 E	6	210
86	1944, April 29	21:41:26	36.5 N 71 E	5.5	200
87	1933, Feb. 6	21:10:16	36.5 N 71 E	5.5±	250

TABLE 2 (contd.)

No.	Date.	Time.	Location	M	D(km.)
88	1946, June 26	15:21:37	36.5 N 71 E	5.3	210
89	1927, April 18	15:02:00	37 N 71 E	6	200
90	1940, May 27	04:10:38	37 N 71 E	6.3	240
91	1929, March 13	11:01:37	36.5 N 70 E	5.8	200
92	1941, May 15	15:19:52	36.5 N 70 E	6	230
93	1932, April 30	10:52:41	36.8 N 70.5 E	6	250
94	1935, July 28	05:23:58	36 N 71 E	6	150
95	1941, April 14	19:32:45	36 N 71 E	5.5	240
96	1942, March 22	02:08:33	36.5 N 70.3 E	6	210
97	1943, Sept. 24	11:31:37	36.5 N 74 E	6.8	120
98	1928, Nov. 14	04:33:09	35 N 72.5 E	6	110
99	1928, April 25	01:16:58	38.5 N 73.5 E	5.8	150
100	1943, April 5	01:56:14	39 N 72.5 E	6.5	100
101	1933, July 25	13:38:23	39 N 72 E	5.5	250
102	1940, Jan. 26	15:20:45	36.5 N 72 E	5.8	200
103	1940, Nov. 4	08:30:12	36.5 N 70.8 E	5.8±	210
104	1937, Nov. 7	19:07:40	35 N 73 E	5.8±	100±
105	1946, June 24	04:11:23	42.5 N 75 E	5.5	100

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RADIATION SOLAIRE A MONTREAL

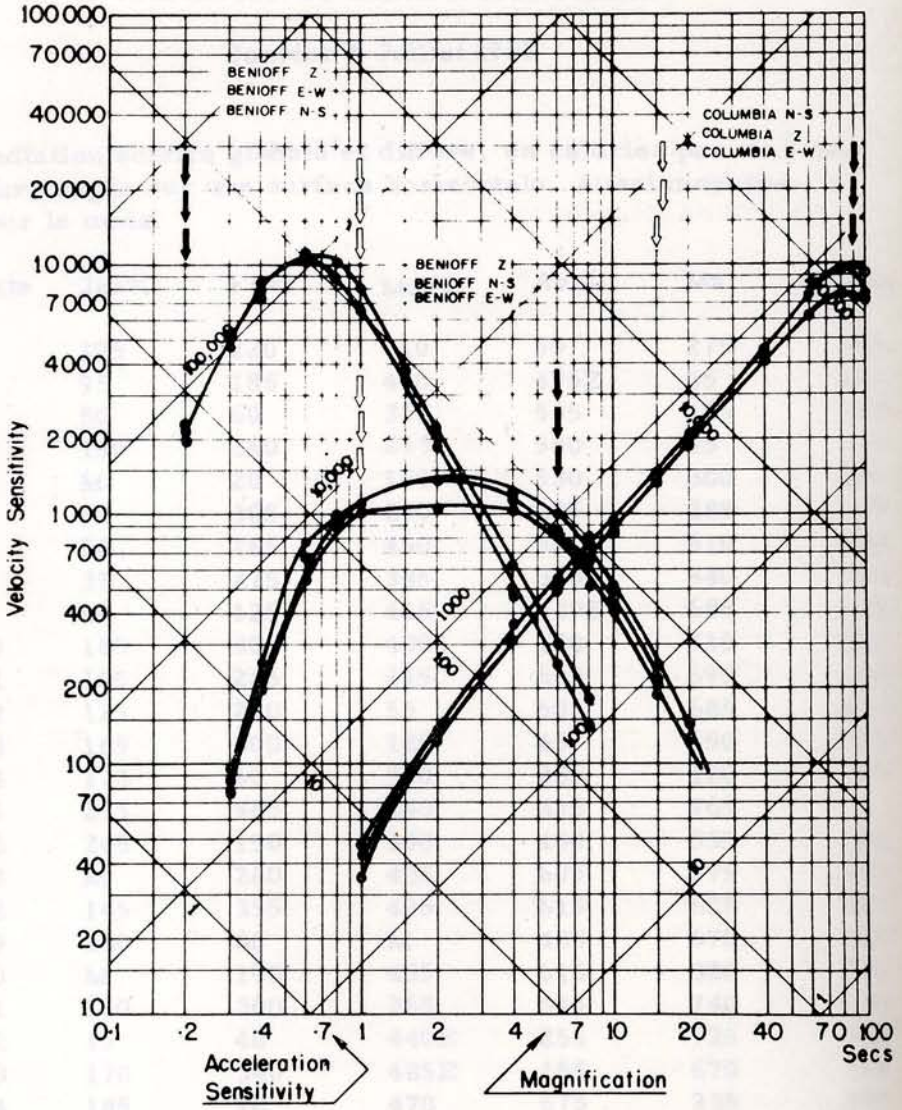
Janvier à Juillet 1962

Radiation solaire globale et diffuse, en calories par cm^2 par jour, reçue sur une surface horizontale. Aussi moyenne pour le mois.

Date	Janv.	Fev.	Mars	Avril	Mai	Juin
1	195	220	410	50	275	390
2	95	185	420	475E	45	240
3	50	60	355	585	185	740
4	190	260	215	580	45	715
5	M	20	150	530	300	580
6	90	305	270	205	285	640
7	50	265	450	60	610	670
8	35	275	385	375	540	725
9	M	125	415	430E	685	675
10	185	300	430	170	715	120
11	185	285	415	605	690	480
12	125	220	55	505	685	550
13	165	300	120	45	650	720
14	175	60	500	285	120	720
15	255	465	240	485	765	
16	245	150	300	400	555	755
17	M	260	435	605	575	480
18	145	355	495	615	625	555
19	230	60	M	485	670	150
20	M	190	455	615	320	490
21	160	300	265	645	740	680
22	15	40	440E	255	725	530
23	170	340	485E	155	670	565
24	185	90	470	675	235	250
25	170	305	375	380	235	675
26	140	85	165	415	570	650
27	315	45	405	575	740	695
28	250	45	515	430	735	730
29	195		400	65	700	740
30	145		330	45	660	430
31	240		140		420	
Moyenne	154	193	358	384	500	570

M: enregistrement manqué.

STATION: MONTREAL



ϕ = 45°30'09"N λ = 73°37'23"W   Altitude 112M

Foundation : Ordovician Limestone (Trenton)

T_s ⇑ T_g ⬆

Date of Calibration: March - April 1962

BENIOFF'S		BENIOFF'S		COLUMBIA'S	
S.P. -Z.	Apr. 4	I.P. -Z.	Apr. 4	L.P. -Z.	Mar.
S.P.H. -N.S.	Apr. 4	I.P.H. -N.S.	Apr. 4	L.P.H. -N.S.	Mar.
S.P.H. -E.W.	Apr. 5	I.P.H. -E.W.	Apr. 5	L.P.H. -E.W.	Mar.

BULLETIN SEISMOLOGIQUE

INSTRUMENTS DE LA STATION

3 séismographes Benioff de 100 kg. avec 6 galvanomètres.
t_o=1 sec. t_g=0.2 sec. pour ZNE. Enregistreur, 60 mm/min.
t_g=6 sec. pour Z'N'E'. Enregistreur, 30 mm/min.
3 séismographes Sprengnether, type Columbia Z"N"E".
t_o=17 sec. t_g=100 sec. pour Z"N"E". Enregistreur, 15mm/min.

Pour les autres caractéristiques, cf. graphique.

Dans notre Bulletin, nous indiquons toujours sur quel séismogramme chaque phase a été lue en ajoutant après cette phase une des lettres suivantes: ZNE pour les séismogrammes de 0.2 sec. Z'N'E' pour ceux de 6 sec. et Z"N"E" pour ceux de 100 sec.

L'heure est inscrite à chaque minute sur les séismogrammes par la Société Radio-Canada au moyen d'une ligne téléphonique avec une précision de ±0.1 sec. à l'année. Cette Société nous fournit en même temps un courant alternatif de 60 cycles, de fréquence absolument constante pour les moteurs des enregistreurs. De plus le signal horaire de l'Observatoire du Dominion relayé par le poste local de radio CBF, à 01.00 p.m. s'enregistre automatiquement sur tous les séismogrammes.

Les positions géographiques des épicentres ainsi que l'heure d'origine et la profondeur sont toujours empreuntées à U. S. C. G. S. pour les séismes éloignés. Pour les locaux, ces données nous sont fournies par l'Observatoire du Dominion, et cela est indiqué chaque fois. Pour sauver de l'espace, nous ne mentionnons pas U. S. C. G. S. à chaque séisme.

Nous indiquons aussi quelques fois, après une phase, sur la ligne suivante, la période de l'onde du sol et son amplitude en microns.

Nous tenons à exprimer publiquement notre reconnaissance à l'Observatoire du Dominion qui envoie chaque année ses techniciens refaire l'étalonnage complet de tous les séismographes et pour toute la gamme des fréquences, par la méthode de Willmore.

M. Buist, S. J.

1 jan. 52.3 N., 177.9 E.
Rat Isl., Aleutian Isl.

h	about 26 km.		
H	02	41	06.0
iPZ	02	51	47.0 d
eLZ"		03	12.1

OK

1 jan. 51.9 N., 177.8 E.
Rat Isl., Aleutian Isl.

h	about 59 km.		
H	06	49	57.9
iPZ	07	00	36.5 d

1 jan. 51.9 N., 177.7 E.
Rat Isl., Aleutian Isl.

h	about 58 km.		
H	10	17	05.6
iPZ	10	27	42.4 d

1 jan. 52.4 N., 177.7 E.
Rat Isl., Aleutian Isl.

h	about 27 km.		
→ H	23	40	20.3
iPZ	23	51	05.8 c
eSE"		59	44
eSSE"	00	03	52
eSSSE"		06	56

OA

2 jan. 17.8 S., 69.8 W.
Peru-Bolivia border

h	about 74 km.		
H	05	23	38.2
iPZ	05	34	03.5d
iZ			37.0

2 jan. 80.0 N., 24.3 E.
Svalbard region

h	about 48 km.		
H	12	22	58.7
iPZ	12	31	31.0 c
eSSE"			42.0

3 jan. 18.7 S., 71.0 W.
Near coast of Peru

h	about 77 km.		
H	06	53	16.2
iPZ	07	03	42.0 c
ipPZ			57.8

3 jan. 52.2 N., 177.5 E.
Rat Isl., Aleutian Isl.

h	about 68 km.		
H	17	53	05.3
iPZ	18	03	43.5 c
eLE"		26	

3 jan. 21.5 S., 169.9 E.
Loyalty Isl. region

h	about 75 km.		
H	23	50	28.8
iP'Z	00	09	22.2 d
eLZ"		52	

4 jan. 33.9 N., 135.2 E
Near Shikoku, Japan

h	about 56 km.		
H	04	35	42.6
iPZ	04	49	11.0
eSKSE"		59	42
eSE"	05	00	26
iPSN"		01	52
eSSN"		07	04
eLE"			14.1

5 jan. 15.5 S., 177.7 W.
Fiji Isl. region

h	about 24 km.		
H	00	23	32.1
eSSE"	00	58	30
eLE"	01		15.2

5 jan. 15.5 S., 172.5 W.
Tonga Isl. region

N
Z = Vertical

h	about 60 km.		
H	08	08	07.5
eLZ"		08	58.0

5 jan. 52.3 N., 177.6 E.
Rat Isl., Aleutian Isl.

h	about 70 km.		
H	23	08	29.9
iPZ	23	19	08.0 d

7 jan. 55.2 N., 51.4 E.
Rat Isl., Aleutian Isl.

h	about 27 km.		
H	01	14	12.5
iPZ	01	23	02.8 c
ipPZ			14.4
iPcPZ		24	24
ePPN		25	09

7 jan. 52.0 N., 177.8 E.
Rat Isl., Aleutian Isl.

h	about 55 km.		
H	01	30	34.5
ePZ	01	41	12.7

7 jan. 43.4 N., 17.4 E.
Yugoslavia

h	about 32 km.		
H	10	03	12.8
iPZ	10	13	[illegible].0 d

8 jan. 18.5 N., 70.5 W.
Near S. coast of Dominican Rep.

h	about 63 km.		
H	01	00	24.2
iPZ	01	06	05.0 c
iZ"			18
ipPZ			25
isPZ"			34
iPcPZ"		09	14
iSE"		10	43
isE"		11	18
iScPZ"		12	48

8 jan. 18.5 N., 70.6 W.
Dominican Republic

h	about 50 km.		
H	02	05	21.1
iPZ	02	11	04.7

8 jan. 12.1 N., 85.7 W.
Nicaragua

h	about 104 km.		
H	22	09	00.5
iPZ	22	16	01.2 c

9 jan. 42.9 N., 144.8 E.
Near coast of Hokkaido, Japan

h	about 78 km.		
H	12	40	49.3
ePZ	12	53	22.5 c
iZ			36
ipPZ			46
eSKSE"	13	03	48
eSE"		04	08

10 jan. 52.9 N., 169.1 W.
Fox Isl., Aleutian Isl.

h	about 43 km.		
H	02	19	57.1
iPZ	02	29	51.0 d
ipPZ			05.0

10 jan. 17.1 S., 68.0 W.
Peru-Bolivia border

h	about 52 km.		
H	02	55	01.2
iPZ	03	05	06.8

10 jan. 44.3 N., 128.8 W.
Off coast of Oregon

h	about 25 km.		
H	06	27	45.2
eLZ"		06	47.5

11 jan. 51.6 N., 176.9 W.
Rat Isl., Aleutian Isl.

h	about 53 km.		
H	02	54	10.8
ePZ	03	05	12.0

11 jan. 43.5 N., 17.7 E.
Near coast of Central Yugoslavia

h	about 25 km.		
H	05	05	01.6
iPZ	05	15	18.6 d
ipPZ			30.0
eSN"		23	38
eLN"			30.4

11 jan. 51.9 N., 179.3 W.
Andreanof Isl., Aleutian Isl.
h about 60 km.

H	06	49	07.6
iPZ	06	59	38.8 d
eLE"	07	17	

12 jan. 52.4 N., 177.7 E.
Rat Isl., Aleutian Isl.
h about 49 km.

H	10	55	00.8
ePZ	11	05	39.8

13 jan. 22.7 S., 68.6 W.
N. Chile
h about 159 km.

H	00	45	12.8
iPZ	00	55	58.0 c
ipPZ		56	23

13 jan. 52.3 N., 177.4 E.
Rat Isl., Aleutian Isl.
h about 49 km.

H	04	48	37.3
ePZ	04	59	14.5 c

13 jan. 37.5 S., 178.7 E.
North Isl. New Zealand
h about 25 km.

H	11	05	20.1
eLZ"	12	04.5	

14 jan. 43.1 N., 145.1 E.
Hokkaido, Japan
h about 30 km.

H	07	24	47.6
ePZ	07	37	25.6

14 jan. 44.9 N., 140.8 E.
Off NW. coast of Hokkaido, Japan
h about 193 km.

H	13	34	02.8
iPZ	13	46	19.9 d

15 jan. 13.0 N., 60.5 W.
Off coast of Venezuela
h about 78 km.

H	08	22	15.9
ePZ	08	29	58 c

15 jan.

iPZ	08	14	43.7
ipPZ			59.6

16 jan.

iPZ	10	40	00.1

16 jan. 30.5 S., 177.9 W.
Kermadec Isl.
h about 39 km.

H	11	35	41.3
iP'Z	11	54	31.9
eSKSE"	12	01	30
eSKKSE"		02	56
ePSE"		06.0	
eSSN"		12	38

17 jan. 15.0 N., 88.0 W.
Honduras
h about 42 km.

H	23	34	32.0
ePZ	23	40	57.6 c
iPZ			58.3 d
ipPZ		41	14.0
iZ			30

18 jan. 51.5 N., 161.1 E.
Off SE. coast of Kamchatka
h about 29 km.

H	06	01	09.5
iPZ	06	12	33.0 d

19 jan. 38.5 N., 21.1 E.
Greece
h about 38 km.

H	19	38	04.1
iPZ	19	49	00.3

23 jan. 52.5 N., 169.5 W.
Fox Isl., Aleutian Isl.
h about 25 km.

H	15	59	20.4
iPZ	16	09	16
ipPZ			28.5
eLZ"		29.1	

24 jan. 21.2 S., 65.7 W.
S. Bolivia
h about 238 km.

H	03	01	17.3
iPZ	03	11	24.4 c

25 jan. 10.7 S., 161.8 E.
Solomon Isl.
h about 80 km.

H	01	50	11.4
eP'Z	02	09	09

25 jan. 15.8 S., 69.5 W.
Peu-Bolivia border
h about 209 km.

H	07	26	05.7
iPZ	07	35	58.2
ipPZ		36	50.7

25 jan. 4.4 S., 152.7 W.
Line Isl. region
h about 50 km.

H	10	03	07.0
ePZ	10	15	26
ipPZ			44

26 jan. 35.1 N., 22.7 E.
Mediterranean Sea, W. of Crete
h about 32 km.

H	08	17	37.0
iPZ	08	28	49.6 c
iZ			57.3
ipPZ		29	02.0
eLN"		51	

26 jan. 10.3 N., 90.6 W.
Off coast of El Salvador
h about 45 km.

H	18	40	23
iPZ	18	47	39.0 d
ipPZ			55.2

27 jan. Dominion Observ.
45° 55' N., 74° 51' W.
About 12 miles WSW. of Arundel Que.
Mag. 4.3

H	12	11	16.7
iP,Z	12	11	33.5
iS,Z			46.4

Δ 106 km.

27 jan. 31.0 N., 114.3 W.
Gulf of California
h about 22km.

H	23	07	42.1
ePZ	23	14	34.0 c
eSE"		20	16
eLRZ"		28.7	

28 jan. 14.0 N., 92.3 W.
Off coast of Guatemala
h about 133 km.

H	05	22	55.7
ePZ	05	29	37.3 c
eLRZ"		35	

28 jan. 0.0 123.9 E.
N. Celebes region
h about 101 km.

H	16	41	13.8
eP'Z	17	00	18.7

29 jan. 9.3 S., 79.1 W.
Near coast of Peru
h about 100 km.

H	06	07	22
ePZ	06	16	44.0 c

30 jan. Dominion Observ.
48° 09' N., 80° 02' W.
Rockburst at Kirkland Lake
Ont. Seismic equivalent
energy to Mag 4.6

H	o8	08	00
iP_nZ	08	09	17.0 c
iS_nZ		10	15
iZ			37
iS,			48

Δ 569 km.

30 jan. 12.7 N., 87.7 W.
Near coast of Nicaragua
h about 101 km.

H	08	34	26.8
iPZ	08	41	11.0 c
ipPZ			32
iZ		42	08.0
iPPZ			31
eSN"		46	45

31 jan. Dominion Observ.
47° 30' N., 67° 08' W.
About 15 miles SSE. of Kedgwick N. B.
Mag. 3.5 h 32 km.

H	14	32	38.2

iP$_n$Z 14 33 51.5
iS$_n$Z 34 41.2
iS,Z 35 11
△ 550 km.

1 fév. 31.7 S., 177.3 W.
Kermanec Isl.
h about 30 km.
H 00 39 54.6
iP'Z 00 58 39.0 c
eLZ" 01 45

2 fév. 45.7 N., 151.6 E.
Kurile Isl.
h about 37 km.
H 05 41 38.7
ePZ 05 53 51.0 d

2 fév. 36.3 N., 89.4 W.
NW. Tennessee
h about 25 km.
H 06 43 28.8
iP$_n$Z 06 47 00.3 c
iS$_n$Z 49 27
eL$_g$Z 51 13
1650 km.

2 fév. 49.9 N., 78.2 E.
Kzakh S.S.R.
h 0km.
H 07 59 58.5
ePZ 08 12 20.5

2 fév. 43.7 N., 148.5 E.
Kurile Isl.
h about 49 km.
H 17 20 11.1
ePZ 17 32 24

2 fév. 18.2 N., 104.9 W.
Near W. coast of Mexico
h about 17 km.
H 23 03 58.9
ePZ 23 11 17.5 d

3 fév. 1.2 S., 137,8 E.
N. of New Guinea
h about 17 km.
H 00 37 53.6
eP'Z 00 57 02

ePPZ" 59 06
ePKSZ" 01 00 26
eSKSN" 04 16
eSKKSN" 06 02
ePSN" 09 08
eN" 11 48
eSSN" 16 08
eSSSN" 21 20

3 fév. 6.5 N., 73.1 W.
Colombia
h about 190 km.
H 21 38 19.9
iPZ 21 45 28.5 c

4 fév. 7.4 N., 82.4 W.
S. of Panama
h about 38 km.
H 17 47 39.7
iPZ 17 55 05.2 c
eLZ" 18 07

4 fév. 5.7 S., 152.1 E.
Near N. coast of New Guinea
h about 85 km.
H 16 16 40.9
eLZ" 17 04.0

4 fév. 0.5 S., 20.2, W.
S. Atlantic Ocean
h about 17 km.
H 21 29 33.2
ePZ 21 40 21.0 c
iSN" 49 09
eSSSN" 56 18

5 fév. 35.9 N., 138.8 E.
Central Honshu, Japan
h about 151 km.
H 22 55 49.6
iPZ' 23 08 56 d

7 fév. 20.4 S., 68.4 W.
Chile-Bolivia border
h about 222 km.
H 07 36 05.1
iPZ 07 46 32.5 c
iZ 58.6

8 fév. 3.2 S., 141.3 E.
New Guinea
h about 87 km.
H 11 49 13.9
eP'Z 12 08 17.0
eSSN" 28.0

10 fév. 19.2 S., 69.5 W.
Chile-Bolivia border
h about 232 km.
H 04 19 41.7
ePZ 04 29 55.2

10 fév. 17.9 N., 62.2 W.
Leeward Isl.
h about 70 km.
H 19 31 56.2
iPZ 19 37 52 c

10 fév. 33.1 S., 69.0 W.
Mendoza Prov. Argentina
h about 171 km.
H 19 46 11.0
iPZ 19 57 55.5

11 fév. 29.6 N., 139.0 E.
S. of Honshu, Japan
h about 400 km.
H 02 42 46.1
ePZ 02 55 37.2
iPPZ 59 46.7

11 fév. 52.0 N., 168.0 W.
Fox Isl., Aleutian Isl.
h about 50 km.
H 10 01 24.8
iPZ 10 11 15.0 c

11 fév. 4.5 S., 153.5 E.
New Ireland Region
h about 100 km.
H 18 55 32.0
iP'Z 19 14 35.5 d

13 fév. 54.1 N., 35.1 W.
N. Atlantic Ocean
h about 27 km.
H 00 46 16.3
ePZ 00 51 52.5
eLZ" 58.5

13 fév. 49.0 N., 156.2 E.
Kurile Isl.
h about 45 km.
H 02 22 15.2
iPZ 02 34 15.8 c

13 fév. 42.7 N., 145.3 E.
Near coast of Hokkaido, Japan
h about 105 km.
H 20 33 42.6
ePZ 20 46 11.0 c

14 fév. 38.1 S., 73.1 W.
Near coast of Chile
h about 44 km.
H 06 36 01.3
ePZ 06 48 27
iPZ 29.0
2.2 sec. 1.5 micr.
ipPz 41.8
iPPZ" 51 24
ePPPN" 53 39
eSE" 58 46
iSSE" 07 03 54
iSSSE" 07 30
ME" 16.5
46 sec. 183 micr.

14 fév. 38.2 S., 73.7 W.
Near coast of Chile
h about 40 km.
H 07 08 21.1
ePZ 07 20 43.5

14 fév. 38.2 S., 73.1 W.
Near coast of Chile
h about 40 km.
H 0829 00.1
ePZ 08 41 23

16 fév. 49.4 N., 156.0 E.
Kurile Isl.
h about 24 km.
H 15 54 32.3
iPZ 16 06 21.8 d

17 fév. 61.6 S., 162.9 E.
S. of Macquarie Isl. region
h about 25 km.
H 03 43 45.1
eP'Z 04 03 30

17 fév. 49.2 N., 156.0 E.
Kurile Isl.
h about 23 km.
H 22 01 51.1
ePZ 22 13 40

18 fév. ePZ 07 10 25

18 fév. 41.5 N., 142.4 E.
Near coast of Hokkaido, Japan
h about 40 km.
H 10 42 32.8
ePZ 10 55 18 d

18 fév. 8.1 N., 74.6 W.
N. Colombia
h about 70 km.
H 17 25 13.3
iPZ 17 32 25.9 d
ipPZ 46.5
iPcPZ 34 02.5
iSE" 38 14
eN" 40 48

18 fév. 0.6 S., 91.7 W.
Galapagos Isl.
h about 43 km.
H 23 25 20.1
iPZ 23 34 03.2 c

18 fév. iPZ 23 19 29.7 d
ipPZ 57.2
iZ 20 09.0

19 fév. 11.7 N., 88.1 W.
Off coast of Nicaragua
h about 39 km.
H 20 16 03.6
iPZ 20 23 03.8 c
ipPZ 18.5

20 fév. 6.9 N., 73.1 W.
Colombia
h about 157 km.
H 16 02 15.0
iPZ 16 09 25.0 d

20 fév. 29.3 S., 68.9 W.
La Rioja Prov., Argentina
h about 140 km.
H 14 11 49.6
iPZ 14 23 09.2 d

20 fév. 43.0 N., 144.9 E.
Near coast of Hokkaido, Japan
h about 55 km.
H 16 05 44.6
iPZ 16 18 17.7 c
iZ 31.0
ipPZ 44.0
eSE" 28 39
eLE" 41

20 fév. 46.8 N., 152.8 E.
Kurile Isl.
h about 22 km.
H 19 08 39.8
iPZ 19 20 45.5 d

20 fév. 2.6 N., 96.8 E.
N. Burma
h about 25 km.
H 22 02 38.2
eLZ" 22 49

21 fév. 16.3 N., 90.0 W.
Chiapas, Mexico
h about 80 km.
H 17 21 57.0
ePZ 17 28 27.5 d

22 fév. 25.6 S., 69.8 E.
Indian Ocean
h about 25 km.
H 10 35 01.4
eP'Z 10 54 34

23 fév. 6.3 S., 147.0 E.
N. coast of new Guinea
h about 80 km.
H 11 40 52.8
iP'Z 11 59 51.2 d

23 fév. 4.0 S., 152.6 E.
New Ireland
h about 25 km.
H 18 05 27.1
eLZ" 19 05

23 fév. 3.8 S., 152.0 E.
New Britain
h about 25 km.
H 20 21 28.6
eLZ" 21 18.3

24 fév. 12.2 N., 88.8 W.
Of coast of El Salvador
h about 40 km.
H 01 03 17.6
iPZ 01 10 11.6 c
ipPZ 28.0

26 fév. 42.0 N., 141.8 E.
S. coast of Hokkaido, Japan
h about 60 km.
H 01 13 09.4
ePZ 01 25 55

26 fév. 44.7 N., 146.6 E.
Kurile Isl.
h about 25 km.
H 15 55 33.7
ePZ 16 08 00.5

27 fév. 6.0S., 76.9 W.
N. Peru
h about 65 km.
H 00 04 43.9
iPZ 00 13 46.0 d

27 fév. 63.0 N., 150.0 W.
Central Alaska
h about 100 km.
H 05 52 28.5
iPZ 06 00 33.5 d
ipPZ 01 05.0

27 fév. 37.4 S., 73.2 W.
Near coast of Central Chile
h about 40 km.
H 12 40 48.9
iPZ 12 53 10.3
eSE" 13 03 24

27 fév. 19.2 S., 69.4 W.
N. Chile
h about 140 km.
H 14 03 27.3
ePZ 14 13 49.5 c
iPZ 50.0 d
ipPZ 14 20.8

28 fév. 9.0 S., 75.2 W.
Peru
h about 180 km.
H 13 44 55.8
ePZ 13 54 06.0 c
iPZ 06.3 d

28 fév. 19.3 S., 69.6 W.
N. Chile
h about 110 km.
H 18 32, 14.4
iPZ 18 42 39
ipPZ 43 08.3
iZ 21.7

28 fev. 19.4 N., 69.3 W.
Near N. coast of Dominican Rep
Rep.
h about 60 km.
H 20 34 24.9
ePZ 20 40 05

1 mars 15.7 S., 74.4 W.
S. Peru
h about 62 km.
H 02 12 37.2
ePZ 02 22 45.0 c
iPZ 45.6 d
iZ 56.5
ipPZ 23 05.0

1 mars 49.4 N., 155.3 E.
Kurile Isl.
h about 86 km.
H 12 21 16.6
ePZ 12 32 57.7

1 mars 43.0 N., 146.2 E.
Near E. coast of Hokkaido, Jap.
h about 48 km.
H 18 35 12.9
iPZ 18 47 47.9 d

1 mars. 37.3 N., 4.9 W.
Near S. coast of Spain
h about 25 km.
H 22 20 03.5
iPZ 22 29 06.5

1 mars 14.0 S., 172.5 E.
Samoa Isl.
h about 73 km.
H 23 41 14.5
eLE" 00 17

mars 51.7 N., 173.5 W.
Andreanof Isl, Aleutian Isl.

h	about 25 km.		
H	02	15	05.9
iPZ	02	25	19.8 c

3 mars 7.4 N., 126.5 E.
Near E. coast of Mindanao

h	about 90 km		
H	12	14	52.1
eP'E	12	33	46.6

4 mars 10.6 S., 75.8 W.
Central Peru

h	about 20 km.		
H	00	41	39.1
iPZ	00	51	19.3 d

mars 67.6 N., 171.4 W.
Near NE. coast of
Chukotsky Peninsula U.S.S.R.

h	about 15 km.		
H	11	40	24.5
iPZ	11	49	32.0 c

mars 4.0 S., 103.3 E.
Near S. coast of Sumatra

h	about 78 km.		
H	03	42	33.3
eP'Z	04	01	54

mars 16.0 N., 104.9 W.
About 250 miles S. of
Jalisco, Mexico

h	about 25 km.		
H	01	50	50.6
iPZ	01	58	21.6 d

mars 34.6 N., 121.6 W.
Off coast of California

h	about 25 km.		
H	07	44	00.0
iPZ	07	51	16.1 d

mars 55.9 S., 27.9 W.
Sandwich Isl.

h	about 25 km.		
H	10	15	22.1
eP'Z	10	34	13.5
eN"		44	40

5 mars 40.3 N., 125.1 W.
Off coast of California

h	about 25 km.		
H	20	57	52.1
eLN"	21	12	

6 mars 43.7 N., 93.7 E.
Andaman Isl.

h	about 18 km.		
H	05	55	42.3
eP'Z	06	14	36
eLE"		49	

6 mars 41.9 N., 127.0 W.
Off coast of California

h	about 25 km.		
H	13	12	58.7
eLZ"	13	32	

7 mars 62.2 N., 26.6 W.
SW. of Iceland

h	about 43 km.		
H	02	07	11.8
eLZ"	02	24	

7 mars 19.3 N., 145.3 E.
Mariana Isl.

h	about 680 km.		
H	11	01	00.4
iPZ	11	14	10.0 d
iP'Z		18	15
iPPZ			50
esPPZ"		22.0	
iSPZ"		27	00
iSPPN"		28	05
iSSN"		33	16
eSSSN"		36	52

8 mars 46.0 N., 152.7 E.
Kurile Isl.

h	about 48 km.		
H	10	47	03.9
iPZ	10	59	12.3 d

8 mars 3.4 S., 29.2 E.
Republic of theCongo

h	about 25 km.		
H	21	38	35.4
eLZ"	22	30	

9 mars 5.8 S., 146.4 E.
Near E. coast of New Guinea

h	about 76 km.		
H	22	07	35.6
iP'Z	22	26	35.0 c

11 mars 14.8 N., 91.2 W.
Guatemala

h	about 206 km.		
H	02	26	05.7
ePZ	02	32	33.7 c
iPZ			34.0 d
iZ			51

11 mars 13.9 S., 172.1 E.
New Hebrides Isl., region

h	about 133 km.		
H	07	18	56.7
eLZ"	08	14	

11 mars 52.3 N., 178.0 E.
Rat Isl, Aleutian Isl.

h	about 135 km.		
H	15	23	40.7
iPZ	15	34	08.0
ipPZ			36
iPcPZ			45
eSE"		42	36
eSSE"		50	14

11 mars 9.0 N., 126.7 E.
Near E. Coast of Mindanao

h	about 25 km.		
H	19	19	05.6
iP'Z	19	38	05.5
ePSE"		49	54
eSSE"		56	26

12 mars 9.0 N., 83.0 W.
Costa Roca

h	about 113 km.		
H	09	41	45.7
iPZ	09	48	52.0 d
isPZ		49	33.2
iPcPZ		51	07
eSSE"		57	22

12 mar
Nea
and Costa Rica

h	about 58 km.		
H	11	40	12.8
ePZ	11	47	31.0 c
iPZ			31.2 d
iZ			39.3
iPPZ		48	05
iPcPZ'			33
iZ		49	13
iSN"		53	15
iSSN"		56	12
iSSSE"			33
iScSN"		57	32
iN"		58	02

12 mars 22.7 S., 68.3 W.
Chile-Bolivia border

h	about 158 km.		
H	13	23	40.8
ePZ	13	34	27.6

12 mars 8.3 N., 83.1 W.
Near S. coast of Panama

h	about 24 km.		
H	13	42	33.4
iPZ	13	49	50.6 d

12 mars 2.9 S., 80.2 W.
Ecuador

h	about 25 km.		
H	16	57	46.8
ePZ	17	06	29

15 mars 45.7 N., 151.3 E.
Kurile Isl.

h	about 43 km.		
H	01	51	19.4
ePZ	02	03	32

16 mars 10.8 S., 165.7 E.
Santa Cruz Isl. region

h	about 25 km.		
H	19	42	39.2
eP'Z	20	01	26.1
eLZ"		42	

17 mars 51.4 N., 159.2 E.
Kurile Isl. region
h about 25 km.
H 17 58 38.6
ePZ 18 10 09.1 d
ipPZ 19.6

17 mars 10.6 N., 43.7 W.
N. Atlantic Ocean
h about 25 km.
H 20 47 31.7
iPZ 20 55 30.4
iPPZ' 57 19
iPPPZ' 24
iSN" 21 01 52
iPSN" 02 08
iSSN" 05 20
iScSE" 30
iSSSE" 06 08
iZ" 07 38

18 mars 16.1 S., 167.2 E.
New Hebrides Isl. region
h about 200 km.
H 03 06 39.4
eLZ" 03 57.1

18 mars 40.6 N., 142.4 E.
Off coast of N. Honshu, Japan
h about 33 km.
H 05 28 21.3
ePZ 05 41 14 d

18 mars 40.6 N., 19.6 E.
S. Albania
h about 25 km.
H 15 30 31.6
iPZ 15 41 09.3
iZ 42 19
eSE" 49 48
ESSN" 54 07
eSSSN" 57 08

18 mars 23.7 N., 114.5 E.
Kwantung Prov. China
h about 43 km.
H 20 18 54.3
eLZ" 21 09

19 mars 0.3 N., 123.5 E.
Near S. coast of Minahossa
Penin. Celebes Isl.
h about 53 km.
H 05 54 24.5
eP'Z 06 13 19 d
iZ 35
iPPZ 14 31
iZ 07 15 44
iPPPZ 16 49
iN" 17 04
iZ 48

19 mars 2.3 S., 77.1 W.
Ecuador
h about 119 km.
H 14 00 08.9
ePZ 14 08 51

20 mars 27.9 N., 111.2 W.
Gulf of California
h about 25 km.
H 10 03 58.3
ePZ 10 10 48

20 mars 50.8 N., 129.7 W.
Queen Charlotte Sound area
h about 25 km.
H 16 31 48.3
ePZ 16 39 25.5

21 mars 62.1 N., 152.7 W.
S. Alaska
h about 122 km.
H 01 53 13.3
iPZ 02 01 28.0
ipPZ 56.3

21 mars 22.2 S., 170.4 E.
Loyalty Isl.
h about 25 km.
H 02 30 18.5
eLZ" 03 30

21 mars 4.4 S., 80.7 W.
Near coast of N. Peru
h about 78 km.
H 06 11 26.2
iPZ 06 20 14.0

22 mars 5.9 S., 113.0 E.
Java Sea
h about 631 km.
H 22 57 51.2
eP'Z 23 16 09
iP'Z 10.0 d
iZ 15.4
iSKPZ 18 55.0
iPPZ 19 11
isP' 20
eSSSN" 41.5

22 mars 5.9 S., 112.9 E.
Java Sea
h about 611 km.
H 00 19 43.1
eP'Z 00 38 03.0
iZ 09.0
iSKPZ 40 50.5
iPPZ 41 05
epPPZ" 43 07
epPKSN" 44 02
eN" 47 07
eP'P'N" 59.0
eSSSN" 01 03.2

22 mars 32.2 S., 66.9 W.
San Luiz Prov. Argentina
h about 249 km.
H 12 07 05.5
ePZ 12 18 45

22 mars 3.2 S., 142.3 E.
Near N. coast of New Guinea
h about 25 km.
H 15 13 03.9
eP'Z 15 32. 10
ePPZ" 34 08
ePKSZ" 35 26
eSKKSN" 41 03
eSSN" 50 20
eSSSN" 55 48
eGN" 16 05.5

22 mars 28.1 S., 67.5 W.
Catamarca Prov. Argentina
h about 217 km.
H 18 59 00.8
ePZ 19 10 14.0

iPZ 14.4 c

22 mars 15.7 S., 68.7 W.
Bolivia
h about 100 km.
H 20 50 24.9
ePZ 21 00 34

22 mars Dominion Observatory
47° 11' N., 69° 28' W.
NW. Maine-Quebec border
H 02 02 20.7
eZ 02 03 20
iZ 03 54
iS,Z 04 05.5
273 km. Mag. 3.3

23 mars 38.0 S., 72.8 W.
Near coast of S. Chile
h about 67 km.
H 05 34 40.5
ePZ 05 47 02.6

24 mars 17.8 S., 173.0 W.
Fiji Isl.
h about 25 km.
H 01 34 07.9
iPZ 01 57 48.1d

24 mars 5.7 S., 145.0 E.
Near N. coast of New Guinea
h about 111 km.
H 12 59 30.9
eSSE" 13 37 44

25 mars 51.2 N., 169.8 W.
Fox Isl., Aleutian Isl.
h about 45 km.
H 08 12 38.0
iPZ 08 22 40.6 c

25 mars Dominion Observatory
47° 34' N., 66° 01' W.
WSW. of Bathurst, N.B.
h about 32 km.
H 05 15 04.9
S_nZ 05 17 23.6
S,Z 58
622 km. Mag. 4.0

25 mars 36.5 N., 1.7 E.
Mediterranean Sea,
E. of Sicily
h about 25 km.
H 21 37 36.1
iPZ 21 48 15.4 c

26 mars 0.5 S., 19.2 W.
Mid. Atlantic Ocean
h about 25 km.
H 12 04 54.6
ePZ 12 15 44.1 c
eSN" 24 32

26 mars 40.6 S., 73.3 W.
Near coast of S. Chile
h about 32 km.
H 16 32 43.6
eSKSN" 16 55 42
eSE" 56 14

31 mars 9.8 N., 121.6 E.
Negros Isl. region
h about 156 km.
H 07 44 36.0
eLE" 08 36

1 avril 33.6 N., 59.0 E.
E. Iran
h about 33 km.
H 00 45 14.6
eLE" 01 22.3

1 avril 41.9 N., 143.4 E.
Near coast of Hokkaido, Japan
h about 55 km.
H 05 01 56.0
iPZ 05 14 38.5

1 avril 4.2 S., 143.6 E.
Near N. coast of New Guinea
h about 80 km.
H 12 11 09.2
iP'Z 12 30 06.0 c
iZ 33 18
eSSE" 49 44
eLE" 13 03.4

1 avril 63.1 N., 152.3 W.
Alaska
h about 100 km.
H 12 11 51.0
iPZ 12 20 02.5

3 avril 9.6 S., 74.7 W.
Peru
h about 125 km.
H 01 21 34.8
iPN 01 30 55.0 c

5 avril 53.7 N., 163.6 W.
Unimak Isl. region
h about 65 km.
H 03 40 08.9
ePZ 03 49 50

6 avril 26.7 S., 113.2 W.
Easter Isl. region
h about 33 km.
H 16 50 14.2
ePZ 17 02 27.3 c
eSE" 12 40
eSSN" 18 08

7 avril 10.0 N., 144.4 E.
Caroline Isl. region
h about 50 km.
H 06 21 38.4
eLZ" 07 15

7 avril 15.0 N., 60.5 W.
Windward Isl.
h about 77 km.
H 23 04 12.2
ePZ 23 10 37.1
ipPZ 57
eLZ" 18.5

8 avril 15.6 N., 99.6 W.
Off coast of Mexico
h about 48 km.
H 20 50 28.9
iPZ 20 57 42.7 d
eSE" 21 03 37
eLZ" 10

9 avril 8.6 S., 124.1 E.
Sawoe Sea
h about 46 km.
H 08 54 22.7
e(P')Z 09 13 47

10 avril 28.6 S., 68.8 W.
Chile-Argentina border
h about 130 km.
H 04 36 27.5
iPZ 04 47 51.0 d
ipPZ 24.0

10 avril 51.1 N., 157.7 E.
Near coast of Kamchatka
h about 33 km.
H 10 31 38.5
iPZ 10 43 35.1 d

10 avril 44.1 N., 73.1 W.
Western Vermount
h about 25 km
H 14 30 46.4
iP,Z 14 31 11.5 c
iS,Z 30.5
△ 155 km.

10 avril 37.9 N., 20.1 E.
Ionian Sea
h about 35 km.
H 21 37 12.6
iPZ 21 48 01.6 c
ipPZ 12.0
iSN" 56 54
eScSN" 58 04
eSSSN" 22 04 11

11 avril 38.2 N., 20.0 E.
Ionian Sea
h about 43 km.
H 10 47 34.0
ePZ 10 58 22
eLZ" 11 26

11 avril 0.2 S., 91.5 W.
Galapagos Isl.
h about 25 km.
H 23 21 26.3
iPZ 23 30 06.0 c

12 avril 38.2 N., 142.3 E.
Near E. coast of Honshu, Japan
h about 68 km.
H 00 52 47.0
ePZ 01 05 43.2
iSKSE" 16 35
iSSE" 22 32
iSSSE" 26 14

12 avril 38.2 N., 142.5 E.
Near E. coast of Honshu, Japan
h about 26 km.
H 05 16 05.0
iPZ 05 29 06.0 d

12 avril 10.4 S., 105.1 E.
S. of Java
h about 84 km.
H 11 20 02.3
eP'Z 11 39 33

12 avril 28.7 S., 71.9 W.
N. coast of N. Chile
h about 34 km.
H 16 36 08.4
iPZ 16 47 39.1 d

15 avril 2.7 S., 11.6 W.
Ascension Isl. region
h about 25 km.
H 18 08 27.3
iPZ 18 19 59.0 d

15 avril 2.9 S., 11.9 W.
Ascension Isl. region
h about 25 km.
H 18 45 17.4
iPZ 18 56 35.7
eLZ" 19 18.8

16 avril 35.6 N., 25.8 E.
Aegean Sea
h about 25 km.
H 07 18 50.0
ePZ 07 30 16.2

16 avril 30.6 N., 140.6 E.
S. of Honshu, Japan
h about 176 km.
H 13 20 15.1
iPZ 13 33 37.0 c

17 avril 42.3 N., 17.3 E.

Adriatic Sea

h	about 25 km.		
H	10	03	46.9
ePZ	10	14	06.2

17 avril 42.6 S., 174.0 E.

South Isl., New Zealand

h	about 25 km		
H	17	43	03.4
eLZ"	18	50	

17 avril 38.4 N., 142.2 E.

Near E. coast of Honshu, Japan

h	about 110 km.		
H	20	54	13.4
ePZ	21	07	08

17 avril 1.5 S., 14.9 W.

Mid Atlantic Ocean

h	about 25 km.		
H	22	34	56.7
ePZ	22	46	08.1

18 avril 10.0 S., 79.0 W.

Off coast of Peru

h	about 39 km.		
H	19	14	37.2
iPZ	19	24	09.1 d
ipPZ			24
iPcPN'		25	10
iPPZ		26	15
iN'		29	10
iSN'		31	51
iPSN"		32	06
eSSE"		35	46

19 avril 38.5 N., 20.5 E.

Ionian Sea

h	about 25 km.		
H	02	05	59.4
ePZ	02	16	45

19 avril 9.8 S., 78.9 W.

Off coast of Peru

h	about 23 km.		
H	02	18	55.9
iPZ	02	28	31.1 d

19 avril 9.4 S., 79.0 W.

Off coast of Peru

h	about 25 km.		
H	20	18	20.5
iPZ	20	27	52.0 d
ipPZ		28	05.5

19 avril 69.8 N., 138.6 E.

Siberia U.S.S.R.

h	about 0 km.		
H	23	16	04.1
iPZ	23	26	30.6
iPcPZ		27	14
eN"		35.0	
eN"		39.0	
eLGN"		45.0	

20 avril 20.6 N., 72.2 W.

Near N. coast of Haiti

h	about 25 km.		
H	05	47	55.3
iPZ	05	53	20.0 c
ipPZ			33.5
iPPZ"		54	00
iSZ"		57	43
18 sec.	88 micr.		
iN'		58	07
eLRZ"		59	48
eMZ"	06	01	12
24 sec.	200 micr.		

22 avril 18.9 S., 169.5 E.

New Hebrides Isl. region

h	about 188 km.		
H	02	10	12.1
iP'Z	02	28	35.0 d

22 avril 15.5 N., 93.1 W.

Near coast of Chiapas, Mexico

h	about 69 km.		
H	04	45	20.3
iPZ	04	52	00.8
ipPZ			20
iPPZ		53	13
eSN"		57	23
eSSE"		59	42
eLGE"	05	01.1	

23 avril 42.9 N., 143.4 E.

Hokkaido, Japan

h	about 25 km.		
H	05	58	04.9
iPZ	06	10	46.6 c
iZ'			50
iZ'		11	12
iPPZ'		14	14
iPPPZ'		16	09.5
iSKSN'		21	09
iSN'			19
MZ"		40	
60 sec.	480 micr.		

24 avril 2.2 S., 76.1 W.

Ecuador-Peru border

h	about 175 km.		
H	16	06	23.7
iPZ	16	14	43.7 c
ipPZ		15	17

25 avril 54.0 N., 160.3 E.

Kamchatka

h	about 29 km.		
H	03	28	56.1
iPZ	03	40	12.5 d

25 avril 38.4 N., 142.5 E.

Honshu, Japan

h	about 56 km.		
H	15	47	29.4
iPZ	16	00	26.0 d
ipPZ			41.0
iSKSE"		11	17
eSE"			26
eSSE"		17	21

27 avril 44.4 S., 74.8 W.

S. Chile

h	about 31 km.		
H	06	47	27.0
ePZ	07	00	25.0
eSKSE"		11	20
eSSN"		17.1	

28 avril 43.9 N., 146.3 E.

Hokkaido, Japan

h	about 155 km.		
H	09	01	10.5
iPZ	09	13	28.7

28 avril 36.4 N., 26.6 E.

Dodecanese Isl.

H	about 40 km.		
H	11	18	57.4
iPZ	11	30	17.8 d
ipPZ			31.7
eSE"		39	39
eSSE"		44.5	

28 avril 36.3 N., 26.7 E.

Dodecanese Isl.

h	about 48 km.		
H	12	43	49.1
iPZ	12	55	07.6 d

30 avril 38.8 N., 140.9 E.

Honshu, Japan

h	about 140 km.		
H	02	26	30.0
iPZ'	02	39	25.0 c
eSE"		50	19

30 avril 17.0 N., 147.3 E.

Mariana Isl.

h	about 109 km.		
H	09	44	17.4
eLZ"	10	44	

30 avril 17.9 S., 176.1 W.

Tonga Isl. region

h	about 26 km.		
H	16	16	47.8
eLZ"	16	45	

30 avril 18.0 S., 176.4 W.

Fiji Isl.

h	about 135 km.		
H	18	31	06.6
eLZ"	19	20	

30 avril 6.4 N., 124.0 E.

Banda Sea

h	about 28 km.		
H	20	39	45.1
iP'Z	20	58	58.8 d
eLZ"	21	50	

30 avril 72.0 N., 7.2 E.
Svalbard region

h	about 25 km.		
H	23	50	33.5
ePZ	23	58	31
eSN"	00	05	02

2 mai 55.9 N., 156.1 W.
Kodiak Isl. region

h	about 25 km.		
H	02	43	25.9
iPZ	02	52	19.8 c
eLN"	03	00	

2 mai 52.4 N., 141.8 E.
Near coast of Sakkalin

h	about 25 km.		
H	06	15	13.3
iPZ	06	27	12.7 d

2 mai 23.6 S., 65.9 W.
Jujuy Prov. Argentina

h	about 163 km.		
H	08	56	29.0
iPZ	09	07	20.1 d
iN"		16	10

2 mai 23.8 S., 66.4 W.
Salta Prov. Argentina

h	about 179 km.		
H	12	33	08.1
iPZ	12	43	57.8 d
ipPZ		44	52.0

3 mai 42.6 N., 144.6 E.
Near SE. coast of Hokkaido, Japan

h	about 49 km.		
H	02	37	56.6
iPZ	02	50	35.6 d
ipPZ			49.4

3 mai 60.0 S., 32.9 W.
Sandwich Isl.

h	about 20 km.		
H	03	34	49.0
eZ"	03	54	04
ePPZ"		57	28
ePSN"	04	04	22
eSSN"		09	32

3 mai 29.1 N., 115.5 W.
Near W. of Baja, California

h	about 25 km.		
H	13	48	23.9
eLZ"	14	08.6	

4 mai 0.9 S., 80.8 W.
Near coast of Ecuador

h	about 74 km.		
H	23	08	05.3
ePZ	23	16	27

5 mai 34.2 N., 139.2 E.
Near S. coast of Honshu, Jap.

h	about 73 km.		
H	11	11	51.4
eLZ"	11	56	

5 mai 54.2 S., 136.5 W.
S. Pacific Ocean

h	about 25 km.		
H	03	33	47.0
eLZ"	04	29	

6 mai 60.0 S., 32.8 W.
Sandwich Isl. region

h	about 25 km.		
H	19	00	10.2
ePZ	19	14	44 d
ePPZ"		19	17
iPPPZ"			40
eSKSN"		25	16
eSE"		26	56
ePSN"		28	35
eSSN"		34	20
iLGE"		45	46
MZ"			52.5

54 sec. 225 micr.

7 mai 45.3 N., 146.7 E.
Kurile Isl.

h	about 25 km.		
H	17	39	53
iPZ	17	52	14.6 c
iSN"	18	02	32
ePSN"		03	26
eGN"		14.1	

8 mai 35.9 N., 24.4 E.
Sea of Crete

h	about 93 km.		
H	23	54	01.7
ePZ	00	05	20.6 d

10 mai 62.0 N., 40.2 W.
Alaska

h	about 72 km.		
H	00	03	40.2
iPZ	00	11	51.2
ipPN		12	14
iPPN'		13	36
ePPPN'		14	26

10 mai 41.8 S., 171.6 E.
South Isl., New Zealand

h	about 54 km.		
H	00	27	17.5
eLZ"	01	33	

10 mai 52.4 N., 170.9 W.
Fox Isl., Aleutian Isl.

h	about 43 km.		
H	05	12	15.9
iPZ	05	22	18.2 c
PcPZ'		23	12
ePPN'		24	21
ePPPN'		25	53
eSE'		30	25
eScSN'		32	07
eSSSN"		37	10

10 mai 49.2 N., 28.6 W.
N. Atlantic Ocean. N. of Azores

h	about 25 km.		
H	14	17	30.0
eLZ"	14	33	

11 mai 6.6 S., 147.7 E.
Near N. coast of New Guinea

h	about 42 km.		
H	07	05	52.5
eP'Z	07	24	54

11 mai 17.0 N., 99.7 W.
Near coast of Mexico

h	about 25 km.		
H	14	11	51.9
iPZ	14	18	50.7 c

iPPN"		20	16
iPPPN'			41
iSE'		24	31
iSSN"		27	24
iScSE'		29	14

46 sec. 400 micr.

11 mai 16. N., 98.6 W.
Near coast of Mexico

h	about 25 km.		
H	16	11	32.2
iPZ	16	18	50.0 d

11 mai 27.5 S., 13.7 W.
S. Atlantic Ocean

h	about 25 km.		
H	20	01	06.9
iPZ	20	09	50.5 c
eLZ"		27.4	

12 mai 17.2 N., 99 W.
Near coast of Mexico

h	about 25 km.		
H	10	16	53.4
iPZ	10	23	50.3 c

13 mai 6.9 N., 73.0 W.
Colombia

h	about 183 km.		
H	09	12	34.3
iPZ	09	19	43.8 c
iZ		20	18
iPcPZ		21	18.0

14 mai 49.0 N., 28.8 W.
Atlantic Ocean

h	about 25 km.		
H	16	53	06.2
ePZ	16	59	19.0 c

14 mai 33.5 N., 140.6 E.
S. of Honshu, Japan

h	about 82 km.		
H	21	06	52.7
ePZ	21	20	20

15 mai 7.3 S., 128.3 E.
Banda Sea

h	about 34 km.		
H	05	23	45.9
ePZ"	05	40	20
eP'Z		43	00

iP$'_2$Z" 14
iPKSZ" 45 54
iPPN" 46 50
iPPPZ" 50 04
iSKKSN" 53 14
iPPSN" 59 23
iN" 06 04 04
iN" 56
iN" 09 02
iSSSE" 11 29

15 mai 7.2S., 128.3 E.
Banda Sea
h about 52 km.
H 06 42 58.9
eP'Z 07 02 25

15 mai 53.4 N., 159.6 E.
Near E. coast of Kamchatka
h about 30 km.
H 19 32 22.5
iPZ 19 43 41.2 c
ipPZ 52.5

16 mai 13.6S., 167.3 E.
New Hebrides Isl.
h about 52 km.
H 05 16 46.0
eLZ" 06 16.2

16 mai 13.4 S., 167.3 E.
New Hebrides Isl.
h about 35 km
H 17 33 05.5
eLZ" 18 32.6

18 mai 48.6 N., 28.7 W.
N. Atlantic Ocean
h about 25 km.
H 12 11 59.8
ePZ 12 18 16

18 mai 46.1 N., 148.5 E.
Kurile Isl.
h about 60 km.
H 18 46 40.1
iPZ 18 58 55.0 c
ipPZ 59 04.5
eLZ" 19 36

18 mai 16.0 S., 173.0 W.
Tonga Isl. Region
h about 25 km.
H 23 18 49.6
eLZ" 00 14.6

19 mai 17.2 N., 99.5 W.
Near coast of Mexico
h about 20 km.
H 14 58 13.3
iPZ 15 05 11.6 c
iPPZ' 06 35.5
iPcPZ" 07 29
iSE" 11 04
iSSE" 13 02
iSSSE" 13 34
MZ" 15.7
14 Sec. 290 micr.

19 mai 13.4S., 76.7 W.
Near coast of Peru
h about 70 km.
H 23 56 32.4
iPZ 00 06 24.0 d
ipPZ 44.1
iZ 07 09

20 mai 20.5 N., 66.0 W.
Off coast of Puerto Rico
h about 38 km.
H 15 01 20.7
ePZ 15 06 51.1 c
ipPZ 07 09.3

21 mai 37.3 N., 96.0 E.
Changhai Prov. China
h about 25 km.
H 12 02 50.6
ePZ 12 16 25.0 d
ipPZ 34.5
iPPZ 20 28
ePPPZ" 22 30
eSKSN" 27 06
eSKKSN" 24
ePSN" 29 08
ePPSN" 52
eSSN" 34 26

21 mai 20.0 S., 177.5 W.
Fiji Isl. region
h about 379 km.
H 21 15 31.0
iPZ 29 42 c
epPZ' 31 10
esPZ" 32 04
iP'Z 33 25.3 d
iPPE 34 71
ipP'E 49
ipPPZ" 35 48
isPPZ" 36 40
eSKSE" 39 39
iSN" 41 41
iSPZ" 43 37
ipSZ" 51
38 Sec. 168 micr.
iPSN" 44 17
iSSN" 49 36
isSSN" 52 16
iN" 56 38
iN" 22 01 12
iN" 02 28
MN" 03
60 Sec. 115 micr.

22 mai 12.3 S., 166.6 E.
Santa Cruz Isl.
h about 151 km.
H 08 06 38.7
iPZ" 08 21 38
eP'Z 25 12.5
ePSE" 36 14
eE" 43 12

22 mai 5.5 S., 152.0 E.
New Britain
h about 100 km.
H 22 03 36.0
eP'Z 22 22 26.0 d
eLE" 55

23 mai 49.1 N., 129.4 W.
Vancouver Isl. Region
h about 25 km.
H 04 24 49.8
ePZ 04 32 00.5 d
eLZ" 43

25 mai 58.6 N., 31.5 W.
S. of Greenland
h about 25 km.
H 00 48 57.1
eLZ" 01 03

25 mai 59.0 N., 31.2 W.
S. of Greenland
h about 25 km.
H 01 07 09.6
eLZ" 01 22

25 mai 20.7 S., 174.3 W.
Tonga Isl.
h about 281 km
H 04 19 57.0
eLZ" 05 14.0

25 mai 2.5 S., 79.1 W.
Ecuador
h about 79 km.
H 14 49 11.2
iPZ 14 57 43.6 d

25 mai 24.1 S., 179.1 E.
Fiji Isl. Region
h about 576 km.
H 17 21 57.6
eLZ" 17 41

25 mai 24.3 S., 65.2 W.
Jujuy Prov. Argentina
h about 69 km.
H 21 28 28.1
iPZ 21 39 45.3 d
ipPZ 40 12

28 mai 42.7 N., 144.5 E.
Hokkaido, Japan
h about 18 km.
H 01 19 52.3
ePZ 01 32 31

28 mai 31.3 S., 68.3 W.
San Juan Prov. Argentina
h about 94 km.
H 23 49 01.0
iPZ 00 00 42.5 d
ipPZ 01 12.0

30 mai 44.6 N., 129.5 W.
Off N. coast of California
h about 25 km.
H 04 57 56.2
eLZ" 05 21

30 mai 30.3 N., 42.4 W.
N. Atlantic Ocean
h. about 25 km.
H 10 02 52.2
eSE" 10 13 40

31 mai 22.1 N., 142.6 E.
Volcano Isl. Region
h. about 257 km.
H 06 28 26.2
ePZ 06 42 24
eSKSN" 52 20
ePSE" 55 14
eSSE" 07 00 55

1 June 13.1 N., 88.0 W.
Honduras
h about 94 km.
H 06 48 32.1
iPZ 06 55 12.0 d

1 June 21.6 S., 63.7 W.
S. Bolivia
h about 128 km.
H 13 07 20.1
iPZ 13 18 13.4

2 June 50.2 N., 129.1 W.
Vancouver Isl. Region
h about 25 km.
H 11 49 49.0
eLZ" 12 07

2 June 49.9 N., 129.8 W.
Vancouver Isl. Region
h about 25 km.
H 12 26 09.6
ePZ 12 33 20
iPPZ 34 46
eSE" 39 12
eSSN" 41 46

2 June 49.8 N., 129.8 W.
Vancouver Isl. Region
h about 23 km.
H 12 35 48.0
ePZ 12 41 58.8

2 June 29.8 N., 130.6 E.
Kyushu, Japan
h about 15 km.
H 17 15 08.7
eLZ" 18 06.6

3 June 22.4 N., 45.2 W.
N. Atlantic Ocean
h about 25 km.
H 15 02 25.5
iPZ 15 08 58.5 d
eSN" 14 22
eSSN" 16 04

4 June 7.5 N., 80.9 W.
S. coast of Panama
h about 56 km.
H 18 50 40.1
ePZ 18 58 00.7

6 June 39.1 N., 123.1 W.
California
h about 23 km.
H 17 50 08.6
eLZ" 18 09

7 June 30.0 N., 113.4 W.
Gulf of California
h about 25 km.
H 00 22 39.4
ePZ 00 29 28.5
eLZ" 42

7 June 51.9 N., 175.9 E.
Rat Isl. Region
h 50 km.
H 05 35 47.3
iPZ 05 46 29.2 d

8 June 11.3 N., 126.0 E.
Timor Sea
h about 60 km.
H 19 17 23.9
iP'Z 19 39 59.5 d

9 June 23.3 S., 66.4 W.
Bolivia-Argentina Border
h about 184 km
H 13 25 48.1
iPZ 13 36 38.5d

9 June 13.6 N., 91.2 W.
Off coast of Guatemala
h about 104 km.
H 19 57 35.5
iPZ 20 04 19.5 d
iPcPZ 06 48
eLZ" 11

10 juin eLZ" 16 41

11 juin 49.7 N., 129.3 W.
Vancouver Isl., region
h about 25 km.
H 00 52 47.3
iPZ 00 59 56.3d
iPPZ 01 01 23

11 June 43.5 N., 18.3 E
Yugoslavia
h about 21 km.
H 07 15 37.6
iPZ 07 26 03.0 d
iPPZ 28 46
eSE" 34 26
eSSE" 38 36

14 June 54.3 N., 169.1 E.
Near Isl. Aleutian Isl.
h about 34 km.
H 07 51 51.0
iPZ 08 02 46.0 d
ipPZ 03 08.3
eSE" 14.00 ~~01~~ 36
eScSE" 12 40
eSSE" 15 30
eSSSN" 18 18
iE" 19 14

14 June 54.2 N., 169.3 E.
Near Isl. Aleutian Isl.
h about 56 km.
H 07 55 48.9
iPZ 08 06 44.5 d
ipPZ 07 09

14 June 19.4 N., 65.0 W.
Puerto Rico Region
h about 64 km.
H 08 30 53.2
ePZ 08 36 45.2
ipPZ 37 07
iPPPZ 58
iSE 41 36

14 June 1.8 S., 76.9 W.
Ecuador
h about 147 km.
H 20 18 04.7
iPZ 20 26 24.0 d
ipPZ 27 04.0

14 June 26.4 N., 126.5 E.
Ryukyn Isl.
h about 22 km.
H 22 14 10.9
eLE" 22 59

15 June 20.4 S., 70.9 W.
Near coast of N. Chile
h about 60 km.
H 06 30 37.0
ePZ 06 41 19 c
iPZ 19.5 d
ipPZ 37.0

17 June 40.1 S., 45.7 E
India Ocean N. of Crozet Isl.
h about 15 km.
H 04 27 38.2
iP'Z 04 47 07.0 d

17 June 10.7 S., 165.3 E.
Santa Cruz Isl. Region
h about 106 km.
H 13 22 21.4
eLZ" 14 21.6

17 June 43.2 N., 88.0 E
Sinkiang Prov. China
h about 50 km.
H 14 26 29.7
iPPPZ 14 44 52
iZ 45 37

18 June 60.5 N., 153.8 W.
Alaska

h	about 193 km.		
H	06	21	04.9
iPZ	06	29	22.5 d
ipPZ		30	02
isPZ			24
iPcPZ			49
iPPZ		31	18

18 June 4.8 S., 151.8 E.
New Britain Region

h	about 47 km.		
H	23	42	31.3
iP'Z	00	01	23.6 c

18 June iPZ	00	15	05.0 c

19 June 7.1 N., 82.7 W.
S. of Panama

h	about 42 km.		
H	00	59	21.3
ePZ	01	06	47.0 d

20 June 45.6 N., 128.9 W.
Off Coast of N. California

h	about 25 km.		
H	19	26	01.8
eLZ"	19	46	

20 June iPZ	23	05	46.0 d
ipPZ		06	04.0
eLZ"		15.8	

21 June eP_1Z	02	06	59.0 c
S_1Z		07	07.5

21 June 5.7 N., 82.6 W.
S. of Panama

h	about 23 km.		
H	04	43	43.3
iPZ	04	51	21.2 c
iZ'			41
iPPZ'		53	07
ePPPZ"			34
eSN"		57	34
eSSE"		00	16
iSSSE"		01	06
iScSE"			30

21 June 61.3 N., 153.4 W.
Alaska

h	about 32 km.		
H	07	55	46.0
ePZ	08	04	12.0 d

23 June 25.7 N., 128.5 E.
Ryukyn Isl.

h	about 36 km.		
H	09	44	37.7
ePPZ		03	22
eSKSN"		09	32
eSKKSN"		10	08
eN"		12	44
eSSN"		18	14

24 June 25.6 N., 101.1 E.
Yunnan Prov. China

h	about 35 km.		
H	01	21	18.2
eLZ"	02	16	

25 June 20.6 S., 71.0 W.
Near coast of N. Chile

h	about 37 km.		
H	02	49	02.1
iPZ	02	59	45.0 d
ipPZ			59.0

25 June 37.3 S., 73.5 W.
Near coast of Chile

h	about 20 km.		
H	06	26	49.6
ePZ	06	39	09.0 d
eSE"	06	49	24

25 June 24.3 N., 122.6 E.
Off coast of Formosa

h	about 33 km.		
H	11	10	24.3
ePPZ"	11	29	20
eSKSN"		35	28
eSKKSN"		36	26
ePSN"		38	48
ePPSN"		39	52
eSSN"		44	58
eSSSE"		49	00

25 June 14.5 N., 82.4 W.
Off East coast of Nicaragua

h	about 25 km.		
H	18	58	35.6
iPZ	19	05	05.0 c
eSN"		10	28
eSSE"		12	24

27 June 37.7 N., 88.5 W.
S. Illinois

h	about 25 km.		
H	01	28	55.7
ePZ	01	32	14.0 d
iSZ		34	49.0
iSSN'		35	09

27 June 48.0 S., 99.6 E.
Indian Ocean S.W. of Australia

h	about 25 km.		
H	13	38	30.6
eLZ"	14	59	

28 June 20.0 N., 155.6 W.
Hawaii Isl. Hawaii

h	about 25 km.		
H	04	27	18.4
iPZ	04	38	34.7
ipPZ			51.0
iSN"		47	46
eSSSN"		55	40

28 June 40.9 N., 20.8 E.
Near Greece Albania

h	about 25 km.		
H	06	51	04.3
ePZ	07	01	45.0 d

28 June 0.2 S., 124.3 E.
N. Celebes

h	about 58 km.		
H	18	50	27.5
iP'Z	19	09	47.0 d
iSKPZ		13	00.5

29 June 62.3 N., 152.4 W.
Alaska

h	about 39 km.		
H	16	28	04.4
iPZ	16	36	25.5
iZ			34.2
eSN"		43	11
eSSSN"		47	28

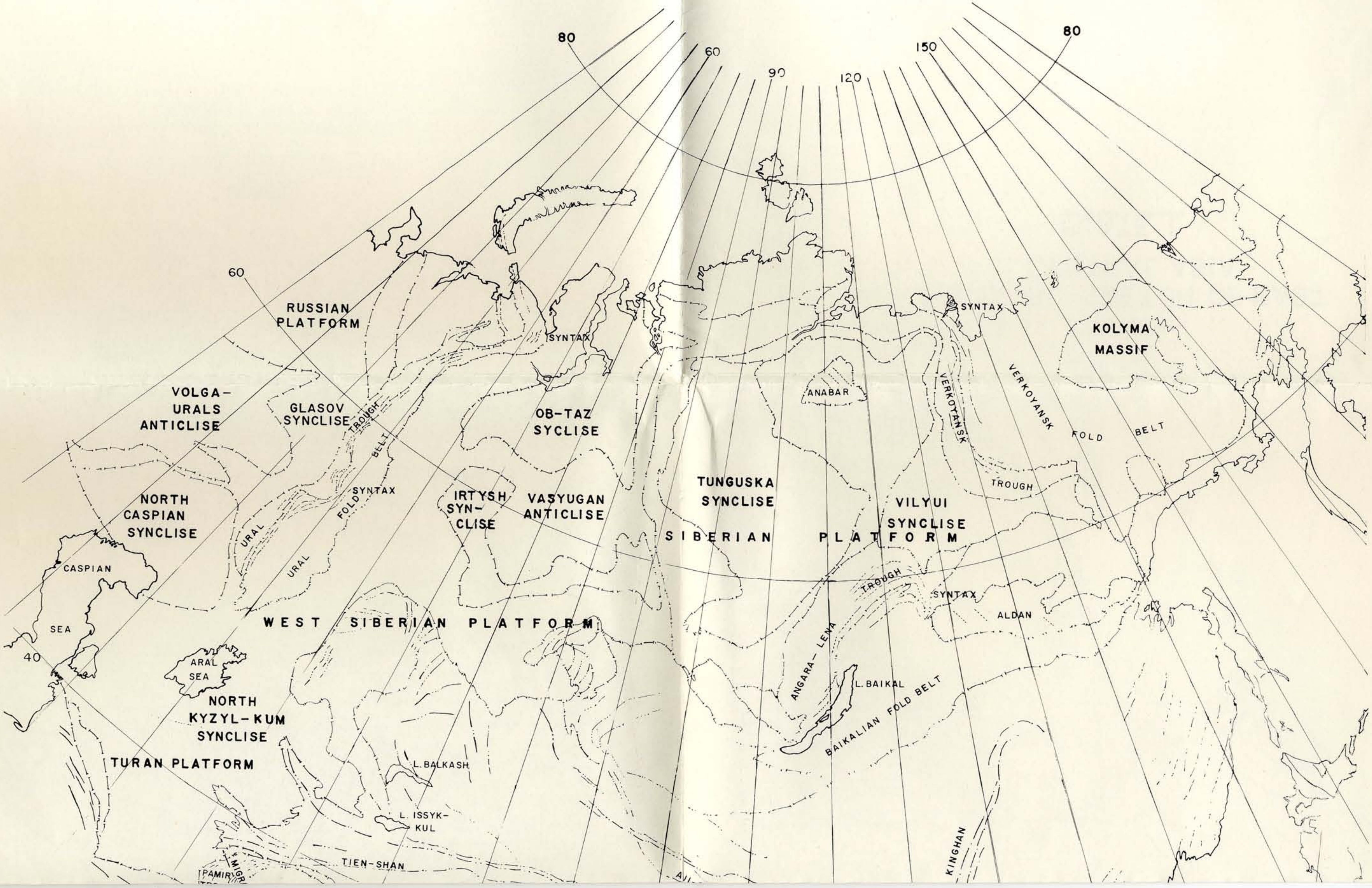
29 June 15.3 N., 105.4 W.
Off coast of Mexico

h	about 25 km.		
H	22	35	20.3
ePPZ"	22	44	30
eSE"		49	07
eLZ"		55	

30 June 16.5 N., 122.0E
N. coast of Luzon, Philippine Isl.

h	about 40 km.		
H	19	21	51.0
eLZ"	20	29	

M. Buist, S.J.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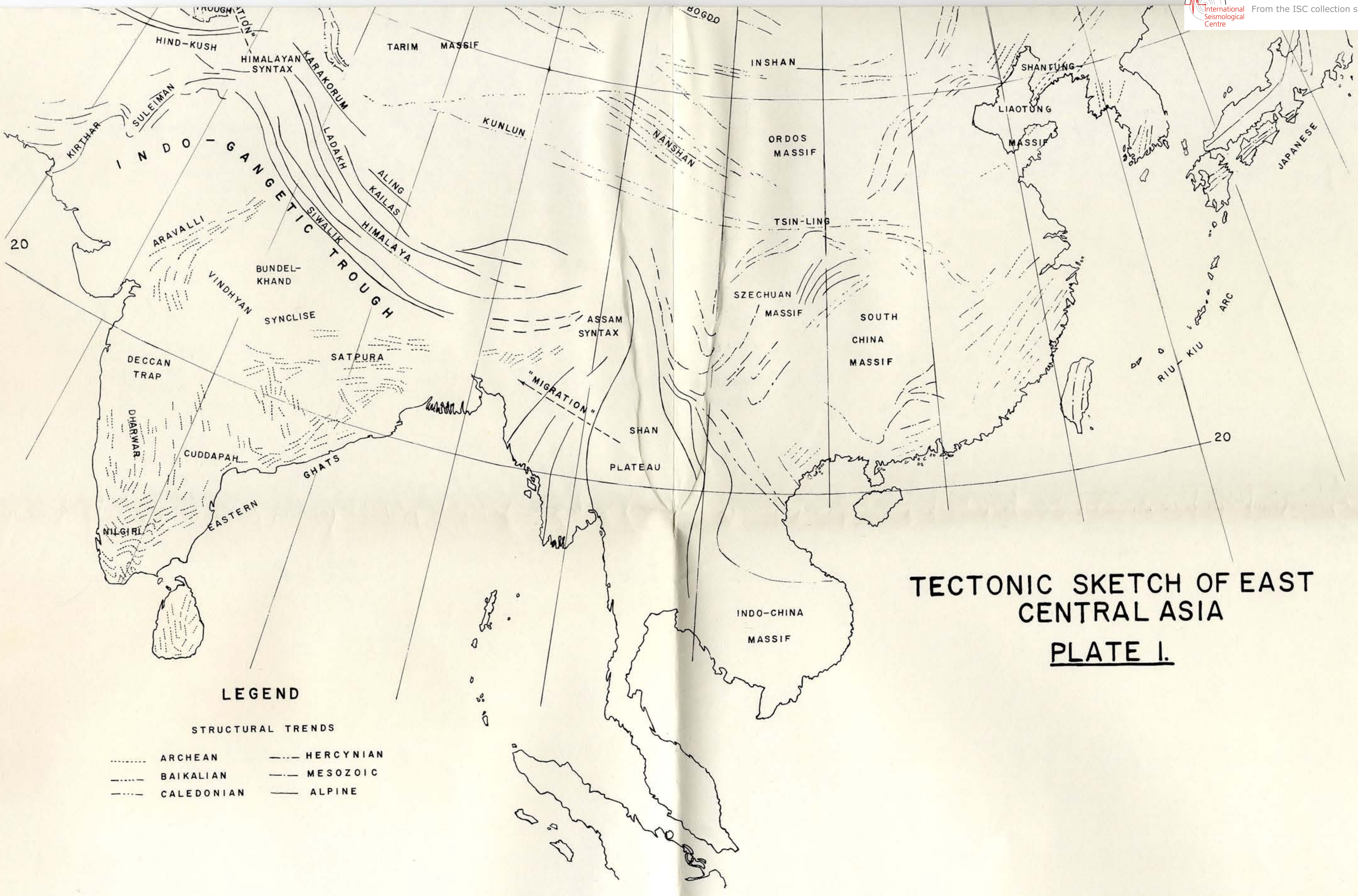
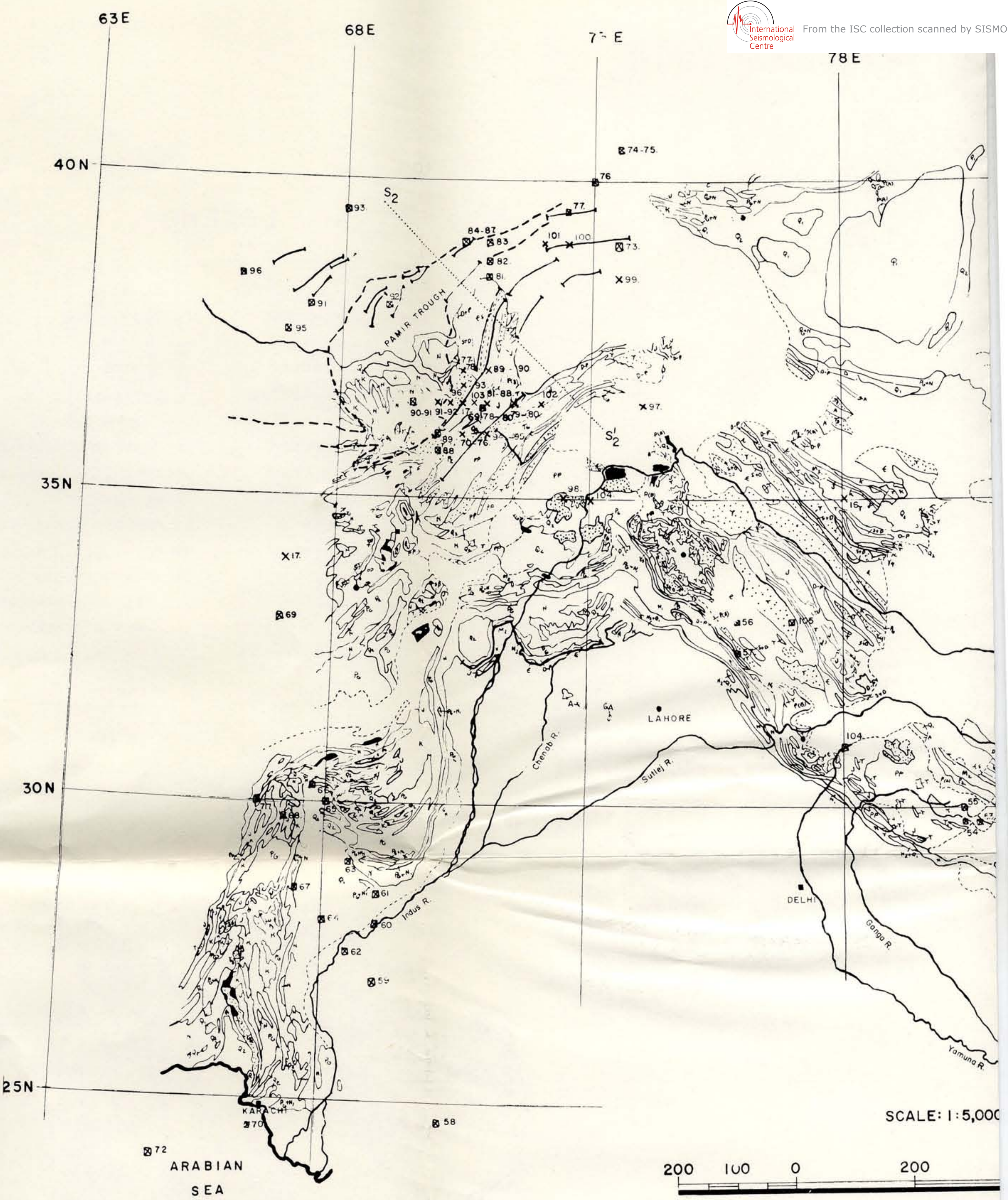
40
RUSSIAN PLATFORM
VOLGA-URALS ANTICLISE
GLASOV SYNCLISE
TROUGH
BELT
SYNTAX
FOLD
URAL
URAL
NORTH CASPIAN SYNCLISE
CASPIAN SEA
ARAL SEA
NORTH KYZYL-KUM SYNCLISE
TURAN PLATFORM
WEST SIBERIAN PLATFORM
SYNTAX
OB-TAZ SYCLISE
IRTYSH SYN-CLISE
VASYUGAN ANTICLISE
L. BALKASH
L. ISSYK-KUL
TIEN-SHAN
PAMIR
MIGR
TUNGUSKA SYNCLISE
SIBERIAN PLATFORM
ANABAR
SYNTAX
VERKOYANSK
VERKOYANSK FOLD BELT
TROUGH
KOLYMA MASSIF
VILYUI SYNCLISE
TROUGH
SYNTAX
ALDAN
ANGARA-LENA
L. BAIKAL
BAIKALIAN FOLD BELT
KINGHAN



TECTONIC SKETCH OF EAST CENTRAL ASIA

PLATE I.



GEOLOGIC MAP OF BURMA AND THE HIM
LOCATING EPICENTERS

PLATE 2.


83 E
88 E
93 E
98 E
40 N
35 N
30 N
25 N
20 N
20N
15 N
15N
LEGEND
Q2 - RECENT
Q1 - PLEISTOCENE
N2 - PLIOCENE
N - NEOGENE
N1 - MIOCENE
PG - PALEOGENE
K - CRETACEOUS
J - JURASSIC
T - TRIASSIC
M2 - MESOZOIC
P - PERMIAN
C - CARBONIFEROUS
FAULTS
RIVERS
CONTACTS
UNKNOWN GEOLOGY
SHALLOW EPICENTER
D - DEVONIAN
S - SILURIAN
O - ORDOVICIAN
Є - CAMBRIAN
P2 - PALEOZOIC
PP - PRE-CAMBRIAN & PALEOZOIC
P(A) - UPPER PRE-CAMBRIAN
P(B) - LOWER PRE-CAMBRIAN
A - ARCHEAN
IGNEOUS ACIDIC ROCK
ULTRAMAFIC ROCK
VOLCANIC ROCK
TECTONIC BOUNDARY
LINES OF SECTION (FIG.3)
ISOSTATIC CONTOURS
× INTERMEDIATE EPICENTER
HALFLONG-DISANG THRUST
MYITKYINA
BHAMO
MANDALAY
RANGOON
BASSEIN
PATNA
ALLAHABAD
CALCUTTA
Padma R.
BAY OF BENGAL
-100 mg
+100mg
0mg.
-100mg.
,000
400
600
800 KM.

ALAYAS

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COLLEGE JEAN-DE-BREBEUF

3200 Chemin Ste-Catherine
Montreal 26, Canada.

Directeur: M. Buist, S.J.
Directeur des Recherches: E. Gherzi, S.J.

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ELECTRIC POTENTIAL GRADIENT MEASUREMENTS MADE AT LOYOLA UNIVERSITY IN NEW ORLEANS, La. U. S. A. (1959 and 1960)

(Radio-active probe at 5. 2 meters above ground, far away from trees).

by

E. Gherzi, S. J.

RESUME

L'auteur rapporte les mesures du potentiel électrique de l'air faites à l'Université Loyola à New Orleans, Louisiana durant les années 1959 et 1960. Ces valeurs ont été disposées jour par jour dans des Tableaux Généraux qui comprennent aussi les conditions météorologiques observées aux mêmes moments. L'auteur souhaiterait qu'une présentation semblable des données électriques fut fournie par d'autres stations ou l'on étudie l'électricité atmosphérique. Le but principal de la discussion est de montrer que l'état atmosphérique appelé "beau temps" /"fair weather"/ diffère avec le type de masse d'air qui est en jeu au moment où l'on fait les mesures. La sensibilité des enregistrements a été diminuée de sorte que seules les variations à grande échelle soient mises en évidence. On sera ainsi à même de connaître quel est le mouvement synoptique de l'électricité atmosphérique indépendamment des perturbations locales orageuses et frontales, qui ne sont que des événements transitoires.

Les conclusions offertes au lecteur ne sauraient être autre chose qu'un travail d'approche, étant donné que ni le courant air-terre ni la conductibilité de l'air n'ont été enregistrés.. En outre l'état du terrain avoisinant la station des enregistrements n'a pas permis de trouver un facteur de correction bien établi, qui permît de donner le gradient absolu du potentiel électrique observé. Toutes les valeurs fournies dans les "Tableaux Généraux" sont celles lues directement sur les enregistrements.

Meteorologists, all over the world are more and more interested in the electricity of the atmosphere and are gradually admitting, with the author of this article, that the atmospheric electricity should be considered as a real "weather factor", besides the usual thermodynamic ones, namely pressure, temperature and humidity.

Nevertheless we feel that the electric exploration of the atmosphere is still, so to say, a scattered one. Going, for instance, over the "Proceedings of the Second Conference on Atmospheric Electricity", published in 1958, we find many interesting articles concerning mostly local soundings and isolated thunderstorms. Very few discussions took place concerning the synoptic aspect of the atmospheric electricity. Besides some very valuable pioneering work done by distinguished and well known experts (Israel; Dolezalek, Chalmers et alii) nobody, according to our documentation, has yet tried to follow the technique used, many years ago, by R. A. Watson at the Eskdalemuir Observatory. (2) Namely the values of the atmospheric electricity have not been listed as we do for those of temperature, humidity and pressure, in daily, monthly and yearly Tables. What has been done for climatological researches should be contemplated also for an inquiry on the electric climate of the earth and its atmosphere.

Although the studies of electric singularities, already given to the public, have a real and captivating interest, any general conclusion regarding the distribution of the electric factors, potential gradient; air to earth current and conductivity does require the tabulation of these values in daily, monthly and yearly Tables. And these Tables should also contain the values and aspects of the meteorological factors, which are well known to affect the atmospheric electricity.

The listing of the daily, monthly and yearly values of the electric potential at Eskdalemuir has been made by Watson, but he did not add the meteorological conditions prevailing on those dates. Nevertheless some interesting paragraphs, concerning the weather aspect and that of the electric response in the atmosphere, were also published.

We will follow the same technique with a more complete presentation of the events, conscious that such a documentation should be at hand before any theoretical discussion.

We do not hesitate to state that several interesting facts are shown in the "General Tables" which we give further on.

But first of all, a word about the so called "fair weather conditions".

We think that they should be differentiated according to the type of air mass prevailing at the time of the recordings. Each one of the three fundamental types of air masses of the earth's atmosphere, the Polar Continental or Arctic, the Maritime and the Tropical, called by some meteorologists the Equatorial, possesses a special type of "fair weather". This is our contention, since such a thermodynamical distinction of the three air masses is well known to meteorologists. It asserts itself also when one contemplates the behaviour of the electric potential, at least on the surface layers of the atmosphere, the same layers which synoptic forecasting considers. How, in the upper levels, these three air masses spread and interact is another question, distinct from the surface weather consideration. Human beings, animals and plants are affected by the evolution of the surface meteorological conditions rather than by those of the upper troposphere and lower stratosphere. Similarly, we, on the surface of the earth, are subject also to the action of the electric values of the surface atmosphere.

Although elsewhere (3) we have pointed out this specific biological aspect of the surface electric potential of the air masses, we feel that it has not yet been given the attention it deserves. Well known electric scientists (Israel, Dolezalek et alii) have already mentioned in their publications a synoptic aspect of the atmospheric electricity. Nevertheless the observations quoted by them has been made, most of the time, on top of mountains. These, we think, cannot be compaired with those made on flat country, in well chosen locations.

It is regretted that what we have been doing in the flat Louisiana region cannot be checked with similar recordings in other flat parts of the United States. The "General Tables" of this article will help such a kind of comparison if similar recordings, unknown to us, have in fact already been published. Our documentation may have been at fault and we would apologize for that.

As one may gather from the title of this paper, we have at hand only the data of the electric potential gradient for the years 1959 and 1960. (Those for 1961 had to be discarded since the zeroing of the recording trace had been too often left aside).

We quite agree that the values of the air to earth current and those of the conductivity should also have been considered. At New Orleans they are lacking. One cannot state if the results of about 40,000 well checked readings, which we offer to the reader, would also apply to the two other aspects of the atmospheric electricity, which we had to neglect.

Besides the meteorological conditions of the atmosphere, the author has also considered if any correlation were found between the wind force and direction with the electric potential. The types of clouds present during the days when the observations were made was also checked and reported.

The polarity of the potential when rain started has been examined and also the possibility of forecasting precipitation by the inspection of the trend of the recordings obtained some time before the event.

Frontal conditions, being very difficult if not impossible to analyse properly, were left out of consideration. Simultaneouslywith fronts, foggy hours were not studied. The chief reason for neglecting the hours with very low visibility and Stratus clouds was the following. We have already objected in several papers to the common word "fog" for any weather conditions of reduced visibility. This word "for", so we think, causes a very regrettable confusion, especially in research on atmospheric electricity. Visibility can be decreased to small or to extreme values either by floating and very minute rain drops or by sand or by colloids and industrial dust. The first type of reduced visibility is called by us "mist": the second type, "haze" and the third type "fog": for instance, London fog.

Such a physical distinction of the factors which can decrease visibility is not only important for health, for agricultural and industrial activities but also from the point of view of research on the electric potential gradient. Misty atmospheric conditions show a different potential value from that of atmospheric periods.

To call "fog" any reduced visibility is tantamount to risking important confusions.

The definition of the "aerosol" seems to be also quite indeterminate or even optional. Most of the time, the dimension of these particles is the gauge used, not the quality, chemical or physical. Our conviction is that the small particles floating in a pure non-modified Polar air are what we would call solid particles (clay, sand, specks of quartz, etc), while the aerosols in pure and non-modified Maritime air mass are chemical compounds (chlorides, sulphides, bromides, etc.).

The modification of the resistance of the atmospheric column might be different according to the different type of the aerosols on the surface and also in the higher atmospheric layers. Reinhold Reiter and Mirjam Reiter have done such a kind of discriminating analysis (4). Other authors, in the study of the electric potential in the upper atmospheric levels, have not mentioned the type of nuclei present.

The location, in New Orleans, at Loyola University, appears to be rather free of industrial pollution, and the two types of air masses making the weather in Louisiana, namely the Polar continental and the Gulf-Maritime, are well distinct and often very powerful. The values of the potential recorded in both air masses are characteristic and, if "electrically charged blobs" similar to the "cold" or "warm" pools of the meteorologists do not exist, the different types of aerosols existing in the two air masses might be a clue to explaining the facts reported in the "General Tables" of this study.

And let us remind the readers that above the Polar air there is a layer of warmer and moister air, coming from the southern latitudes, while above the Maritime air one has to go very high up, often to the tropopause, to find another kind of air stream, mostly westerly in some seasons. In summer, the upper wind is easterly.

Very interesting measurements of the nucleus content over the ocean have been reported by R. C. Sagalyn. Some of her statements might appear contradictory to our own description of the Maritime Anticyclone centered over the sea expanses. (5) As a matter of fact the measurements reported appear to have been made on Polar air masses, arriving from the continent, loaded with continental types of aerosols and overlaying a shallow surface Maritime air tongue, with the inversion at around 4000-5000 ft. Nevertheless the same author quotes reports of significant nuclei counts up to 14,000 ft. in the western edge of the high pressure area (the Maritime anticyclone). This location, with numerous high level nuclei counts, was apparently in the real body of the Maritime air mass, which as we have stated, tops at times the tropopause level. And such a powerful dimension of the maritime air mass is not, to us, exceptional as it might be inferred from the reports of Sagalyn. Radio soundings in the Far East (those at our disposal) have often shown Easterly winds from the surface up to more than 20,000 ft. The exchange layer should have been much higher than the 4000-5000 ft. already mentioned. Cirri clouds are also often observed moving from the East, without any tropical cyclone being present. We believe that similar conditions exist for the Atlantic Ocean Maritime air mass. Quite recently, coming to New Orleans from Washington on the "Golden Falcon" jet of the Eastern Airlines, the pilot told us that the southwesterly wind from the Gulf was blowing from the surface up to more than 31,000 ft. reaching at that level a velocity of over 100 miles per hour. It would be very instructive to know the nuclei counts at those high levels, in such atmospheric conditions.

The usual definition of the Trade wind air mass as "a current usually with a lower moist layer with Cu. in its upper part and a dry cloudless upper layer of dry air, being separated by an inversion at between 6000-10,000 ft." appears to reject the much greater thickness of the real body of this Maritime air mass which we have mentioned and which is not a pure guess.

We now give the description of the contents listed in the six columns of the "General Tables" which will follow.

Column 1. Days of the month.

Column 2. Wind's speed and its prevailing direction during the 24 hours. Speed is read on the recordings of a pressure tube anemometer sensitive to 1-2 meters per second and the direction with a special recording wind-vane. We have distinguished 3 aspects of the wind: calm or almost calm: speed reaching 5 meters per second: speed reaching 10 or more meters per second. When only the prevailing direction is given, this means that never, during the 24 past hours, did the wind reach 5 meters per second. When the hours' period is given, for instance 17-19, that means a period during which the wind was steady at 5 meters per second. Underlined figures for the hours mean a wind speed of 10 or more meters per second. N W-W means a NWly wind backing in the afternoon to the Western quadrant.

It is a striking fact that, most of the time, any freshening of the wind to 5 or 10 meters per second has been short lived. Furthermore, the change in direction happens most frequently just after the noon hour.

Column 3. This column gives the values (in volts) of the electric potential gradient, not reduced to the absolute values (see further on), as they were recorded at 5.2m above ground, well away from trees, and on the top of a small hut. Groups of two figures f.i. + 200 + 100 mean that during the period of hours with a wind speed of 5 or 10 meters per second, the value of the electric potential went from + 200 to + 100 volts. The values of the potential were obtained from the recordings by means of the "equal areas" technique. We found these measurements more realistic than those obtained by reading at the beginning of each hour the displacement of the registering pen.

Occurrence of negative bays, their duration in time and their electric value are also given in Column 3.

Rainfall and the time of its beginning at Loyola University, is reported with an approximation of 3 minutes. We have also been interested in quoting, when that was possible, the polarity recorded at the time of the first and of the last shower. That is shown with such marks as -- : +- etc. close to the hour figure. When the rainfall has been of very short duration, the value of the potential during the dry hours has been added.

Owing to the low sensitivity chosen for the recording, namely 1000 volts on each side of the central zero line, only tens of volts could be read. To be more exact, only 40 to 20 volts were accepted as reliable. As a matter of fact the lines of the recording Easterline-Angus paper being 2mm. apart and the thickness of the trace covering about one mm. a more accurate reading than 20 volts could not be accepted. We wonder how Watson could read the voltage corresponding to one tenth of mm. in his registrations? Since often the very same potential value is recurrent with the same air mass conditions, checks were made with hourly values and, as expected, a mean difference of 40 to 20 volts was found. Nevertheless we think that the mean of 24 hours' readings cannot be the same as the one obtained with the "equal areas" technique, which we have used. No wonder there should be some difference between the two figures.

Column 4. This column gives the types of cloud decks visible during the daylight hours. They were checked with the recordings of the global solar radiation obtained with an Epley thermocouple. We have followed the usual division of the three main layers: low clouds, St. and Cu.; mean clouds, Ac. and As; high clouds, Ci. and CiCu. Often, of course, overcast skies had also, above the St., mean and high clouds. Not having any radio soundings we could not ascertain such conditions. It was noticed that very often the type of clouds changed in the afternoon hours. Such a change in the cloud deck is shown by writing f.i. Ci.--Cu. Such an interesting aspect of the evolution of clouds can often be explained, especially in stationary frontal conditions, by the fact that, at night and in the early morning hours, the continental colder air invades the locality, only to recede and be replaced by the warmer Gulf-Maritime air after the noon hour.

Column 5. This column shows the atmospheric conditions: the types of the air masses and the fronts. • These meteorological data were taken from the two daily weather maps published by the Washington Weather Bureau. One gives the meteorological conditions at 1h a.m. Eastern Standard time, and the other, the situation twelve hours later. Only a few times was the interpretation of these maps found difficult. The different air masses are marked with the following abbreviations: P. for Continental Polar; M.P. for modified Polar air, namely Polar air mass that had crossed the southern Coast of Louisiana and was central over the Gulf of Mexico; G. for the Maritime air mass of the Atlantic reaching New Orleans through the Gulf of Mexico. This last type of air mass, namely the Maritime from the Atlantic, has been, so to say, divided into two portions by many USA meteorologists. The southern part is called Tropical Maritime, and the Northern portion Polar Maritime. Such a splitting of the Atlantic Maritime air mass causes confusion. The so called Tropical and Polar Maritime portions belong to the same air mass, as the wind circulation clearly shows. It is obvious that in a higher latitude the temperature of this air mass will be different, but there are other air mass characteristics to be considered and these do not change as much as the temperature does. When we check weather forecasts that proved to be wrong, we often find that the reason for these mistakes are in the division of the Maritime air into two portions which do not exist as totally distinct. The fact that the Continental Polar air mass is usually subsiding while the Maritime is rather convective has some bearing in the synoptic study of atmospheric electricity.

The barograms obtained at Loyola University were also at hand for such a check of the atmospheric synoptic conditions at the times when the electric potential gradient was measured.

The Fronts reported in column 5 are those formed between the two air masses already quoted. The zone covered by a Front, belonging to a moving extratropical cyclone, is smaller and better defined than the Front, formed during the warm months, between the same two air masses but without the presence of a cyclonic center. The types of clouds observed during these periods with a stationary Front have been a great help for discriminating the real synoptic regime acting over our station.

The value in millibars (19 = 1019 Mb.) of the atmospheric pressure reduced to sea level at 1h a.m. E.S.T. has been added after the type of the air mass: for instance P. 19.

A striking fact is that nowhere in the Weather maps can the presence, on the surface, of the Tropical air from Mexico or Texas (with its normal low pressure and cyclonic circulation) be traced over Southern Louisiana.

lumn 6: Gives the Maximum and Minimum temperature values in Fahrenheit degrees for the current day in New Orleans. They often show very nicely which one of the two prevailing air masses considered in this article was in action.

GENERAL TABLE I 1959

(1)	(2)	(3)		(4)	(5)	(6)
JANUARY						
1	NW 10-13	+200+240	+ 90	St. Cu.	FR. 15	62 48
2	E 9-10 17-18	+4+200	+160	As.	P. 13	49 42
3	E - NE		+ 40	St. Cu.	P. 08	51 40
4	NE 2-8	-80-80	0	St.	Fr. 15	63 45
5	NE 00-24	+90+200	+200	Cu. Ac.	P. 31	54 39
6	E/S 1-3 5-13	+200+200				
		+200+520	+320	As. Ac.	P. 32	40 30
7	SE 9-17	+280-40	+120	As. Ac.	P. 23	49 32
8	NE 9-17	-80+190				
	22-24	+120+80	+ 40	St. Cu.	G. 19	61 40
9	NE 1-23	+80+200	+190	Blue Ci.	P. 24	54 53
10	E 3-8	+200+200	+240	Blue	P. 30	54 38
11	Calm -E		+160	Ci.	P. 31	46 31
12	S -Var.		+120	?	P. 31	59 29
13	S		+160	Blue Ci.	P. 30	64 30
14	S		+160	Ac.	M. P. 24	69 43
15	SW 14-15	RAIN 12h-+ -	?	St.	G. 15	70 45
16	NW		+160	BlueAc.	P. 12	56 44
17	Variable		+200	St.	M. P. 20	49 30
18	S. 11-14	+120+120	+200	St.	M. P. 25	48 31
19	S		+120	Ac. Ci.	G. 20	62 44
20	S 9-16	-40-40				
	17-24	-80-280	- 80	St. Cu.	G. 16	75 62
21	S-N 00-12	-200+680 R. 12h	- +	Thick St.	Fr. 08	73 64
22	N 00-16	?		Blue Ci.	P. 24	46 31
23	ENE		+200	Blue	P. 31	55 31

TABLE 1 (contd.)

JANUARY (1)	(2)	(3)		(4)	(5)	(6)
24	Calm-ENE		+280	Blue	P. 32	52 34
25	ENE		+120	Blue Cu.	P. 26	57 45
26	Calm-E		+ 90	Ac. As.	M. P. 17	71 44
27	NE		+120	Cu.	M. P. 16	74 53
28	NNE		+130	Blue	P. 18	66 49
29	S		?	St.	Fr. 20	73 53
30	E	Interm. RAIN	?	St.	Fr. 20	73 47
31	NE 00-11	-160-80	- 40	ThickSt.	Fr. 20	65 61
FEBRUARY						
1	NE 7-8	0-0				
	19-23	0-80	- 40	ThickSt.	Fr. 25	54 50
2	ENE		-240	ThickSt.	Fr. 28	54 51
3	Variable	RAIN 19h - -	- 40	St.	Fr. 20	56 48
4	N-NW 8-14	IntermRAIN - -				
			+ + ?	St.	Fr. 08	55 51
5	SE	RAIN - +	?	St.	Fr. 12	62 38
6	Var. -NE		+160	Blue	P. 23	62 38
7	ENE		+ 90	St. Cu.	P. 30	62 49
8	S		+200	St.	M. P. 22	65 57
9	S 9-17	+200+200	+240	St. Cu.	M. P. 16	72 64
10	S 2-5 10 -13	Negat. Bay	-1000 ?	St. Cu.	G. 14	72 67
11	NE 5-6		- 40	St. Cu.	Fr. 23	64 57
12	ENE-ESE		?	Cu.	Fr. 26	73 54
13	Calm-S		?	St. Cu.	Fr. 22	81 62

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
FEBRUARY							
14	S - SW 10-17	RAIN 22h	+120	Cu.	M. P. 20	81	63
15	NE		+120	Cu. St.	Fr. 16	63	51
16	NE		+160	Blue	P. 24	64	48
17	S 10-18		+200	Blue Cu.	M. P. 16	76	52
18	N-NE 14-16	+120+120					
	16-24	+120+120	+120	Ac.	M. P. 07	75	65
19	NE 00-15	Some RAIN - -	?	As.	P. ?	40	39
20	NE 2-18		+200	St. Cu.	P. 24	57	38
21	NE 9-10		+120	As. Cu.	P. 35	51	37
22	Variable		+120	Blue	P. 30	70	40
23	S 12-15	RAIN 14h - -	?	St. Cu.	M. P. 22	80	59
24	S-NE	RAIN all day	?	Thick St.	Fr. 19	64	56
25	NE	RAIN 4h30	?	St.	Fr. 20	55	47
26	E	Interm. RAIN		Thick St.	Fr. 18	55	50
27	NE - E		+160	St. Cu.	Fr. 15	63	52
28	Variable 23-24		+120	St. Cu.	M. P. 17	62	48
MARCH							
1	N 2-17		+120	Blue	P. 17	65	47
2	S 13-18		+120	Blue	M. P. 18	63	43
3	N 9-15	RAIN 7h - -		St. Cu.	Fr. 15	64	54
4	E 7-20-24		+ 40	St. Cu.	Fr. 18	75	48
5	SW-NW	RAIN ∓-		St.	Fr. 11	71	63
6	NW 00-2 9-13		+120	St. Cu.	P. 13	60	41

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
MARCH							
7	E -NE		+120	Ac. Blue	P. 21	65	43
8	Calm-E		+120	Ac. As.	P. 23	60	42
9	SE - SW		+110	Cu.	G. 18	72	54
10	Calm-S		+ 80	Ac.	M. P. 16	75	43
11	S - SW		?	St. Cu.	G. 12	74	63
12	N 00-4-17		?	Ac.	Fr. 17	62	41
13	Calm-SW 9-17		+160	Blue	P. 23	60	46
14	SSE 9-19		?	St.	G. 16	69	57
15	SW-N-NE 8-14		+ 90	Blue	G. 10	70	64
16	NE 00-15	Interm. RAIN	+ - + -	St.	P. 21	66	51
17	NE 4-14		+200	Ac. St.	P. 24	58	49
18	ENE 5-15		+160	Ac.	P. 26	62	48
19	ENE -E 7-24		+120	As.	P. 27	62	53
20	E -SE 15-20		+160	St. Cu.	G. 19	75	58
21	SW -NW 23-24		+ 40	Cu. Blue	G. 12	73	64
22	NNE 00-16		+140	Blue	M. P. 16	68	50
23	E - ENE		+120	Blue	P. 22	72	46
24	Calm - S 13-14		+120	Cu.	M. P. 21	75	46
25	SE 9-20	RAIN 11h - -	?	St. Cu.	G. 19	76	60
26	S-SW 9-22		- 20	St.	G. 16	78	67
27	SW-NW 9-13		+ 60	Ac. As.	Fr. 13	76	67
28	ENE 8-11	RAIN 11h - +	?	Thick St.	Fr. 16	62	56
29	NE - E		- 40	St.	Fr. 16	70	56
30	ENE Var.		+ 60	St.	Fr. 16	72	56
31	Variable		+ 80	St. Cu.	G. 15	73	59

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JULY							
1	Variable 15.16	RAIN 14h30 - -	?	Cu. St.	M. P. 16	92	74
2	Variable	RAIN 14h	?	St. Cu.	Fr. 18	92	75
3	Calm Variable	RAIN 14h30 - -	?	Cu.-St.	M. P. 16	92	74
4	Calm-W	2Mod. Neg. Bays RAIN 16h - +	+100	Cu. St.	Fr. 18	88	74
5	Calm-W 10-13		+ 60	St. Cu.	G. 15	88	76
6	NE 12-16	RAIN 11h + -	?	As.	G. 14	89	76
7	Calm Variable	Interm. Rain - -	?	St. Cu.	G. 17	91	77
8	Calm -E	Interm. Rain - -	?	St. Cu.	G. 17	88	76
9	E-ESE	HeavyRAIN 3h - -	?	St. Cu.	G. 18	87	72
10	Calm - S	RAIN 11h	?	St. Cu.	G. 17	83	74
11	Var. Calm		+ 80	Cu. As.	G. 15	90	73
12	Variable	RAIN 11h - -	?	St. Cu.	M. P. 14	92	76
13	Calm-Variable	RAIN 12h - -	+ 40	St. Cu.	M. P. 16	88	73
14	N - Calm	RAIN 13h30 + +	+ 60	Ac. St.	G. 17	91	74
15	Variable	RAIN 11h - +	?	St-As.	G. 17		
16	Var. - Calm	Negat. Bay -800 12h45-15h15	?	St. Cu.			
17	Variable 14-16	RAIN 14h - -	+ 40	As-St.			
18	Variable	2 Neg. Bays -900 10h30-15h15	?	As. St.		NO DATA	
19	Calm-Variable	RAIN 10h - +	?	Var.			
20	Calm-Variable	RAIN 12h- -	+100	Ac. As.	P. ?		
21	Calm-NE-SE	RAIN 12h- -	+ 80	St. Cu.			
22	SE	3 Mod. Neg. Bays	?	St. Cu.			

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
APRIL							
27	SW 9-16		+200	Cu.	G. 20	81	65
28	SW 9-17		- 20	?	Fr. 14	83	70
29	WNW		+ 40	Cu.	G. 13	85	68
30	Variable		+ 80	St. Cu.	Fr. 12	81	66
MAY							
1	SW - S 13-15	+120+120	+120	BlueCu.	M. P. 15	80	65
2	SSW 13-14		+120	Ac. As.	M. P. 17	85	67
3	SW 11-13	+200+120	+120	Cu.	G. 18	85	67
4	Calm S		+120	Blue Ci.	P. 18	86	68
5	S 11-15		+120	Cu.	G? 16	85	67
6	Calm-SW 12-15		+ 90	Ac. As.	G. 18	86	66
7	Variable		+ 60	Blue	G. 22	89	66
8	N-NW 8-9		+ 40	Blue Cu.	G. 22	89	69
9	Calm NW 15-16		+ 40	Blue Cu.	G. 18	88	69
10	SW 8-19	+160+40	+120	Cu.	G. 14	85	72
11	SW-NW 18h30	RAIN 14h + +	?	Cu. St.	Fr. 12	84	72
12	SW 13-14	RAIN 8h + -	?	ThickSt.	Fr. 15	74	67
13	NW -NE 16-17		+ 40	Cu. Blue	G. 17	87	69
14	NE-E	RAIN 15h - -	?	St. Cu.	Fr. 16	88	67
15	ESE		+ 80	Blue Ci.	P. 17	78	65
16	Calm E-S		+ 80	Blue Ci.	P. 18	82	61
17	Calm -SE		+100	Blue	P. 17	86	69

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
APRIL							
1	N-SW 8-9	RAIN 5h - +	?	St.	G. 12	76	64
2	N 8-14		+110	Cu. Blue	P. 12	76	60
3	S-SW 9-17	+200+40	+120	Blue	G. 13	79	64
4	NW-NE 7-12	+40+160	+120	Blue	P. 17	75	60
5	SE-S 15-17		+160	Cu.	G. 19	80	52
6	Calm Variable		?	Cu.	G. 19	79	60
7	S 10-18		+ 90	Cu.	G. 19	88	60
8	S 8-18		+ 90	Cu.	G. 19	88	66
9	Variable	RAIN 8h - +	?	St.	G. 12	79	67
10	Variable	RAIN 10h30 + +	?	ThickSt.	Fr. 18	70	65
11	NE	RAIN 21h - + -	+200	St.	Fr. 19	68	63
12	NE	RAIN 00h - -					
			+ 80	St. Cu.	Fr. 13	66	54
13	NE 7-24		+130	Cu. Ac.	P. 19	60	49
14	NE 9-16		+120	Ac. As.	P. 26	63	49
15	Var. -SE		+130	St. Cu.	M. P. 27	70	51
16	ESE 12-16		+ 80	Cu.	M. P. 27	75	55
17	SE	2Neg. Bays -400	?	St.	M. P. 20	74	65
18	SE		+120	St. Cu.	G. 17	81	66
19	SE- SW		?	Cu.	G. 12	86	70
20	Variable		?	St. Cu.	G. 10	81	72
21	Variable	RAIN 8h - +	?	St.	Fr. 10	71	66
22	NNE 00-15		+120	Ac. Blue	P. 16	69	51
23	NNE-N 9-12		+160	Blue Ci.	P. 21	71	56
24	Calm Variable		?	Blue Ci.	M. P. 22	76	51
25	S 10-14		+130	Cu.	G. 22	77	53
26	S		+ 50	Cu. Ac.	G. 22	80	60

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JUNE							
6	Variable		+ 80	St.	Fr. 13	81	72
7	S 10-15	RAIN 9h30 --	?	St. Cu.	Fr. 13	84	72
8	SE 10-12	RAIN 12h - -	?	St. Cu.	Fr. 14	78	72
9	Variable 15-19	+160+120	+ 90	?	G. 12	88	75
10	S 11-12 14-15	Neg. Bay -950	+ 40	Cu.	G. 13	88	75
11	W	RAIN 10h - +	?	St. Cu.	G. 13	96	74
12	W 14-16	RAIN 9h15 - -	?	St. Cu.	Fr. 12	90	74
13	Variable	RAIN 11h - +		St.	Fr. 11	79	71
14	?		+ 80	St. Cu.	Fr. 11	85	75
15	E-ESE 12-15	RAIN 15h - +	+ 80	Cu.-St.	Fr. 14	88	72
16	E 11-19	RAIN 9h30 - -		St. Cu.	Fr. 13	87	74
17	SE -E		+ 40	Cu. Blue	G. 10	90	75
18	NE-Calm 9-15		+120	Blue	P. 09	93	75
19	Calm - NE		+ 20	Blue	? 11	93	74
20	NE		+ 80	Blue Ci.	P. 14	89	75
21	Calm-Variable		+ 40	As.	G. 12	90	75
22	Calm-S/W	RAIN 14h + +	?	St. Cu.	Fr. 14	89	74
23	SW 11-16	+50+120	+ 90	Cu.	G. 16	91	77
24	S 7-17	RAIN 10h30 - -	?	St. Cu.	Fr. 17	88	77
25	S 8-11	+80+280	+120	St.-Cu.	G. 16	90	76
26	S/W		+160	Cu.	G. 16	91	76
27	Variable		+ 90	Blue Cu.	G. 18	92	76
28	Variable 13-18	RAIN 15h - -	?	St. Cu.	G. 19	93	78
29	Variable		+ 80	Cu. Blue	M. P. 19	94	76
30	NE-SW	RAIN ?	?	As-St-	M. P. 17	94	77

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
MAY					
18	S.	RAIN 11h30 - + ?	St. Cu.	Fr. 14	86 69
19	S. 14-16	+120	St. Cu.	G. ?12	89 71
20	Variable 12-14	RAIN 11h - - ?	Cu.-St.	Fr. 13	86 71
21	SSW 9-14	RAIN 12h - - ?	Cu.-St.	G. 14	87 72
22	SW 12-18	+200	Cu. Blue	P. 17	89 76
23	Variable	RAIN 11h - + ?	Cu.-St.	Fr. 20	80 70
24	Variable 12-12h30	RAIN 10h - + ?	Cu.-St.	Fr. 20	83 70
25	Calm - S.	Negat. Bay -1000 13-16h. ?	Cu.-St.	G. 19	86 77
26	S - SW	RAIN 10h0 - - ?	Cu.-StCu.	G. 17	86 73
27	S-SE	RAIN 10h - - ?	Cu.St.	G. 12	87 74
28	E 7-18	+ 80	Ac. As.	G. 20	87 74
29	E 4-20	Interm. R. - - ?	Cu.StCu.	Fr. 16	79 74
30	SSE-S 7-10	3Negat. Bays at 12h17h and 18h ?	Cu.-StCu.	Fr. 12	83 74
31	SW 00-5-12	Heavy R. all day - + ?	ThickSt.	Fr. 09	77 73
JUNE					
1	SW	+ 80	Cu.	G. 13	80 74
2	Variable	+120	Blue Cu.	P. 13	86 70
3	Var.-NE	+ 90	Ac. As.	P. 15	87 74
4	Variable	+ 40	St. Cu.	Fr. 16	87 74
5	W 16-18	RAIN 12h + - ?	St. Cu.	Fr. 15	84 72

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
JULY					
23	SE 10-12h30	RAIN 12h15 - + 0	St. Cu.		
24	S - Variable	Interm. RAIN - - ?	St.		
25	S. 9-15	RAIN 11h30 - + ?	St. Cu.	Fr. 15	89 75
26	S. 9-10	RAIN 9h30 - - ?	St. Cu.	Fr. 15	86 79
27	Calm - S	+140	St. Cu.	P. 17	90 73
28	Calm-E-SE	Neg. Bay -960 at 11h +160	Cu.	P. 17	90 75
29	SE-S 11-15	+160	Cu.	P. 17	92 79
30	Calm-ESE	+ 40	St.	P. 20	87 71
31	N	?	Ac. As.	M. P. 20	93 76
AUGUST					
1	NW	RAIN 13h45 -- +160	Ac. As.	P. 16	94 74
2	NW	+140	Ac. Ci.	P. 14	93 74
3	Calm Variable	3 Negat. Bays ?	St.	G. 14	89 78
4	Calm - SE	+ 80	Cu.	G. 14	91 79
5	Calm - SE	+140	Cu.	G. 13	98 76
6	Calm Variable	+120	Cu.	G. 13	98 76
7	NW - SE	RAIN 16h30 - + ?	As.	Fr. 14	93 77
8	W	RAIN 15h30 - + + 80	Ac.-St. Cu.	Fr. 13	81 77
9	Variable	RAIN 11 ?	ThickSt.	Fr. 12	89 71
10	E - Calm	Radio Interf. ?	St. Cu.	Fr. 13	81 77
11	Calm-E-Calm	Radio Interf. ?	Blue. Ci.	P. 15	91 75
12	Calm	Radio Interf. ?	BlueAs.	P. 17	92 76

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
AUGUST					
13	SE - S	RAIN 14h30 -- ?	St. Cu.	G. 17	86 76
14	Calm - SE	Interm. RAIN - - ?	St. Cu.	G. 18	89 76
15	SE	RAIN 9h50 - - ?	ThickSt.	G. 19	87 75
16	SE - S	RAIN 11h - - ?	ThickSt.	G. 18	86 75
17	Calm-Variable	RAIN 10h - + ?	ThickSt.	G. 16	87 75
18	Calm - SE	Radio Interf. ?	Cu.	G. 17	91 73
19	Calm - S	HeavyR. 8h - - ?	St.	G. 18	84 75
20	Calm - SE	RAIN 9h30 - - ?	St. Cu.	G. 17	88 75
21	Calm - E	RAIN 9h30 - - ?	ThickSt.	G. 17	84 75
22	Var. Calm	RAIN 12h30 - - +140	St. Cu.	G. 16	90 78
23	SE	Large Neg. Bay -1000 at 12h30 ?	St. Cu.	G. 10	90 75
24	SE - S 10-11-12	RAIN 9h - + ?	St. Cu.	G. 18	83 74
25	SE 10-17	Interm. R. 8h - - ?	St. Cu.	G. 18	89 74
26	SE 8-14	Interm. R. 8h - - ?	St. Cu.	G. 16	90 76
27	Calm - SW	0	Cu.	G. 16	93 76
28	Calm	+ 40	Ac. As.	G. 17	91 71
29	Calm-NW	+200	Blue. Cu.	M. P. 15	93 71
30	NW	+ 90	?	M. P. 08	94 77
31	NW 8-10	+140	?	M. P. 08	93 71
SEPTEMBER					
1	W	+ 60	Cu.	G. 09	91 77
2	W	+120	Blue	G. 13	93 75

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
SEPTEMBER					
3	Calm-Variable 15	RAIN 14h30 - - +140	Ac.	P. 16	99 76
4	Var. -NE 11-13	+120	Blue	P. 17	91 70
5	NE 12-13	+100	Ac. As.	P. 17	91 74
6	?	+ 90	Ac. Blue	P. 15	92 73
7	?	RAIN 11h - - ?	?	Fr. 15	91 75
8	SE 1-8 16-24	RAIN 09h - + ?	St.	G. 17	83 75
9	Variable 00-24	RAIN 11h - - ?	ThickSt.	Fr. 15	87 75
10	ENE 00-11	Neg. Bay -1000 19h15-20h30 · ?	Cu. Blue	G. 16	85 70
11	ENE	+ 80	St. Cu.	G. 15	82 72
12	ENE	?	Fr. Cu.	Fr. 13	83 72
13	ENE	- 40	St.	Fr. 10	76 72
14	NW	+ 90	St. Cu.	Fr. 12	82 71
15	NE - Calm	+ 80	St. Cu.	G. 11	81 68
16	ENE	+140	St.	P. 09	81 70
17	E	+120	Cu. Blue	P. 15	87 69
18	Calm - ESE	+120	St. Cu.	P. 19	86 71
19	ESE 11-18	+120	Cu. Blue	P. 22	? ?
20	ESE	- 90	St.	Fr. 22	83 75
21	SE 8-17	0	Cu. Blue	G. 20	89 74
22	Calm -ESE	+ 40	?	G. 19	83 ?
23	Calm -ESE	+ 40	?	G. 18	83 72
24	Calm - SE	RAIN 13h - - - 40	St.	G. 19	86 72
25	SSE 9-16	+ 40	?	G. 16	85 73
26	SW 8-11	Interm. R. - - ?	ThickSt.	G. 13	89 74
27	SW	Neg. Bay -1000 14-15h30	ThickSt.	G. 12	90 76

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
SEPTEMBER							
28	SSE	RAIN 12h - -	?	St. Cu.	G. 15	88	72
29	Calm - NE		+120	As. Blue	P. 15	90	72
30	Variable		+ 80	St. Cu.	G. 13	90	73
OCTOBER							
1	Variable		+ 80	Blue Cu.	P. 14	90	74
2	Calm - S		+120	St. Cu.	P. 14	90	72
3	S - SSE		+140	St. Cu.	G. 14	90	72
4	S' 8-16	Neg. Bay -600 13h 13h50	+120	Cu.	P. 16	90	76
5	S - SSW 9-16	Neg. Bay -1000 12h50 13h25.	+ 40	Cu. Blue	G. 16	91	75
6	Var. - SSE	RAIN 14h - +	- 20	ThickSt.	Fr. 15	81	73
7	E		+ 40	St. Cu.	G. 09	82	72
8	Calm -NE		+140	St. Cu.	Fr. 04	86	75
9	Calm E-SE		+120	St. Cu.	P. 11	88	72
10	Calm - SW	2 Neg. Bays -640 11h50: 15h	+120	St. Cu.	Fr. 12	88	75
11	Calm - Var.	RAIN 10h - +	?	ThickSt.	Fr. 15	84	79
12	Calm - SW		+120	?	P. 18	88	73
13	Calm - SW 12-13	Heavy R. 1h --	?	ThickSt.	Fr. 16	88	74
14	Var. - ENE		+160	St. Cu.	Fr. -P. 09	77	71
15	ENE 00-15		+ 80	Ac. As.	P. 12	78	61
16	ENE		+ 20	St.	Fr. 13	71	64
17	ENE 10-24		- 80	ThickSt.	Fr. 15	71	68

TABLE 1 (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
OCTOBER							
18	ENE 00-17		+100	Ac. Blue	P. 13	76	62
19	E		+140	St. Cu.	P. 16	74	61
20	E 10-16		- 40	St.	Fr. 14	74	61
21	ESE 8-16	RAIN. Neg. Bay	-660				
		2-3h20	?	St.	Fr. 12	74	61
22	ESE		+ 60	St.	Fr. 12	73	61
23	Calm - N		+ 60	St. Cu.	Fr. 12	79	63
24	N - NNW		+ 40	Blue St.	Fr. 09	75	66
25	NW 11-13		+180	Blue	P. 12	75	51
26	Calm - SW		+120	Blue	M. P. 11	82	57
27	NE -E 6-24	RAIN 18h - -	+ 80	St.	Fr. 10	59	50
28	ENE 2-6	RAIN 12h30 - -		ThickSt.	Fr. 10	69	50
29	ENE		+ 20	St.	Fr. 13	74	55
30	E		- 40	St.	Fr. 17	73	62
31	Calm - Var. 9-10	Interm. R. 00h30					
		- +	?				
		- -		St. Cu.	Fr. 20	80	67
NOVEMBER							
1	NE		+ 80	St. Cu.	G. ?	80	69
2	Calm - NE		+120	Cu. -Ac.	P. 20	87	64
3	Calm - SE		+120	St. Cu.	P. 21	81	66
4	S - SW 7-13-23		- 20	Cu.	M. P. 18	81	66
5	SW - NW 20-24	0+40	+ 60	St.	G. 18	82	63

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
NOVEMBER					
6	NE 00-24	+140	St.	P. 14	82 63
7	NE 00-17	+210	Blue	P. 14	82 63
8	NE 8-15	+200	Blue	P. 13	81 74
9	NE - Calm	+240	Blue	P. 23	61 44
10	Calm - ESE	+200	Blue Ci.	P. 31	55 34
11	Calm - E	+160	St. Blue	P. 27	60 42
12	Calm- E -S	+ 80	Blue Ci.	P. 20	75 56
13	SE 12-16	+ 60	St. Cu.	G. 17	79 56
14	NE - SE	+ 40	St.	G. 17	76 57
15	NE 00-5	+ 40	St.	Fr. 20	56 45
16	NE 8-17	+ 20	Thick St.	Fr. 21	59 52
17	NE 2-20-24	RAIN 3h20 + - +120	St.	Fr-23	60 45
18	NE- Calm 00-9	+320	Blue	P. 29	53 39
19	E - Calm	Peak+1000 18h50 +360	Blue As.	P. 26	60 40
20	E	+200	St. Cu.	P. 19	66 39
21	ENE - Calm	+120	As.	P. 15	73 57
22	Calm- SE	+ 40	Thick St.	G. ? 13	74 57
23	SW	+120	St. Cu.	M. P. 15	77 66
24	N	+120	Blue Ac.	M. P. 11	74 64
25	Calm - SW	?	Blue	M. P. 16	68 47
26	SW-SSW 9-15	+ 80	Blue Cu.	G. 15	79 55
27	NE 6-24	?	St.	Fr. 16	68 49
28	NE - ENE 00-6	+160	Blue	P. 30	53 38
29	ENE- Calm	+180	Blue	P. 30	49 33
30	Calm- SE	+200	Blue	P. 32	57 33

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
DECEMBER					
1	Calm - SE	+ 80	Ac.	P. 29	63 39
2	Calm - NE 13-17	+120	Var.	P. 27	61 46
3	ENE- Calm 8-13	+200	Blue	P. 24	54 41
4	Calm-SE	+240	St.	P. 21	59 36
5	SE - NE 20-24	+ 60	St. Cu.	M. P. 18	61 52
6	NE -N-W 00-1	+160	Blue	P. 18	54 42
7	NE - Calm	Peak+920 at 20h40			
		+320	Blue	M. P. 20	62 44
8	Calm-SW	+160	Blue As.	M. P. 22	71 40
9	Calm - S/E	+160	Ac. As	M. P. 24	73 49
10	SE 10-14	+ 80	St.	G. 25	70 59
11	S - SW 10-16	+ 80	St.	G. 19	70 61
12	NW-NE-Calm 5-16	RAIN 2h15 - - + 80	Ac. Blue	Fr. 10	61 56
13	Calm-ENE-Calm	+120	Blue Ac.	P. 19	62 42
14	Calm - ESE	+ 90	St. Cu.	P. 21	64 43
15	ESE-SE 9-23	-160	Fr. Cu.	Fr. 19	69 53
16	ESE 3-24	- 90	St.	Fr. 12	73 61
17	Variable 00-4	RAIN 3h + + +120	St. Cu.	Fr. 12	72 58
18	W-NE 10-24	+120	Blue Ac.	P. 15	69 49
19	NE 2-16	+280	Blue	P. 25	55 38
20	E	+140	As.	P. 25	59 40
21	ENE-Calm	+180	Blue	P. 26	62 46
22	E - ESE	+ 90	Var.	P. 26	62 46
23	ESE 17-18	+120	St. Cu.	P. 23	64 46
24	ESE	+ 40	Blue St.	P. 20	64 53
25	ESE	- 80	?	? 24	64 46

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
DECEMBER					
26	SE - SSE	RAIN ?	St.	Fr. 20	76 54
27	SW - NW 2-16	+ 80	Var.	Fr. 14	86 63
28	W 3-15	+160	Blue	P. 10	60 44
29	Calm	+280	Blue Ci.	P. 11	64 41
30	Calm - NE	+180	St. Cu.	P. 17	58 36
31	E - ESE	RAIN 9h - - +120	ThickSt.	Fr. 21	52 45

GENERAL TABLE II 1960

(1)	(2)	(3)	(4)	(5)	(6)
JANUARY					
1	ESE 14-17	0 + 80 R. - 40	As.	Fr. 20	52 48
2	NNE 22-24	-40-200 R. - 60	As.	Fr. 17	65 59
3	NE-E 00-15	-400+160 + 80	Ac.	P. 17	65 49
4	Variable	+160	St.	P. 24	60 42
5	E 21-24	+320+200 Neg. Bay 21h -560	As.	P. 24	62 47
6	NE-E	RAIN ?	St.	Fr. 17	52 45
7	N 00-9	0+250 Peak + 820 at 19h +240	Var.	M. P. 20	52 41
8	Calm-E	Peak +640 at 9h +240	As.	M. P. 24	60 31
9	Calm-E	+280	Ac.	P. 26	60 35
10	ESE Calm	+ 80	Var.	G. 25	74 47
11	Calm-SSW	+ 80	Var.	M. P. 23	63 53
12	SSW 12-16	+400+400 +280	Var.	P. 21	80 58
13	SSW 13-15	+200+200 +120	St. Cu.	G. 19	81 63
14	SSW-S 11-22	RAIN + 80	Var.	Fr. 17	79 65
15	N	Peak +920 at 8h +280	AcB.	P. 11	70 53
16	E-E/S	+ 80	Var.	P. 17	60 43
17	SE- NW	RAIN ?	St.	Fr. 13	75 56
18	NW-N 11-24	+200+120 +200	Blue	P. 14	56 44
19	NE 00h-16	+120+120 +200	St. Cu.	P. 29	49 31
20	NE-N 11-16	+120+120 +160	Ac.	P. 28	47 34
21	NE	+240	Blue	P. 32	50 27
22	Calm-NE	Peak +640 at 8h30 +320	Ci. B	P. 33	50 28
23	E	+160	Var	P. 32	43 28
24	E	RAIN ?	ThickSt.	P. 29	41 28

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JANUARY							
25	E		+120	Var.	P. 25	58	32
26	E-S		0	Var.	G. 24	74	41
27	S-SW	Neg. Bay -800 at 8h	+ 40	St. Cu.	Fr. 20	75	50
28	W		+ 80	Var.	Fr. 19	69	56
29	N 1-3. 4-24	RAIN. Negat. Bay -1000 at 22h		St.	Fr. 15	69	50
30	N 1-21	0 to 0v.	+ 80	St.	P. 16	46	44
31	Variable		+ 50	ThickSt.	Fr. 17	46	42
FEBRUARY							
1	E-N		+ 80	?	P. 18	58	43
2	Variable		+ 40	St. Cu.	G. 20	56	46
3	SE-N 9-18 18-19	RAIN Strong wind	?	St.	G. 15	74	49
4	SE 10-12	RAIN	?	St. Cu.	Fr. 14	67	51
5	NW 9-17	+400+200	+200	BlueAc.	P. 06	61	44
6	NW		+200	St. Cu.	P. 14	58	48
7	NE		+160	Blue	M. P. 19	63	34
8	SW 10-16	+480+400	+200	St. Cu.	M. P. 20	71	39
9	SW 10-20	+160+40	+120	Cu.	G. 08	73	55
10	NW 13-15	+40. 0 Negat. Bay -1000v 11-17		?	Fr. 06	77	64
11	NE-ENE 2-4	+200+200 +320+40	+200	Var.	P. 07	59	44

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
FEBRUARY							
13	N 00-17	-200+320	+ 40	Var.	Fr. 12	44	33
14	Variable		+360	Blue	P. 20	51	23
15	S 12-16	+400+280 Negat. Bay -1000 19-24	+ 40	Var.	P. 26	58	34
16	NE		+120	St. Cu.	M. P. 20	56	45
17	N-E-W	R. Negat. Bay-200 3-6 Peak +1000	?	Cu. Blue	P. 17	60	34
18	N 3-10	+120-360	+200	?	P. 12	30	39
19	ENE 9-10	+360+60	+320	Blue	P. 26	53	35
20	E 8-17 19-23	+400+160 +120+160	+280	As.	P. 26	53	29
21	E 6-7 8-15	RAIN		ThickSt.	Fr. 19	62	50
22'	NE 6-9	Rain. Peak +800 20-23	?	St. Cu.	Fr. 16	59	46
23	SE 9-17	+480+280	+280	Blue	P. 19	60	38
24	SE 12-15	RAIN	?	St.	Fr. 17	66	44
25	NW 1-4-14	+120 +200+320	+160	Blue	P. 03	69	31
26	N	Peak +800	+320	Ci. Ac.	P. 19	52	31
27	E 10-22	+160-40	+160	Var.	P. 24	58	30
28	Variable	0v.		Var.	G. 19	75	48
29	ENE 9-24	-40+40	- 80	ThickSt.	Fr. 19	60	51
MARCH							
1	E/S 9-16	0-+40	+ 40	St.	P. 25	51	46

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
APRIL							
17	Calm		+ 80	St. Cu.	G. 16	79	65
18	ENE 2-14	-80+40	+ 50	St. Cu.	Fr. 19	72	59
19	ESE		+ 80	Cu.	G. 22	79	51
20	Var. 11-16	+200-0	+ 80	St. Cu.	Fr. 19	82	55
21	WSW		+120	As.	G. 14	86	59
22	SE		+ 80	St. Cu.	G. 16	86	59
23	SE		+120	St. Cu.	G. 19	86	59
24	SSW		+120	St. Cu.	G. 19	81	62
25	W 15-16	+280+90	+120	St. Cu.	G. 17	86	59
26	W	RAIN	?	St. Cu.	G. 13	85	59
27	NE 11-12	+160+120	+160	Blue	M.P. 11	83	60
28	Calm-NE		+160	Blue	P. 09	85	58
29	SSW 9-20	RAIN	?	St. Cu.	Fr. 13	86	68
30	N-SW 00-3 5-7 22-23	?	?	St. Cu.	Fr. 09	84	67
MAY							
1	E 10-17	+80+200	+120	NO CLOUDS OBSERVATIONS.	P. 17	74	64
2	?	RAIN	+240		P. 16	70	60
3	SE 15-16	+200+200	+160		P. 16	74	66
4	SSE 12-14	RAIN	+ 40		Fr. 14	79	58
5	SW 3-4	RAIN	?		Fr. 12	80	69
6	SW-NW 8-22	RAIN	+120		Fr. 11	84	71
7	NE-N 19-20	+820+820	+240		P. 12	70	61

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
MAY							
9	NW 12-15	+400+400	+200	NO CLOUDS OBSERVATIONS	M.P. 12	82	52
10	NE 8-16	+400+400	+120		M.P. 13	79	66
11	ENE 17-19	RAIN	+200		P. 12	78	51
12	ENE 12-17	+260+200	+240		P. 15	65	52
13	Variable		+200		P. 18	73	41
14	SW 16-17	+210+210	+200		M.P. 15	76	48
15	SW		+120		G. 16	83	55
16	SW 16-18	+400+190	+160		G. 16	84	59
17	Variable		+120		G. 15	86	63
18	SW		+120		G. 14	88	61
19	SW		+120		G. 13	86	75
20	N 21-23	RAIN	+160		Fr. 16	88	74
21	W		+120		P. 15	88	67
22	W		+120		M.P. 15	89	66
23	W		+ 80		M.P. 14	87	63
24	SW		+200		M.P. 13	88	61
25	W 15-17	+190+190	+ 80		G. 13	89	63
26	NE 11-12 15-18	RAIN	?		Fr. 13	89	70
27	NE		+120		P. 15	90	61
28	SW	RAIN	?		P. 14	91	62
29	S/W		+120		P. 14	88	61
30	NE		+ 80		G. 18	88	55
31	Var. -NE		+160		P. 16	84	66
JUNE							
1	Calm Var.		+ 80		G. 14	90	68

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JUNE							
2	Variable		+ 80	NO CLOUDS OBSERVATIONS.	G. 12	90	68
3	Variable		+ 40		G. 11	92	66
4	Variable		+ 40		G. 11	92	66
5	Variable		+ 50		G. 10	94	71
6	Variable	RAIN	?		Fr. 11	94	69
7	Variable		+160		P. 11	94	69
8	Calm Var.		+160		P. 11	94	69
9	NW Calm		+150		P. 11	88	69
10	N Var.		+120		P. 16	88	67
11	N. Calm		+180		P. 16	88	63
12	Variable		+120		P. 19	86	61
13	Calm		+160		P. 19	89	64
14	NW-NE		+160		P. 14	94	73
15	W Var.		+120		P. 13	93	65
16	SW 8-17	+80+120	+ 80		G. 14	91	75
17	N 11-14	RAIN	?		Fr. 13	91	69
18	SE		+120		P. 15	88	72
19	SE		+ 40		G. 15	91	66
20	SW-W	Peak +1000	+240		P. 15	91	71
21	W		+200		P. 14	91	70
22	W	RAIN	?		Fr. 16	91	69
23	NW 13-14	+40-0	+ 80		G. 16	91	73
24	W 11-16	+120-0	+160		G. 15	92	74
25	SW	?	?		G. 16	92	73
26	W		?		P. 17	92	78
27	W	RAIN	?		G. 18	92	71
28	E-SW	RAIN +-	?		G. 18	89	72

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JUNE							
30	W Var.	RAIN + -	?		G. 18	92	72
JULY							
1	W	RAIN - +	?	Cu.	G. 17	93	71
2	W	Neg. Bay -650 15-16	+ 40	Cu.	G. 17	94	76
3	NW		+ 50	Cu.	G. 16	94	74
4	N-W		+ 80	Cu.	G. 14	95	74
5	N-W	RAIN	?	Cu.	Fr. 14	95	75
6	N	RAIN	?	Ci. St.	Fr. 18	93	74
7	E- ENE		+ 40	Ci.	G. 18	96	74
8	NE	RAIN	?	Ac. St.	Fr. 17	93	78
9	S -SW	RAIN	?	Ac. St.	Fr. 17	92	74
10	NW Var.	Negat. Bay -1000 13h 30 - 45h	?	Cu-St.	G. 17	94	74
11	N. Var.	RAIN - +	+ 40	Cu-St.	Fr. 16	93	76
12	E 14-16	RAIN 16h - -	?	?	? 14	97	76
13	Var.	RAIN - +	+130	BlueSt.	Fr. 12	96	62
14	NE 18-19	RAIN 18h - -	+ 80	BlueSt.	Fr. 12	96	74
15	NW Calm	RAIN 16h + +	+120	?	Fr. 14	84	71
16	Variable	RAIN 11h - -	+ 40	Var.	Fr. 16	94	74
17	NE Var.	RAIN + +	+ 40	Var.	Fr. 15	92	72
18	NE	RAIN 18h - -	+120	Var.	P. 12	87	69
19	Var.	RAIN 13h - -	+240	Var.	P. 14	91	70

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
JULY							
20	Calm Var.	RAIN 15h - -	+160	Var.	P. 18	94	73
21	Calm Var.	RAIN 12h - +	+ 30	Var.	Fr. 20	95	73
22	Variable	RAIN 15h - +	+ 80	Var.	G. 18	96	77
23	Variable	RAIN 11h - -	+ 80	Var.	G. 17	94	75
24	Calm	RAIN 10h - +	+160	St.	Fr. 16	93	75
25	E-N	RAIN 10h - +	?	Var. St.	Fr. 16	92	74
26	NE-N		+120	Blue	P. 17	95	76
27	E Var.		+200	BlueAs.	P. 14	94	74
28	E		+ 90	Blue	G. 10	95	73
29	E-NW		+ 80	Blue	G. 08	97	77
30	N 14-15	RAIN 13h	+ 40	Cu.-St.	Fr. 08	97	77
31	N 11-11. 30	RAIN 13h	+140	St. Cu.	P. 11	92	76
AUGUST							
1	NE 13-14	RAIN 12h- +	+ 40	St. Cu.	Fr. 14	92	72
2	W	RAIN 12h - +	+ 40	St.	G. 17	83	76
3	N 13-14	RAIN 13h - +	+120	St.	G. 18	89	74
4	W	RAIN 11h - +	+120	St. Cu.	G. 17	88	75
5	Variable	RAIN 10h - +	+ 40	St. Cu.	Fr. 16	90	75
6	Calm Var.	RAIN 10h ∓ ∓	+ 50	St. Cu.	G. 18	89	74
7	Calm-Var.	RAIN 11h ---	+ 80	St. Cu.	G. 19	89	74
8	Variable	RAIN 9h - -	+ 80	St.	Fr. 17	88	73
9	Calm Var.	RAIN 7h - -	+ 40	Cu.-St.	Fr. 17	88	73
10	Variable	RAIN 9h - -	?	St. Cu.	G. 17	88	?
11	N 11. 45-12	RAIN 10h - +	?	St. Cu.	Fr. 16	84	73

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
AUGUST							
13	SW-Calm	RAIN 9h - -	?	Cu.-St.	Fr. 15	89	73
14	SW-Calm	RAIN 13h - -	+ 40	Cu.-St.	G. 16	91	73
15	SE 14-15	RAIN 14h - +	+120	Cu.	G. 18	91	75
16	S	RAIN 10h - -	?	Var. Cu.	G. 16	93	72
17	Calm-S.	Negat. Bay - 1000 15-17	?	Cu.	G. 17	91	75
18	Variable	RAIN 10h - -	?	St. Cu.	G. 15	89	73
19	W	RAIN 11h - -	?	Cu.	G. 15	91	74
20	Calm-W	RAIN 11h - -	?	Cu.-St.	G. 15	88	74
21	NW 12-13	RAIN 10h - -	?	Ac-St.	Fr. 16	90	75
22	N 10-10h15	RAIN 10h - -	?	St.	Fr. 14	85	75
23	NW	RAIN 12h - +	+120	Cu.	G. 13	92	75
24	Calm-N	RAIN 8h - -	?	Cu.	G. 13	88	74
25	Variable	RAIN 11h - +	- 40	Ac.-St.	Fr. 14	90	73
26	N -Calm	RAIN 12h - -	0	Cu.-St.	Fr. 16	90	72
27	SW 13-13h30	RAIN 13h - +	0	Cu.-St.	G. 17	89	70
28	S 11-13	RAIN 15h - +	?	Cu.	G. 13	92	75
29	SW		+ 80	Cu.	G. 18	91	80
30	SW-Calm		+120	Ac.	P. 20	91	69
31	E 9-13		+ 40	Cu.	G. 18	92	76
SEPTEMBER							
1	Variable	RAIN 11h - -	?	Cu.	G. 17	91	72
2	SE-Calm	RAIN 2. 11. 18h --- - -	?	Cu.	G. 17	91	74

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
SEPTEMBER							
3	E-SE		+ 90	Cu. Blue	G. 17	91	72
4	E- S		+ 40	Cu. Blue	G. 17	92	72
5	E - S		+120	?	P. 16	95	71
6	E - S		+120	Ac.	P. 15	92	71
7	E - S		+160	Cu.	G. 14	88	72
8	SE 8-9 10-17	Neg. Bay -800	?	St. Cu.	G. 13	83	74
9	S. 9-10	RAIN - - Neg. Bay					
		-800	?	St. Cu.	G. 12	83	73
10	Var.	RAIN 5h - -	?	St. Cu.	G. 12	84	73
11	E 8-10	+120+120	+120	Ac.	P. 09	85	73
12	E-ENE 7-8 12-13		+120	Blue	P. 10	83	70
13	SW-Calm		+200	Var.	P. 13	87	69
14	E 13-24	+120-80	+ 50	St.	Fr. 14	81	68
15	NE-N	RAIN 9h + -	?	ThickSt.	Fr. 10	77	76
16	W 9-17		+160	Cu.	? 11	90	70
17	N -Calm		+160	Ac. Blue	P. 17	89	72
18	E - Calm		+120	Cu.	P. 18	89	70
19	Var. -Calm		+120	Blue	P. 16	80	66
20	Calm-E		+160	Blue Ci.	P. 16	90	65
21	Calm-N-E		+200	Var.	P. 17	92	65
22	Calm - E		+120	Ci.	P. 15	93	68
23	E 10-16		+120	Cu.-As.	P. 15	89	63
24	E 10-13	-120+50	+ 50	Cu.	G. 13	90	69
25	E 12-14 18-23	+80+40					
		-200-90	- 40	St. Cu.	G. 12	87	69
26	E		+ 20	Var.	Fr. 12	81	72

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TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
OCTOBER							
1	NE		+ 40	Blue Ci.	M. P. 12	86	60
2	SE 16-17	+120+130	+ 50	Blue Ac.	G. 19	88	60
3	SE 13-14	+120+160	+ 80	Var.	M. P. 20	89	66
4	SE 10-1						
	S 14-14h30	RAIN - - 14h	+ 40	St.	M. P. 18	87	69
5	S 9-13						
	N 15-15h30	RAIN 11h - -	?	Var.	Fr. 12	68	66
6	NE 14-16	+200+200 RAIN 6h- -		Var.	Fr. 14	78	72
7	Variable		+ 50	Blue Cu.	G. 09	80	64
8	W 10-14	+200+200	+120	As.-St.	G. 11	83	63
9	Var.	Neg. Bay-1000					
		13-14h	+ 40	Blue	G. 13	85	64
10	Calm NE.		+ 50	Cu.	G. 16	86	65
11	E-NE-S		+ 80	As-St.	G. 18	85	64
12	E - S		0	Var.	Fr. 15	84	65
13	S 12-15	+120+240	+120	Blue As.	P. 15	86	66
14	SW 12-13	RAIN + + 10h	?	ThickSt.	Fr. 14	77	63
15	Calm ENE Calm		+ 80	Var.	M. P. 13	85	61
16	E - Calm		+ 40	As. Blue	M. P. 17	86	64
17	E - Calm		+120	Ci-Ac.	P. 16	89	63
18	S/W 10-16	+80-+400	+ 60	Var.	P. 16	89	63
19	S-NW 7-12	RAIN 5h	?	St.	Fr. 14	80	72
20	NE 2-15	-90+90	+120	St.	P. 15	73	61
21	E-NE 8-15	+120+200	+160	Ac.	P. 21	65	51
22	E-Calm		+240	Blue	P. 21	69	43
23	Variable		+160	Blue	P. 18	77	44
24	Variable		+240	Blue Ci.	P. 14	81	53
25	ESE		+100	Blue Ci.	M. P. 14	81	56

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
OCTOBER							
26	S-Calm		+ 90	St.	M. P. 16	77	55
27	Calm-N		+120	St.	P. 13	79	66
28	Calm- E		+ 50	Blue	M. P. 11	77	55
29	SSE 9-12	+160+160	+ 40	Blue-St.	G. 12	80	57
30	SSW 9-12						
	W 14-17	RAIN 12h - -	?	St.	Fr. 10	84	66
31	N 00-17	-40-40	+ 80	Ac.	P. 12	66	53
NOVEMBER							
1	Calm NE-W		+140	Blue	M. P. 12	72	42
2	W - NW		+ 40	Blue	M. P. 12	78	44
3	Calm E Calm		+120	Blue	P. 18	79	53
4	E -SE		+ 40	Blue	M. P. 25	77	52
5	NE 21-24	-160-320	?	Blue Ci.	M. P. 25	80	50
6	NE 00-15	-90+160	+160	Blue	P. 24	66	51
7	E 6-11	+80+200	+120	Blue	P. 24	66	44
8	Variable		+ 50	Cu.	G. 25	75	39
9	SSW 9-15	+300+10	+ 80	St. Cu.	Fr. 22	79	54
10	NE-ENE 3-23	-120-0	- 80	St.	Fr. 21	68	51
11	ENE-Calm		+160	Blue	P. 25	64	46
12	E		+120	Blue. Ci.	P. 23	69	39
13	ESE		+ 40	St.	G. 24	73	51
14	SE 13-16	+120-0	+ 40	Cu.	G. 23	80	61
15	SSW 9-16		+120	Cu.	G. 23	80	59
16	W 10-11	RAIN 14h					

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
NOVEMBER							
17	E 8-11	+120+120	+120	St.	P. 20	66	61
18	NE 15-16	+40-20	0	St. Cu.	Fr. 17	67	59
19	E 8-11		+ 80	Blue	P. 19	69	53
20	Calm-E		+120	Ac.	P. 20	79	48
21	ESE 13-14	+90+120	0	Ac. St.	Fr. 20	70	60
22	SSW 11-16	-40-40	0	St.	Fr. 20	78	60
23	NE 10-14	0-0	- 10	St.	Fr. 19	76	62
24	E -Calm		+ 40	St. Cu.	G. 22	70	62
25	E-Calm		+ 40	St. Cu.	G. 20	69	52
26	E/S - S		+ 40	Blue Cu.	G. 20	70	44
27	SSW 12-16	+80+120	0	St. Cu.	G. 20	79	50
28	SW		+ 80	St. Cu.	G. 16	82	61
29	NE		+ 50	Blue	G. 16	71	53
30	NE-E		+120	Blue	P. 26	56	42
DECEMBER							
1	E 1-24	0-0	+ 40 ?	Blue	P. 29	53	39
2	E-ESE 00-8	-40+280					
	10-11	+200+200	+ 80	Blue	P. 34	53	34
3	SE 14-17		+120	Blue Ac.	P. 32	66	29
4	SE - S 13-16	+40+80	+120	Ci.	P. 27	74	?
5	S -SSE 11-13	+120-160	?	Ac.	G. 23	78	60
6	SSW 9-14	?	?	Ac.	G. 25	79	61
7	Variable	?	?	Var.	G. 22	77	54

TABLE II (contd.)

(1)	(2)	(3)		(4)	(5)	(6)	
DECEMBER							
8	E 12-24		+ 40	Ac. St.	Fr. 21	64	51
9	E 00-16	Large Neg. Bay -900					
			0	ThickSt.	Fr. 21	54	43
10	ESE-WSW	RAIN 20h - -	+ 40	ThickSt.	Fr. 20	72	50
11	NNW-N/W		+120	Blue	P. 13	60	51
12	ENE 9-13	+120+160	?	ThickSt.	Fr. ?	49	45
13	ENE 00-12	0+120	+200	Blue	P. 13	60	51
14	E/S	RAIN - +	?	ThickSt.	Fr. 29	45	32
15	NE 3-24	RAIN - +	?	St.	Fr. 14	49	41
16	E/N 4-14	?	?	Blue	P. 23	51	42
17	E/N Calm		+160	Blue	P. 28	52	25
18	Calm-SE		+140	Var.	P. 29	43	34
19	Calm		+ 80	Ci.	P. 29	43	34
20	WSW-NNE						
	20-24	RAIN - -	?	St.	Fr. 22	72	43
21	NE 00-17		+120	Ac. Blue	P. 18	48	34
22	NE 11-12		+120	?	P. 28	46	25
23	SE 11-17		+200	?	P. 33	36	25
24	Variable		-200	ThickSt.	Fr. 30	58	40
25	SE- SSW 11-16	+80+280	+120	Var.	?	73	51
26	Variable	RAIN - -	?	St.	Fr. 24	69	52
27	ESE		+120	As.	P. 21	63	53
28	ESE 6-11	0-80	+ 80	As. Ac.	G. 23	70	55
29	Variable		?	St.	Fr. 22	71	55
30	ENE		+ 80	St. Cu.	P. 19	57	49
31	SE-NW 1-4						
	9-16	+200+160	?	Cu.	Fr.	?	?

ELECTRIC POTENTIAL GRADIENT

If one considers the groups of values given, for instance +200+100, and checks in Column 2 the period of hours when the wind had freshened, one sees at once that there is no correlation between the two reports. At times the potential increased from the beginning to the end of the wind gust, and at times, it decreased and even changed its polarity. Watson had the following to say. We quote: "1- The electric potential is very largely dependent on the wind speed, a high wind being associated with a low potential. 2- Very high potentials never occur with high winds but low potentials may occur with light winds. 3- The effect of the wind is greater in winter than in summer and greater at 21h than at 9h".(7) This is what has been recorded in Eskdalemuir. In New Orleans these statements do not hold. Of course in most cases where the wind reached a speed of 10 to 20 meters per second, it was accompanied by rain.

The very high potentials, negative or positive, registered at those times are usually attributed to the rain itself and not to the wind's action. Since the mechanism of these sudden and strong variations of the potential during rainshowers is still, to say the least, quite mysterious, we cannot reject, as Watson does, the possibility of a real influence of high winds on the intensity, if not on the polarity, of the electric gradient oscillations.

One might admit that the rapidity of these potential oscillations, which in New Orleans also have reached 20,000 volts, depends on the rapidity of the atmospheric turbulence oscillations. Microbarographs (x 100) recordings in Montreal have shown that these ups and downs have reached at times a period of one second or less. To complete our discussion of this question we must first report how Watson explains his statements just quoted. "All effects observed can be explained if we assume that the earth has a charge sufficient to cause a potential gradient of 100 to 150 volts per meter, and that the local atmospheric charges, which increase in the absence of wind or of other mixing agents, cause the remainder of the observed potential gradient. A sufficiently high wind in winter annihilates this atmospheric charge; but if, as at 9h in summer, vertical convection has already done so, the wind can produce no other effect. It would have been interesting to see the curves for 21h in winter become horizontal with still higher winds, but, unfortunately, observations were not available".

We apologize for such a long quotation but it raises interesting problems.

Anemometers used in most stations record only the horizontal component of the air flow. The vertical component is left aside. Years ago, by means of special anemometers, we measured this vertical component and have found that, at times, it is the main cause of the wind's impact: especially so on the occasions of rapidly moving strong cold fronts or of rapidly subsiding Polar air anticyclones.

The vertical component of the wind (or "pumping of the pressure") might have some influence on the behaviour of the potential by increasing or decreasing the resistance of the atmospheric column. As a matter of fact, during January 1959 we had several days with strong wind without rain and high potential. The waves at horizontal surfaces of discontinuity already mentioned by Goldie imply vertical compressions and dilatations of the atmosphere. Statements contrary to our own experience might be explained by the fact that the recording station was liable to feel more atmospheric pollution than had been the case at the New Orleans' location, which, as we have already stated, appears to be rather immune from such a disturbing factor.

The increase of the potential at 9h and its decrease at 21h at the Eskdalemuir station seems to be rather a local phenomenon because the morning convection's time varies with the latitude of the place and the days of the year.

Since the direction from which the wind is blowing can bring over the station industrial contamination, we checked if any correlation existed between the direction of the wind and the variations of the potential. We did not find any. As reported already many of these checks were marred by rainfall.

Often the trace of the recordings in the morning hours has been almost horizontal and close to the zero value. Whether this was due to the radioactive probe being grounded by the dew, or to the fact that at those hours the wind usually falls to a calm, we do not know. Anyhow these registrations did not fully substantiate the statement that with light winds or calms the electric gradient is higher than during high winds.

Other scientists have published a curve representing the daily variation of the potential. We failed to find anything

very striking. Probably the technique of the "equal areas" for finding the mean 24 hours value of the potential was the reason for this failure. Nevertheless, checks made in "fair weather conditions", using the hourly values showed only that the potential is more variable and stronger during the daylight hours than during the night.

Sudden high to very high peaks of the gradient were noticed and they are reported in the "General Tables". They are rather exceptional. If one had read the potential only at the beginning of the hours, he could have missed them and, as a consequence, the daily variation as well as the 24 hours mean value could be wrongly stated.

The so called "seasonal variation" has also been considered. We feel that such an expression can be misleading, since this variation is not so much connected with the calendar months of the year, **January**, February and so on as with the types of the air masses acting during the different months. The monthly division of the calendar year has no meteorological meaning. It would be better to start from the spring equinox and end the series of recordings at the next spring equinox. The action of the solar radiation could be better shown and the variation in time of the electric gradient better understood. But even then there is no guarantee that the motion of the air masses would follow the astronomical dates.

Anyhow, using all available data, and not just those with "fair weather conditions", we have calculated the mean electric potential according to the sun's position during the year. Spring: from the 21st of March to the 21st of June; summer: from the 21st of June to the 21st of September; autumn: from the 21st of September to the 21st of December; and winter: from the 21st of December to the 21st of March of the next year. The potential values corresponding to the real seasons are rather erratic. Between brackets is the number of observations.

TABLE A

1959	Winter	(61)	**142 volts.**	**Spring**	**(57)**	**98**
	Summer	(41)	105	Autumn	(74)	124
1960	Winter	(62)	168 volts.	Spring	(76)	124
	Summer	(56)	122	Autumn	(65)	95

Dobson has published similar data but we do not understand the reason for his grouping of the months (l. c. p. 159). The three seasons referred to include the following groups of months. For winter; November, December, January and February. For summer; May, June, July and August. For equinox; September, October, March and April. Even with such a grouping of the months, the mean seasonal potential gradients for winter, summer and the equinox at Kew and Eskdalemuir are just as debatable as those in our table. A similar remark applies to the values of the Table given by Watson (l. c. p. 7) concerning the mean Potential Gradient on 0a days. There is as in our own Table A, only the proof that higher values are present in cold days and lower ones in warm periods. No explanation of this fact is given. Since it is not sufficient to state "that is that", we believe that the action of the different types of air masses gives the solution of the problem. Moreover even the so called "local meteorological conditions" are greatly, if not totally, affected by the presence of different synoptic air masses.

Owing to the lack of a meteorological meaning to the calendar months attributed to each season, we were more interested with the "yearly variation". Our 'General Tables' were assembled according to the calendar months.

We followed at first the example of other publications on the same subject; namely, we put together all the gradient values of the "fair days" of each calendar month. In this Table B (see under), we accepted the usual definition of "fair weather" namely "no rain nor any disturbed atmospheric conditions". Days were either with blue skies or partly cloudy.

TABLE B
(Volts)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1959	157	147	119	118	103	81	86	121	88	102	140	143	116
1960	160	183	167	112	145	119	94	86	114	99	90	109	123
Mean (1959 & 1960)	158	165	139	115	124	100	90	107	101	100	115	146	119

The yearly variation is apparent in both years especially in 1959.

Another Table is given showing the electric potential values distributed according to our definition of "fair weather", namely according to the presence of the two air masses, the Continental Polar and the Gulf-Maritime.

TABLE C (Volts)
Continental Polar Air Mass

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1959	173	135	137	120	95	102	125	150	117	180	179	160	140
1960	197	213	180	172	182	162	164	120	140	142	130	124	160
Mean (1959 & 1960)	185	174	158	146	138	132	144	135	128	161	154	142	150

Gulf-Maritime Air Mass.

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1959	80	80	96	113	83	88	70	110	82	105	87	90	90
1960	100	80	110	107	104	83	63	90	76	51	56	80	83
Mean (1959 & 1960)	90	80	100	105	93	85	66	100	79	78	71	85	86

This Table C shows a somewhat more constant value of the electric potential in the succeeding months of the year. Nevertheless one should remember that the number of days with the "fair weather" either according to the definition accepted by most electric scientists or according to the one we prefer, namely special to each type of air mass, are not equally distributed in each calendar month. None-the-less Table C shows that the potential of each air mass is not so much a function of the time of the year, as the values of Table B seem to indicate. A real Polar Air anticyclone in summer will give potential values almost similar to those recorded in winter and a Gulf-Maritime Air powerful invasion will act similarly all year long. We feel that the distinction of different types of "fair weather" is rather well justified. We add that some more discordant values for the Gulf-Maritime Air mass can be explained by the action of not too distant thunderstorms.

Anyhow we feel confident that a similar discrimination of the types of "fair weather" should be interesting also elsewhere for the study of the potential gradient.

Of course the values reported show a rather great dispersion and we will now consider this important question.

Going back to the monthly means in each year, 1959 and 1960 for the Continental Polar air we find that the maximum scattered figures in 1959 has been +40 volts on one side and -45 on the other side: a range of 85 volts. In 1960 with similar atmospheric conditions it has been +43 volts and -40 volts: a range of 83 volts. With the Gulf-Maritime air mass in 1959 we had +23 volts and -20 volts: a range of 43 volts. In 1960 it was +27 and -32 volts: a range of 59 volts. The mean range of all these scattered values is 67 volts.

We have already mentioned that the sensitivity of our recording had been fixed to 1000 volts on both sides of the zero volt line in order to get rid of the small and transient variations of the electric potential. Such a choice of sensitivity made possible only the reading of plus or minus 40 volts. It corresponds to a 2mm displacement of the recording pen of the Easterline Angus recorder which has a trace 1mm thick. At times we could read down to 20 volts, corresponding to 1 mm vertical length of the registration. We find interesting to note that the mean of the scattered maximum value on both sides has been 67 volts. Half of such a figure, namely 33 volts, could be called the instrumental error, and should have affected the 17,520 values of the 730 recordings examined. We agree that a photographic trace would have been more accurate. In our case a more sophisticated statistical treatment of the data at hand would not make much sense. Nevertheless the mean total range of the maximum scattered values, 85 volts in Polar air conditions and 59 volts in Gulf-Maritime anticyclone would show that the variations of the potential gradient in Polar air is almost twice as great as in Gulf-Maritime air. As a matter of fact meteorologists know that a continental Polar air is not generally as homogeneous as the Maritime air. We would need more data to find out if the range of variations observed during the two types of "fair weather" is the normal one. Extreme values can be caused by the different intensities which the meteorological phenomena do show in different locations of the earth. Since succeeding winters or summers are at times greatly dissimilar, it remains well apparent that the behaviour of the electric potential is different in each type of air mass. It would be difficult to attribute this aspect of the potential gradient to the world-wide activity of thunderstorms.

How can we explain the different values of the electric potential in different air masses? The resistance or resistivity of the atmospheric column between the ground and the ionosphere layer must be different. Since specific floating charges in the upper levels seem not to be acceptable, we would mention the water vapor of the tropical air which overruns the Polar air mass. Pilots have often reported in the higher levels the existence of a kind of mist not visible from the ground. Could the exhaust of jets (contrails) give any hint? Continental dust also exists high up in the atmosphere.

Concerning the action of invisible smoke particles often quoted by other authors we find interesting the following quotation. Scrase in his study: "The charged and uncharged nuclei in the atmosphere", Met. Office - Geoph. Memoirs No. 64, p. 15, states that "The influence of smoke particles on the resistivity of the air has been examined and it is concluded that the effect is much smaller than earlier observations at Kew appeared to indicate. Shall we consider the ionosphere itself and check if its positive potential is varying? The intensity of ionization by cosmic rays and the earth crust radioactive emanations are considered as being practically constant. Nevertheless the unshielded ionization chamber in Montreal shows high current and large oscillations of intensity when a Polar air anticyclone is stationed over that locality. (9) During invasions of Atlantic Maritime air the current is smaller and the oscillations quite reduced.

Of course all our reasoning would have been better justified if we had had also the recordings of the air to earth current and of the conductivity. Nevertheless there must be a different value of resistivity in the Polar and the Maritime air. We know that positive ions moving downward are slowed down by the increasing specific resistance of the air. The density of the Polar air is greater than that of the Maritime air. Could that produce a greater electric potential at least some thousand feet above the earth's crust? Could that produce a positive charge greater than that of the negative ions which at the same time move upwards to the ionosphere level?

Agreeing that these ideas may be rightfully considered as wishful speculations, we will go back to the data collected in the "General Tables" of this article.

CLOUDS

The 4th column of the "General Tables" gives the type of clouds which were prevailing on each day. They fit quite well with the type of air mass which was found, by the analysis of the daily weather maps, to be present on the same dates. As a matter of fact Polar air conditions are well correlated with blue skies and high clouds, while the Gulf-Maritime shows the well known cumulus of the Trade wind "fair weather".

The Stratus clouds correspond to frontal conditions and they also show a quite good agreement with such a type of weather. We have also made a special Table showing the values of the electric potential and the type of clouds. The correlation found is that already discussed when mentioning the "fair weather" of the two main air masses. It is not reproduced in this article as it would not serve any special purpose. Although it is a foregone conclusion that types of clouds and types of air masses go together, such a correlation should convince the scientists that the continuous observation of the evolution of clouds is very important not only for synoptic weather forecasting but also for any research on the electric potential of the surface atmosphere. It is not so much the amount of clouds, the only item reported most of the time, as the types and distribution of these that matters

TYPES OF AIR MASSES AND ATMOSPHERIC PRESSURE

The data are found in column 5 of the "General Tables We have already discussed the question of the synoptic aspect of weather and mentioned that the symbol M.P. meant a Polar air mass no longer centered over the continent, but covering the Gulf of Mexico.

The pressure values could also have been examined with a more detailed analysis. The readings of the hourly value for both the barograph and the electric potential curve should then be made. As we were more interested in the general trend of the electric phenomenon and had used the "equal areas" tech que we could not make this special study. The sensitivity of the recording should have been greatly increased and such a move would have been contrary to our main purpose. Too many local and transient variations would have been present.

TEMPERATURE

Column 6 gives the Maximum and Minimum temperatures in Fahrenheit degrees for each day, according to the Daily Weather maps of the Washington Weather Bureau. The total divided by two can give a sufficiently good idea of the mean daily temperature.

These temperature values were used for checking ou discrimination of the air masses, since it is obvious that a Polar air mass would give a lower Minimum temperature figure than the one read with Gulf-Maritime air over the place. A similar reasoning cannot be made concerning the Maximum. With blue skies, in Polar air, the thermometer can show high readings.

The reader may have noticed that up to now we have made no mention of the so called "solar effect" on the potential gradient. As a matter of fact we have tried to draw up a reliable list of the days when this effect occurred, but with no satisfying results. Although this effect does exist and shows clearly in the Montreal recordings, in those obtained at Loyola University the values are confusing, to say the least. Very often the trace remains almost flat and near the zero volt value until the noon hours. On other days the increase of the potential happens several hours after or before the local astronomical sunrise. The increase at the expected hour seems to be rather exceptional. Is there any latitude effect connected with these happenings? Once more our reduced sensitivity might have been the reason why we were unable to report on the sunrise effect. Anyhow, on the numerous days when the increase in the morning hours had been very gradual, a higher sensitivity would not have helped to find the beginning in time of this "solar effect". We do not know if elsewhere, in a geographical situation similar to that of New Orleans, the same failure has been reported. It remains a mysterious fact, the more so that, as already stated, in Montreal, even with a lower sensitivity than the one chosen for Loyola University, the phenomenon does show up.

Concerning the evening variation of the potential gradient, we reach a similar negative result.

Since the solar radiation can produce ions which will affect the resistance of the atmospheric column and its electric factors, we tried to get local ozone data. They do not exist in or near New Orleans.

Sudden and great peaks of potential are mentioned in Column 3 of the "General Tables". Are they connected with any ozone variations? We cannot say. At any rate, they do not show any correlation with the type of clouds present at that same hour. Of course invisible clouds or trails of atmospheric pollution, exceptional in our locality, might have caused these sudden and shortlived increases of the potential. The more so that no rain was falling in the New Orleans region at that time.

Going back to the statements made by the author and concerning the necessity of simultaneous synoptic studies of the electric potential gradient, we would stress the fact that one should examine very simple and clearly defined air mass conditions. We have said already that the analysis of fronts is an impossible task. A tremendous amount of successive and simultaneous aerological soundings should be at hand to ascertain the volume of the air mass which commands the evolution of the frontal zone. Fronts are not steady meteorological conditions. Furthermore the so called "cold front" is often a double, or may even be a triple front. A rush of cold air flowing rapidly in the higher level, where friction is less, does very often overrun the cold air layer on the surface. At times also, while on the surface the cyclone is occluded, frontal conditions still exist in the upper levels. Air pilots who meet them could testify to this; so much so that the measurements of the potential gradient in fronts is necessarily a greatly handicapped task.

Many measurements of the potential gradient have been made by different authors on high mountains. Can we be sure that these measurements are better for our purpose than series made on flat and well chosen locations? We do not believe so. One has to remember the existence of "mountain waves" produced on the slopes of the high summits. These waves can reach the upper troposphere, and thus the wind, even when slight, is disturbed by the obstacle. Of course we suppose that forest trees are absent, otherwise the point-discharge effect would be very troublesome, even in "fair weather conditions". One should consider also the ever present, though invisible, turbulence revealed by soaring kites. It is not only a question of convections.

So much so that we prefer measurements made at flat ground stations, if these are immune from industrial pollution and well away from point-discharge actions. We would also like that these two or more stations, recording simultaneously, be located in the same type of air mass, otherwise their measurements would provide different and random values.
And this simultaneity should be that of the same local solar time and not that of same standard time zone. Namely the recordings should be obtained on the same longitude line; especially when analyzing transient phenomena. Only then could one find the extent of the increases or decreases of the potential and be sure that these were not strictly local events, but were connected with the air mass in action at those moments.

In this way the mysterious peaks of intensity and the baffling negative bays could be attributed to a reliable physical cause.

In the "Proceedings of the Second Conference on Atmospheric Electricity"(Foot Note of p. 196) Dolezalek has given a definition of the adjective "synoptic" which is not the one that a meteorologist would usually use. It reads: "an investigation should only be called "synoptic" when the observation-net covers

an area large anough to eliminate all common local influences. Complete different weather situations may occur simultaneously at the different stations of such a sufficient wide-spread synoptical net". The definition we prefer, and which we have considered, would call "synoptic observations of the atmospheric electric factors" those made simultaneously in different distant stations all situated in the body of a same air mass. The "fair weather" would be of the same type in all these locations.

While the Dolezalek definition plainly admits the simultaneous existence at the stations of "completely different weather situations", our definition rejects such a disturbed type of weather. The study of the electric properties of the air masses as a function of their thickness, temperature, types and intensity of aerosols, etc., would greatly facilitate matters.

Of course the meteorological situation considered by Dolezalek presents some interesting possibilities, for instance, that of checking if the electric conditions reported by a station in such a type of air mass will, in due time, together with the displacement of this air mass, cause in a new location similar variations of the potential gradient.

If our distinction of the different types of "fair weather" based on the different thermodynamic characteristics of different air masses should be found acceptable and working also elsewhere, the meteorologist would have been provided with a new tool for forecasting the "electric weather" and even biologists might be rightly interested!

Statement which is greatly relevant to our own research has been quoted by Israel (10): Ch. J. Brasefield has reported the following: "These measurements indicate that 'clouds of ions, sometimes positive sometimes negative, frequently pass overhead at an altitude as low as 10 meters and less. The origin of the ion clouds is unknown, but it has been observed that they are more prevalent when the potential gradient is large". Could these ion clouds be also floating at some higher level? One could then accept as possible the existence of those charges we mentioned at the beginning of this article as being rather a wishful consideration. Anyhow, the "large potential" referred to by Brasefield could be the one which our research has shown to be present in the Continental Polar air mass. Since the same author does not attribute these ion clouds to any industrial pollution, we can infer that they belong to the moving atmosphere layers. Otherwise it would be very extraordinary that these ion clouds should have passed over our collector only in Continental

Polar air situations.

A word now about the relative humidity value on the days of the 1959 and 1960 series of observations. It has not been reported in the "General Tables". Are we right in believing with Dobson that "the effect of the relative humidity seems to be very small" (l. c. p. 169)?. In order to be consistent with our distinction of the air masses, we would admit that humidity has an action on the conductivity of the atmosphere and, as a consequence, also on the electric potential. As a matter of fact, the Continental Polar air is drier than the Gulf-Maritime air mass, and humidity is a conservative characteristic of air masses.

And what about the effect of temperature on the potential gradient? The same author Dobson has another skeptical statement similar to that concerning the relative humidity: "..in the case of the effect of the temperature, while earlier observations seemed to show a fairly constant effect, the other set is very uncertain, and nearly half the months show the effect in one direction and half in the other" (p. 169 loco cit.). Of course Dobson had not considered, as we did, the different types of "fair weather". We reported the value of the daily Maximum and Minimum temperature mostly as a means of distinguishing the Polar from the Gulf-Maritime air mass. The first should show temperatures lower than does the other. Since the temperature affects the density of the air, it should also affect its resistance, and so also the potential gradient. Notwithstanding the fact that there is change of density with different temperature values, one should agree that the temperature will not affect the quality of the aerosols or nuclei, which will be only more or less apart, according to warmer or colder air conditions. So much so that we fail to subscribe totally to the following statement "The variations of the local atmospheric charge must depend on local agents (and, therefore, on local time) which stir up the atmosphere, chiefly the wind and the vertical convection, controlled by surface heating and the general circulation" (p. 16). We believe that, besides these local factors, there are factors special to each type of air mass. In Montreal as in New Orleans, with powerful Polar air anticyclones, high potential values were registered at night as well as during the day-light hours. Our experience in these two localities does not warrant the following statement by the same author: "Studies of the effect of meteorological elements on the potential gradient made at different places have been so contradictory that...". Nevertheless, further on we read: "It appears then safe to assert that it is the wind speed or the associated turbulence which has so marked an effect on the potential gradient, but it is probable that some temperature effect also exists". (p. 13 l. c.)

Simpson in his most interesting study (11) has mentioned recurring types of patterns in his recordings. These are well represented in Montreal at Brébeuf College. In New Orleans they are almost completely absent. Only those obtained during rainfall were given some attention. The strong positive or negative oscillations often have a period of one second or less. Occasionally the negative plunge of the trace remains negative during several hours and off scale. In some cases it fluctuates up and down with different intensities of a same polarity. That happens also when the trace has gone off scale in the positive region. During these hours the Dines type anemometer shows only steady strong winds, with no apparent correlation between its continuous oscillations and those of the electrical potential, which, as already reported, remains steady in the positive or the negative side. Some of these rainfall patterns show continuous negative oscillations which just cross slightly the zero volt line. If they reach the positive region their intensity is greatly inferior to that on the negative side. When a thunder-clap has been heard, it takes several seconds before the electrometer starts recording. We have not been able to find out if this delay was greater when the thunderstorm region was farther away. We have the impression, which further checks might prove erroneous, that the inertia of the recorder is not the only factor involved. Possibly the complex oscillations registered during a thunderstorm by a microbarograph could help to find the answer. Since the lightning travels with the velocity of light, it would be interesting to ascertain whether the sound waves would have any pressure effect on the ion clouds. Of course due attention was given to the fact that, many times, it is just after the lightning flash has happened that a rainshower is recorded. That would explain the delay in the recording.

CONCLUSIONS

A few points, not necessarily new, seem to have been confirmed by the values collected in the "General Tables".

1 - The different air masses, Polar, Maritime, and Tropical (this latter not checked by us), which make the surface weather, have a specific columnar resistance; this is inherent to the body of the air mass and can be attributed, for instance, to the chemical type of aerosols, to their quantity, to the water vapor content in the higher levels, etc.

As a consequence, the mean values of the electric potential in "fair weather" will differ according to the type of the air mass.

Such a fact has been confirmed by the recordings made in Montreal, Canada, and in New Orleans, Louisiana. We may add, that all the readings of the potential in both places, were made BEFORE consulting the Daily Weather maps for ascertaining the synoptic situation of the atmosphere. No subconscious preconceived idea could have been present.

We find interesting the following statements by Israel and Dolezalek which appeared in the "Proceedings of the Second Conference on Atmospheric Electricity". "Fluctuations in the atmospheric electric field arise from changes in the condenser potential of the global atmospheric condenser or from changes of the distribution of space charges within this condenser". "Air masses of different origin make it possible to characterize and differentiate between various atmospheric electric effects". These assertions fit in with our own findings. But should there always be a turbulent exchange process? (12). We think not.

Dolezalek's words come closer to our opinion, when he states that, among the factors to be considered, are "the chemical nature or the size distribution of aerosols", since they "may differ from one air mass to another". (13). A turbidity factor will not change the chemical nature but only the space distribution of these aerosols. Of course we understand this turbidity factor to be a physical and not a chemical one.

2 The "sunrise effect" is at times apparent. Too often it is impossible to time its beginning. There is a general impression that, if the radioactive probe has not too frequently been grounded by the dew, there is a recurring maximum potential around 13h local solar time (19h. U. T.) and a minimum around 22h local solar time (4h U. T.).

3 The action of the wind, moderate or strong and from any quadrant, over a station well protected against industrial pollution, has not shown any real correlation with the values of the electric characteristics of the different air masses: the Continental Polar and the Gulf-Maritime. The Tropical (or Equatorial) air mass has not been examined, but we may infer that its type of "fair weather" would make a similar special show.

4 The intensity or volume of rainfall has no apparent correlation with the intensity of the electric potential variations. The polarity of the recordings at the beginning and at the end of a shower is generally negative. Some beginnings and some endings have been found positive. It has been impossible in New Orleans to find and examine rain recordings not caused by local or near-by thunderstorms, advectional or convectional.

5 - Frontal analysis was not contemplated. It would be well nigh impossible to discriminate between the two types of air mass contacting. Fronts are most of the time transient phenomena. The electric recordings obtained during these events cannot be considered useful for a basic and synoptic knowledge of the atmospheric electricity.

6 - Solar radiation has surely a great influence on the electric potential. The contradictory results reported by Watson (page 7 l. c.) will most probably be modified, when a greater number of solar cycles and simultaneous potential measurements will be at hand. Such a research was out of the question in New Orleans.

7 - Days with a 24 hour negative potential and deep negative bays remain unexplained, but they are not necessarily just a locally restricted event. The recordings of one station alone cannot help to find how extensive in time and space are these phenomena.

8 - Temperature and humidity affect the potential gradient although their action appears to be slight and most of the time confined to the place of observation. Nevertheless temperature inversions and moist air layers in the upper levels should partly explain the specific electric characteristics of the atmospheric column of the air mass considered. The lack of radiosoundings in New Orleans itself made impossible any research along this line.

9 - The scattered maximum values of the monthly means of the electric potential related to the yearly mean figure seem to show that in Polar air the variations of the potential during "fair weather" conditions, are greater than those recorded in Gulf-Maritime air.

10 - The potential in misty conditions and with calm of wind has almost always been very low. We have given our point of view and our definition of reduced visibility: mist, haze and fog. Such a distinction explains why we could not forecast the clearing of the reduced visibility as it has been

done elsewhere (Serbu). In New Orleans, at Loyola University, the surface visibility is reduced by mist (called also wetting fog) or by very low thick Stratus. The distinction of mist from haze and fog is very important and these three causes of reduced visibility should not be confused.

11 - Exceptionally very long period oscillations were recorded.

12 - Since no measurements of the air to earth current and of the conductivity of the air were made at Loyola University, we have to admit that the conclusions just formulated are not absolute. Although incomplete, they might not be totally wrong. Most of the results described are similar to those obtained elsewhere in better equipped stations.

All the values of the electric potential given in the preceding pages are those which were read directly from the recordings. Trial measurements were made by means of a long wire, stretched over a nearby lawn at one meter above ground, to obtain the reduction factor and to get the absolute volts-per-meter figures. These measures were apparently not conclusive, since the long wire technique can at best give only a 30 per cent accuracy. The corrected potential values obtained appeared to be too low and puzzling. We tried another technique: a vertical metal rod, entered into the teflon insulator of the Keithley electrometer (10^{12} ohms input impedance) and holding the radioactive probe at one meter above ground. The values obtained, although still debatable, are relatively interesting in that they confirm our statements concerning the different electric conditions existing in the body of different air masses. Here they are:

Mean potential for all "fair weather days"	72v/m.
Mean potential for all "fair weather days" in Polar air.	89v/m.
Mean potential for all "fair weather days" in Gulf-Marit. air.	51v/m.
Mean monthly maximum for all "fair weather days".	108v/m.
Mean monthly minimum for all "fair weather days".	48v/m.
Absolute monthly maximum for all Polar "fair weather days".	126v/m.
Absolute monthly minimum for all Polar "fair weather days".	56v/m.
Absolute monthly maximum for all Gulf-Marit. "fair weather days".	67v/m.
Absolute monthly minimum for all Gulf-Marit. "fair weather days".	30v/m.

Mean total spread about the mean value for all "fair weather days".	60volts
Mean total spread about the mean value in Polar "fair weather days".	70volts
Mean total spread about the mean value in Gulf-Marit. "fair weather days".	37volts

These low electric potential values might be explained as being due to an almost year-long high conductivity of the air, caused by the great ambient humidity. Only in winter, during strong invasions of the Polar air, does the relative humidity decrease appreciably. Nevertheless, even during these days of a drier atmosphere, the readings obtained were nothing but moderate.

The crucial problem is to find out if the increased (Gulf-Maritime air conditions) or the decreased (Polar air conditions) conductivity of the air at Loyola station is always a function of a very thin layer close to the ground, or if it is due to different space charges, positive or negative. We are inclined to accept the latter explanation.

The natural radio activity of the soil at Loyola Station should be very small. The alluvium is several hundred feet thick and the underground water level is at a depth of a few feet. No outcrops of rocks are to be found in the New Orleans region.

We might add that very great care was taken in checking the accuracy of the Keithley electrometer used for the recordings.

Notwithstanding all these remarks, we hope that the following distressing words of Watson do not apply to Loyola station. "The absolute value of potential gradient is difficult and in many places perhaps impossible to determine"(14).

Pierce had something similar to state in 1958. "The distribution of ionization, particularly in the bottom meter of the atmosphere, will be steadily changing. 1944 is indeed perhaps the last year that may be considered as representing stable conditions of ionization in the atmosphere". (15).

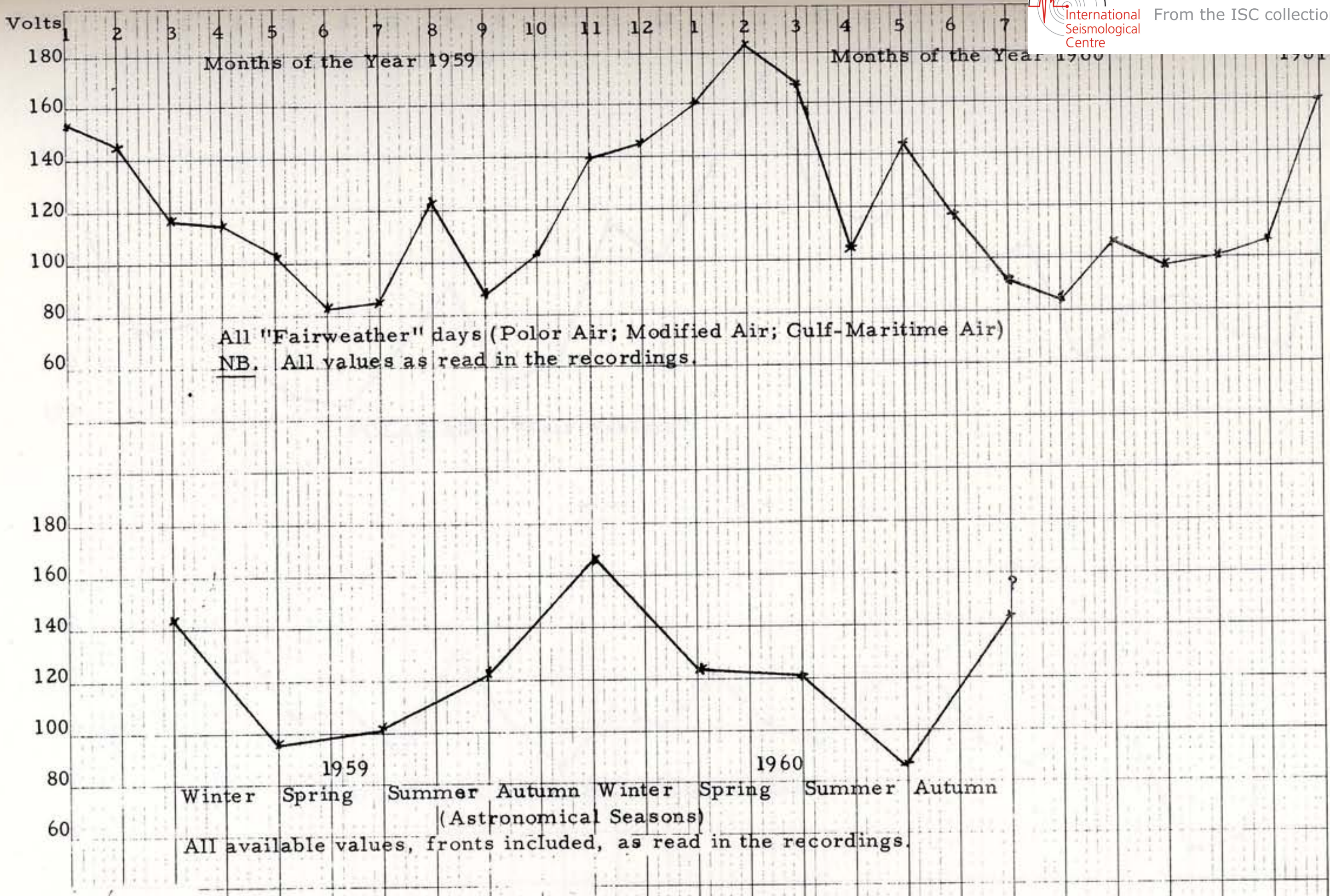

PLATE I. Electric Potential of the Air at Loyola University, New Orleans, La.

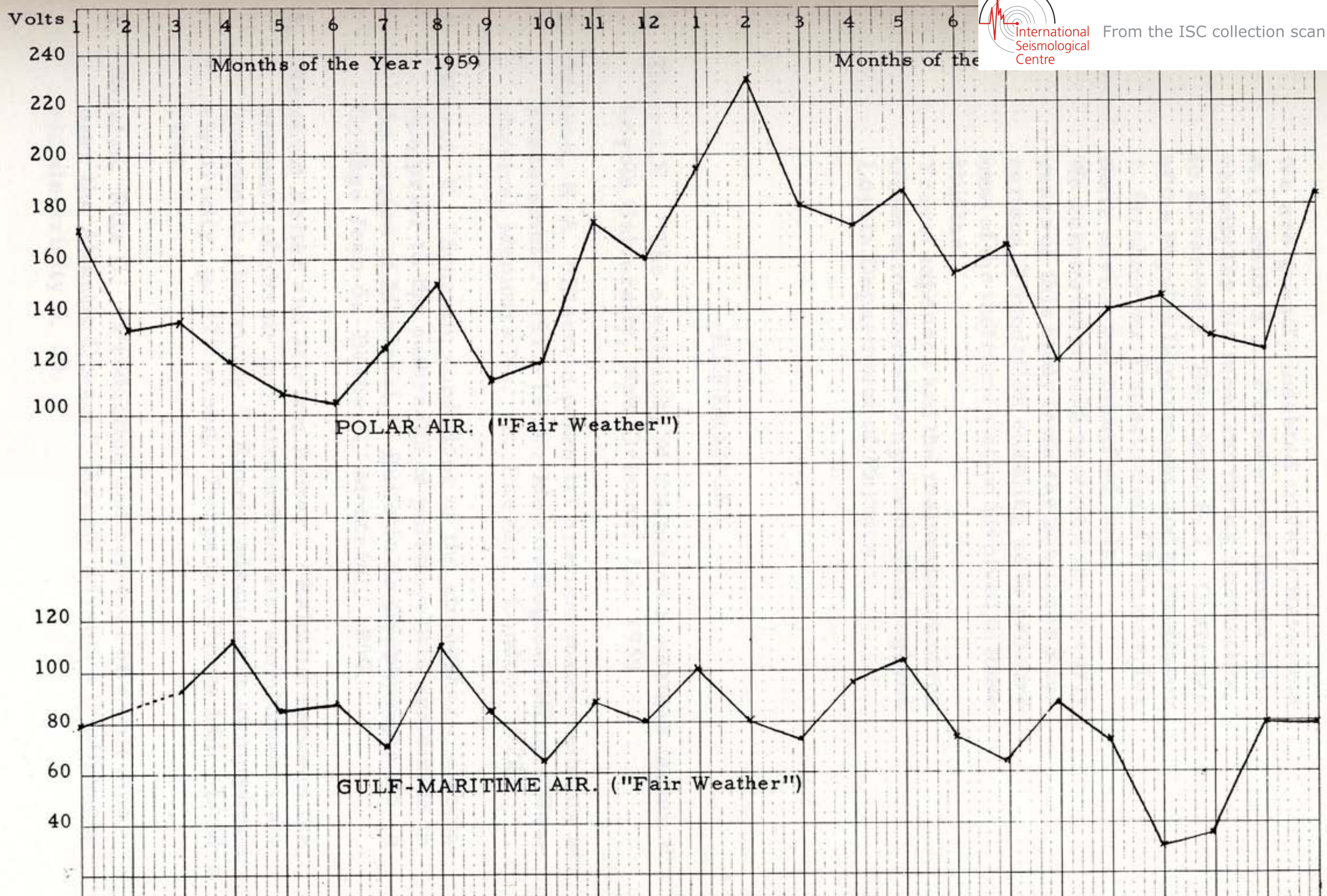

PLATE II. Electric Potential of the Air at Loyola University, New Orleans, La.

N. B. All values as read in the recordings.

ACKNOWLEDGMENTS

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We acknowledge help received in the-early years of this study from the Schlieder Educational Foundation enabling us to procure most of the instrumentation involved in these studies.

Travel expenses and the maintenance of the Observatory have been provided through the Loyola Department of Physics.

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GEOMAGNETIC STORMS AND 500 MB TROUGH BEHAVIOR*

By

Paul F. Twitchell**
Office of Naval Research
Boston Branch Office

RESUME

Le but de ce travail est de sonder l'hypothèse selon laquelle les variations solaires sont reliées aux changements d'aspects de la circulation de la basse atmosphère ou de la troposphère. On passe brièvement en revue les recherches récentes sur la corrélation entre les données géomagnétiques et la circulation troposphérique à grande échelle. Les tempêtes magnétiques furent acceptées comme indices d'invasion de l'atmosphère terrestre par les corpuscules solaires et l'intensité des couloirs dépressionnaires en mouvement à 500 mb couvrant l'hémisphère nord a servi de mesure quotidienne à la circulation troposphérique. On a remarqué une intensification des couloirs à 500 mb, environ 7 jours et aussi 14 jours après le début brusque des tempêtes magnétiques.

On conclut que des recherches plus poussées sont justifiables, puisqu'il a quelqu'évidence de corrélation entre les émissions solaires observées et la circulation troposphérique.

* This report is based upon research work performed at Melpar and is in part a synopsis of the author's Masters thesis in geophysics submitted to the Department of Geophysics, Boston College.

** Formerly with Melpar, Inc., Applied Science Division.

ABSTRACT

The aim of this study is to investigate the hypothesis that solar variations are correlated to changes in the circulation patterns of the lower atmosphere or troposphere. A brief review of recent research directed toward correlating geomagnetic data to large-scale tropospheric circulation is presented. Sudden-commencement magnetic storms were designated as indices of solar corpuscular invasion of the earth's atmosphere and the intensity of moving 500 mb troughs circumventing the northern hemisphere was indexed daily as a measure of tropospheric circulation. An increase in the 500 mb trough index was noted at approximately seven and again at fourteen days following sudden-commencement magnetic storms.

It is concluded that further research is warranted as there is some evidence that detected solar corpuscular emissions are related to tropospheric circulation.

INTRODUCTION

Many studies have been published concerning the relationship of solar activity and weather parameters, but generally, the publications of the last decade only are important to the limited investigation to which this report is restricted. This is in part due to an early emphasis on sunspot numbers and in part due to the lack of knowledge of atmospheric behavior. More recent studies include Craig's (1) analyses of the average surface pressure variations after geomagnetically disturbed and geomagnetically quiet days for a latitude belt 30° to 70° around the northern hemisphere. A rather consistent negative correlation between pressure variations following both magnetically quiet and disturbed days were noted by Craig. Shapiro (8) attacked the problem by describing the pressure pattern by orthogonal polynomials then correlating the individual polynomials to a magnetic index. (11) The polynomial, which indirectly represents the north-south wind gradient, was shown to be correlated to selected magnetic key days over the North American Continent and Western Atlantic Ocean.

About the same time (1956) that Shapiro and his group at Air Force Cambridge Research Laboratories were running their computer programs, J. London (5) and his group at New York University were investigating the possible correlation between strong magnetic disturbances and days of solar flares to subsequent changes in 100 millibar (mb) zonal winds. For the limited geographical area considered they reported no significant correlation.

In 1958 Lethbridge (2) reported her findings on research directed toward the study of the relation of solar energy variations to changes in tropospheric circulations. This study, carried out at Pennsylvania State University, consisted of several separate applications of spectrum analysis and superposed epoch analysis to solar weather relations. In the eastern half of the northern hemisphere, the analysis of the zonal index showed a 27-day peak related presumably to the 27-day recurrence of magnetic storms. An analysis of the cosmic ray neutron count was reported to show considerable coherence with the zonal index at 500 mb's at 60°N latitude. This finding and the relation of polar vortex breakdowns at 100 mb several days after a magnetic storm may be important clues to the study of solar-terrestrial relationships.

By 1959, a group at High Altitude Observatory, Boulder, Colorado, began to publish (12) results of their research concerning the relationship between magnetic storms and 300 mb flow characteristics. MacDonald and Roberts (6) reported that 300 mb troughs passing over the western-northern hemisphere deepened significantly several days after a sudden-commencement magnetic storm or the sighting of a bright aurora. The work of MacDonald and Roberts is an important scientific contribution which, if proven correct, could have many ramifications. An obvious practical application would be its use as an aid to upper air forecasts for several days in advance; but more important, if the relationship shown by MacDonald and Roberts is substantiated, then a basis for further research on solar-terrestrial mechanisms will be established.

The Problem of Indices

On a world-wide basis there are several geomagnetic indices available. Most involve considerable subjective interpretation at each observatory. The one possible exception is the onset time of a sudden-commencement magnetic storm which, if recorded at an observatory, cannot be changed substantially by subjective interpretation.

Actually, there is no index which accurately indicates the corpuscular or electromagnetic radiation received at the earth's surface or in the earth's atmosphere. Electromagnetic radiation from the sun has been estimated from solar flares and coronal temperatures, but the presence of corpuscular radiation is more easily determined from geomagnetic records than electromagnetic radiation is from estimates of coronal temperatures. Specifically, it was decided that sudden-commencement magnetic storm observations are the simplest indication of corpuscular radiation impinging upon the earth's magnetic field.

A meaningful index of tropospheric weather which would reflect an extraterrestrial source of perturbation must somehow describe large scale circulation patterns.

There are available zonal index data for middle latitudes depicting the over-all atmospheric behavior at the level for which they are generated. Some of the zonal index data are presented in averages of a few days duration. For the ultimate aim of determining whether short term variations of solar activity is correlated to tropospheric weather, such indices were not considered. Atmospheric circulation indices based on the flow across a fixed longitude were also discarded on the premise that they would suffer the same disadvantages as those indices based upon surface weather parameters measured at a fixed geographic location. The reason for discarding these indices is that there is no assurance that topography may not introduce bias into the data. Other techniques for describing the circulation in the atmosphere were considered. For example, variations of the zonal index determined by measuring the length of a selected contour height circumscribing the northern hemisphere was afforded serious study but was eliminated primarily due to the difficulty in readily obtaining this index. For simplicity, physical significance, and uniqueness it was decided that a trough indexing technique reported by Woodbridge et al (12) would be best suited for this study; and this will be described in the next paragraph.

The Design of an Experiment

An important step in a geophysical study is the selection of representative data to insure that throughout the investigation the data remains meaningful. It is believed that the index methods selected for use in this investigation preserve physical meaning. Since the atmospheric circulation indices were manually computed, great care was exercised in the initial selection of meteorological data. The data selection, acquisition and the generation of the indices were accomplished while the author was on the staff of the Applied Science Division of Melpar, Incorporated. The cost of the research at that time was under-written by Melpar's in-house research program. This section, describing the data sample and procedure for computing the indices, is based upon a portion of a Melpar, Incorporated report (10) prepared by this author.

The majority of previous attempts to correlate atmospheric circulation characteristics and magnetic field disturbance data have been restricted to using atmospheric data from a geographical area. Therefore, an early decision was made to carry out this program employing data circumventing the entire northern hemisphere and to select a time period for which no previous investigations of this nature had been published. Contributing to the selection of the winter of 1960-1961 for this study were the many solar and geophysical phenomena of interest which occurred during the period of November 12 to November 20, 1960 and to a lesser extent in early February.

To gain scientific knowledge about atmospheric circulation and its correlation to solar corpuscular emissions detected by magnetic observatories, it is necessary to employ a technique for quantitatively describing the circulation characteristics of some fixed level in the troposphere. For practical and dynamic reasons the 500 millibar (mb) level was determined to be a good level for use in this study. This level is found about 18,000 feet above mean sea level, which is a useful altitude for determining wind flow for routine commercial air traffic purposes. It is a level for which meteorologists have devised many empirical rules for forecasting. In addition, dynamically the 500 mb is the standard chart level which is closest to a level of non-divergence in the lower atmosphere; and, as a result, this is a popular level upon which to base dynamic or numerical weather prediction techniques. Finally, the 500 mb level was selected because in previous studies an attempt to correlate magnetic storms to circulation parameters at 100 mb (53,000 feet) and 300 mb (30,000) feet has been reported in the literature, (5, 7, 11)

With the time period and data level determined, ozalid copies of the 500 mb northern hemisphere charts were ordered for October 1960 through March 1961 from the National Weather Analysis Center (NWAC).

The acquisition of magnetic data was also straightforward. A list of key magnetic days and days of bright aurora was independently selected and forwarded to the author from the National Bureau of Standards, Boulder, Colorado. These data were supplemented by the published (3, 4) geomagnetic data. In addition, magnetic data in digital and graphical form from Weston Observatory, Weston Massachusetts were available.

The objectives of this investigation can be reached with little or no additional effort in preparing magnetic or meteorological data. The key days were selected from a list of those days when a sudden-commencement magnetic storm was observed at ten or more observatories. The days satisfying the criteria for key days are presented in Table I.

To correlate atmospheric circulation it was necessary to perform several tasks to convert the meteorological data into a digital form. It will be useful to describe here the operations required to obtain a quantitative index of atmospheric circulation and a description of the tabulated data.

The first operation in reducing the information contained on the 500 mb charts is to label selected moving troughs. For the purpose of this study the middle latitudes from about 25°N to about the Artic circle were established as the area of interest. Approximately 160 troughs were labeled from October 1960 through March 1961 of which nearly 50 per cent satisfied the criteria established for indexing.

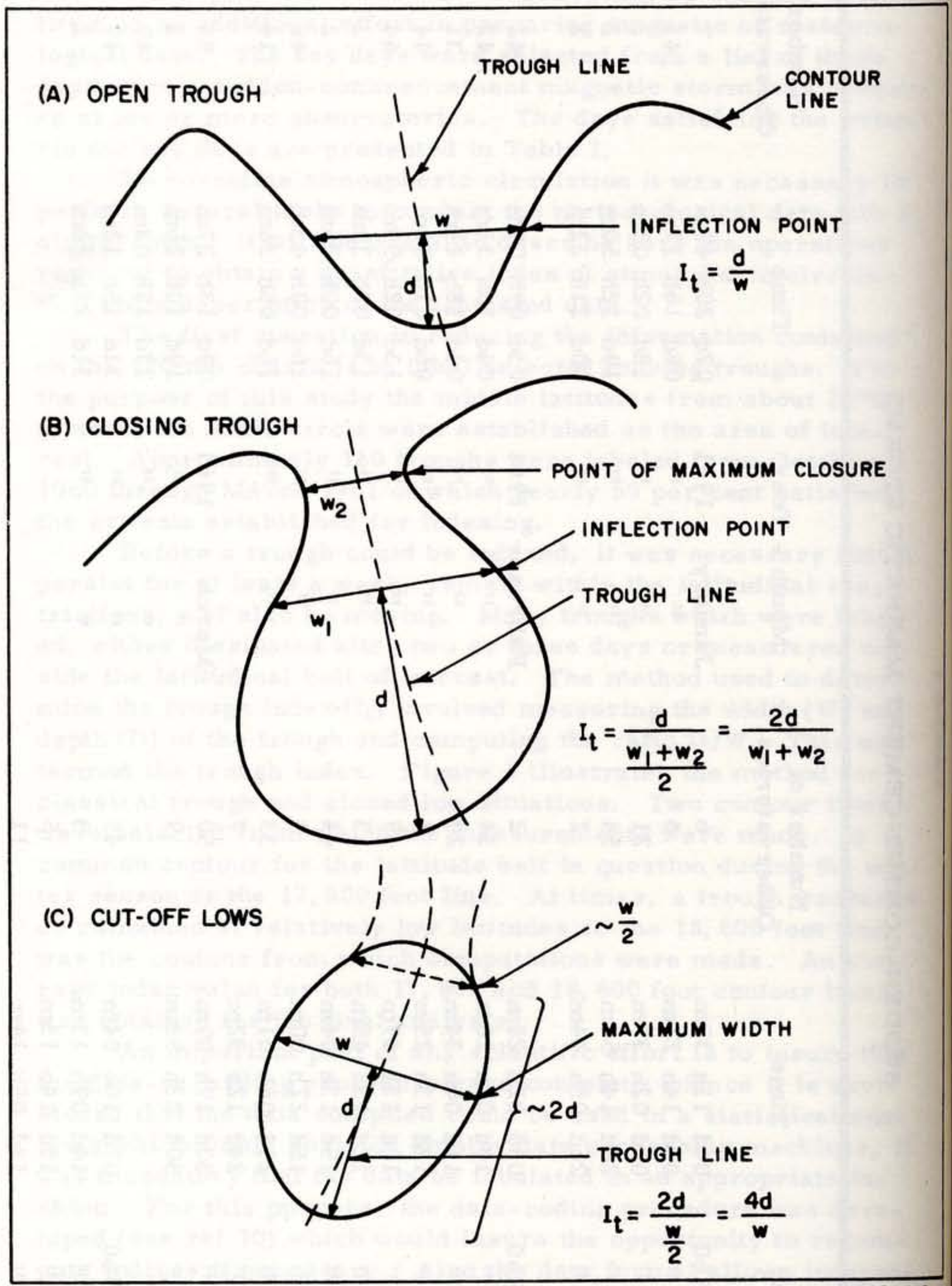
Before a trough could be indexed, it was necessary that it persist for at least a week, remain within the latitudinal restrictions, and also be moving. Many troughs which were labeled, either dissipated after two or three days or meandered outside the latitudinal belt of interest. The method used to determine the trough index (I_t) involved measuring the width (W) and depth (D) of the trough and computing the ratio D/W. This was termed the trough index. Figure 1 illustrates the method for classical trough and closed low situations. Two contour lines were selected from which the measurements were made. A common contour for the lattitude belt in question during the winter season is the 17,800 foot line. At times, a trough weakened or remained at relatively low latitudes so the 18,600 foot line was the contour from which computations were made. An average index value for both 17,800 and 18,600 foot contour lines was obtained for the final analysis.

An important part of any scientific effort is to insure that the data-recording procedures are complete. Since it is envisioned that the data compiled could be used in a statistical analysis which would possibly employ data processing machines, it was mandatory that the data be tabulated in an appropriate fashion. For this purpose, the data-coding procedure was developed (see ref 10) which would insure the opportunity to recompute indices if necessary. Also the data format allows independent studies of the relations of W and D. This is important as it is felt that the value of D is a good indication of wave amplitude and W could assist in determining the wave number.

TABLE I

SUDDEN-COMMENCEMENT MAGNETIC STORMS

Month - Year		Time	Number of Observatories
October	1960	04d 11h 32m	6
"	"	04d 14h 27m	8
"	"	06d 02h 37m	21
"	"	24d 14h 52m	54
"	"	26d 05h 44m	2
November	1960	03d 22h 28m	2
"	"	10d 07h 18m	34
"	"	11d 00h 34m	23
"	"	12d 13h 25m	8
"	"	12d 13h 49m	49
"	"	12d 18h 45m	3
"	"	15d 13h 04m	44
"	"	15d 22h 00m	4
"	"	21d 06h 31m	33
"	"	24d 12h 32m	7
"	"	30d 19h 09m	50
"	"	30d 23h 58m	9
December	1960	07d 18h 04m	45
"	"	14d 09h 13m	3
"	"	15d 14h 13m	5
"	"	18d 05h 14m	11
"	"	25d 20h 02m	43
"	"	27d 05h 10m	3
January	1961	07d 20h 49m	7
"	"	08d 16h 17m	41
"	"	18d 02h 00m	2
"	"	19d 12h 50m	2
"	"	30d 21h 22m	2
February	1961	03d 09h 08m	41
"	"	04d 13h 31m	42
"	"	04d 18h 29m	31
"	"	06d 01h 06m	44
"	"	13d 02h 53m	44
"	"	13d 07h 39m	2
"	"	16d 00h 26m	2
"	"	16d 00h 43m	46
"	"	16d 05h 36m	14
March	1961	09d 13h 27m	55
"	"	19d 10h 26m	2
"	"	27d 15h 03m	49
"	"	31d 15h 12m	49
"	"	31d 23h 24m	2



after WOODBRIDGE

FIGURE 1. Method Used to Determine I_t; Final I_t was Obtained by Averaging the Calculations Using the 17,800 ft. and the 18,600 ft. Contours

Discussio

The data sample of 1875 trough indices in itself represents a result from which many correlation efforts could be fostered. The purpose of this study is to determine if solar corpuscular emissions impinging on the earth have any effect upon the circulation of the atmosphere. For this investigation it has been decided that the observance of a sudden-commencement magnetic storm will signal the arrival of a corpuscular impingement on the atmosphere and will be termed a "key" day. A simple procedure for relating the behavior of troughs following a key day is to plot their index against time following the key day as shown in Figure 2. This can be done individually, then averaged; or if automatic processing is deemed economical, then such a graph could be generated by a machine. Regardless of how the data is presented the results would be of little value until the statistical significance of the relationship shown is tested.

A number of studies could be designed to relate the data compiled for this investigation. Some, like the one discussed above, are conceptually very simple and may in themselves be sufficient to justify further research. However, other analysis techniques can be applied to these data to determine the behavior of certain types of troughs, for example, weak, medium or strong. Also selected geographical areas could be designated as test areas and studied in detail. Possibly more sophisticated analysis techniques could be applied to reveal characteristics of the data not shown by simpler approaches.

Table II lists the data and hour of sudden-commencement magnetic storms selected as key days. This is a considerably shorter list than presented in Table I as it was thought that a rapid succession of magnetic storms would introduce more information than desired for this study. To ascertain a correlation between sudden-commencement magnetic storms and trough indices, it was initially decided to select only those magnetic storms which were not preceeded or followed by another sudden commencement within at least ten days. A rapid scanning of Table I will demonstrate the non-feasibility of such stringent restrictions. A review of all the magnetic data for the six-month period led to the compromise of selecting as key days the last magnetic storm of a series, provided it was not followed within five days by another magnetic disturbance. Five of the eight storms listed in Table II satisfy the above criteria; the remaining three were relatively isolated sudden-commencement storms. The dates of the isolated magnetic disturbances

TABLE II

Sudden-Commencement Magnetic Storms selected as "key" days

Month	Year	Time
October	1960	06d 02h 37m
October	1960	24d 14h 52m
November	1960	15d 13h 04m
December	1960	18d 05h 14m
January	1961	08d 16h 17m
February	1961	06d 01h 06m
February	1961	16d 00h 43m
March	1961	09d 13h 27m

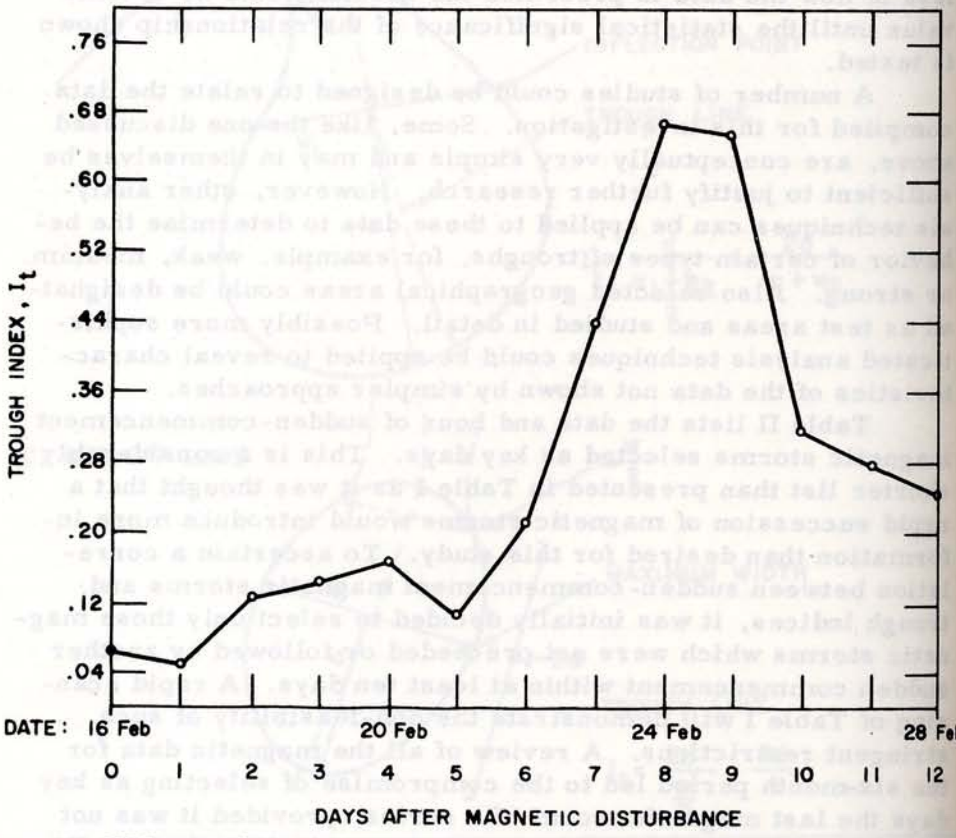


FIGURE 2. Trough 120 intensity for the Period Following the Sudden Commencement Magnetic Storm of February 1961.

would be the best key days for the purpose of this study, however, any relationship noted by using only three key days would be of questionable statistical significance.

With the selection of key days, the index value for the key day and subsequent 15 days were tabulated for troughs in existence at the time of the magnetic storm or developed during the 15 days which followed. Figure 3 is a curve representing the average behavior of all indexed northern hemisphere troughs following the key days listed in Table II.

The increase in the trough index peaking on the 7th day suggests an increase in meridional flow or trough deepening following a magnetic storm. This finding is in general agreement with Shapiro (8), MacDonald and Roberts. (6) Further, concerning the breakdown in the polar vortex at 100 mb, this finding agrees with the work of Lethbridge et al. (2) The secondary peak at ten days does not appear to agree with any previous work; however, the peak on the 14th day agrees with the findings of Shapiro.

The trough data were subdivided into those troughs passing over the western-northern hemisphere. Figure 4 presents the average trough index of 25 troughs passing over the eastern-northern hemisphere following the eight selected sudden-commencement magnetic storms. Again a general agreement with previous work is evident with the 14-day rise being more pronounced and with the peak at 7 days broadened to a double peak on 6 and 8 days. The rise on the fourth day is not as pronounced and the 10-day peak noted in Figure 3 is not in evidence.

Since the work of MacDonald and Roberts was limited to the western-northern hemisphere and the trough indexing technique was patterned after their work, the results shown by Figure 5 are of particular interest. The saw-toothed heavy curve depicting average trough index characteristics for 38 troughs again shows increases in trough index on the days which previous investigators have noted, with exception of the pronounced rise on the 10th day.

The results of Figure 5 precipitated some further investigation. First a closer look at the key days employed for this study reveal some definite shortcomings. Figure 6 demonstrates at least one source of "noise" in the data employed. Here the fluctuations of the index of a single trough are shown for a period when considerable magnetic activity was taking place. If the storm of 12 November was selected as a key day a sharp rise in the trough index would be noted 8 days later. For the storm of 15 November this same rise occurs 5 days later. It can be speculated that the rise shown on 2 December could be attributed to storm D or possibly a delayed effect of storm B.

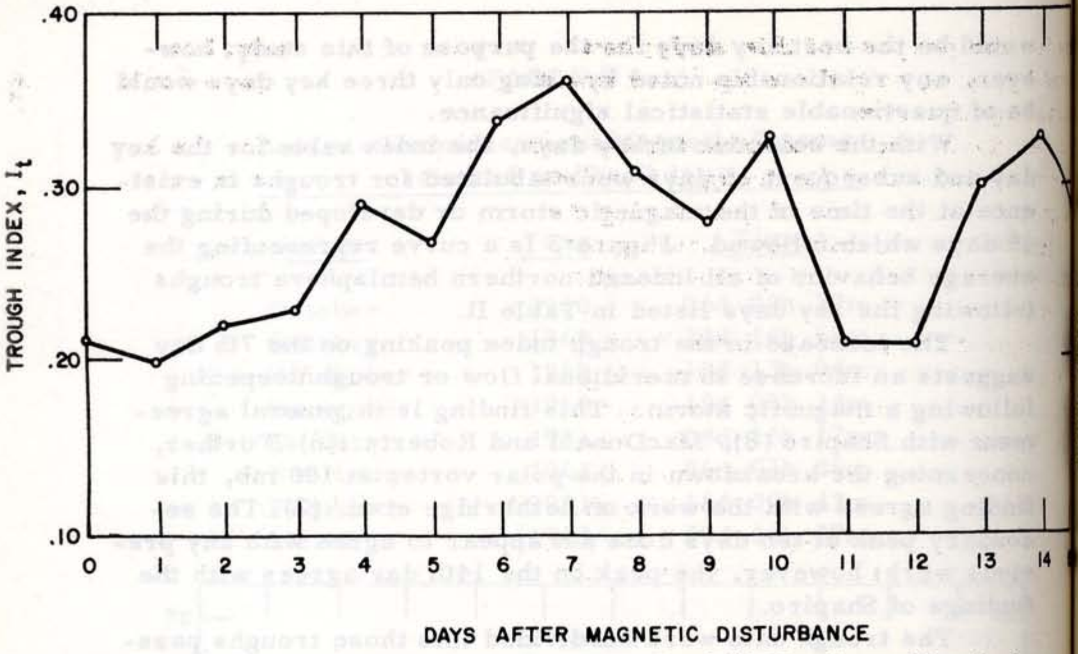


FIGURE 3. Average Trough Index, I_t of 63 Northern Hemisphere Troughs Following Sudden Commencement Magnetic Storms Listed in Table 2.

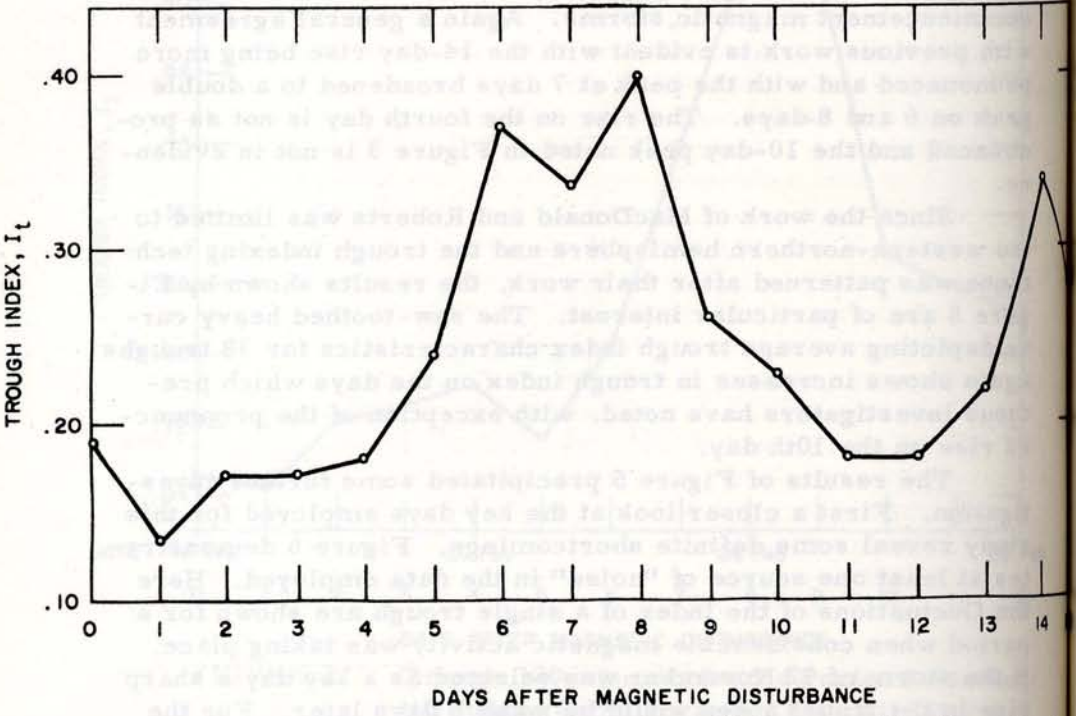


FIGURE 4. Average Trough Index, I_t of 25 Eastern Northern Hemisphere Troughs Following Sudden Commencement Magne Storms Listed in Table 2

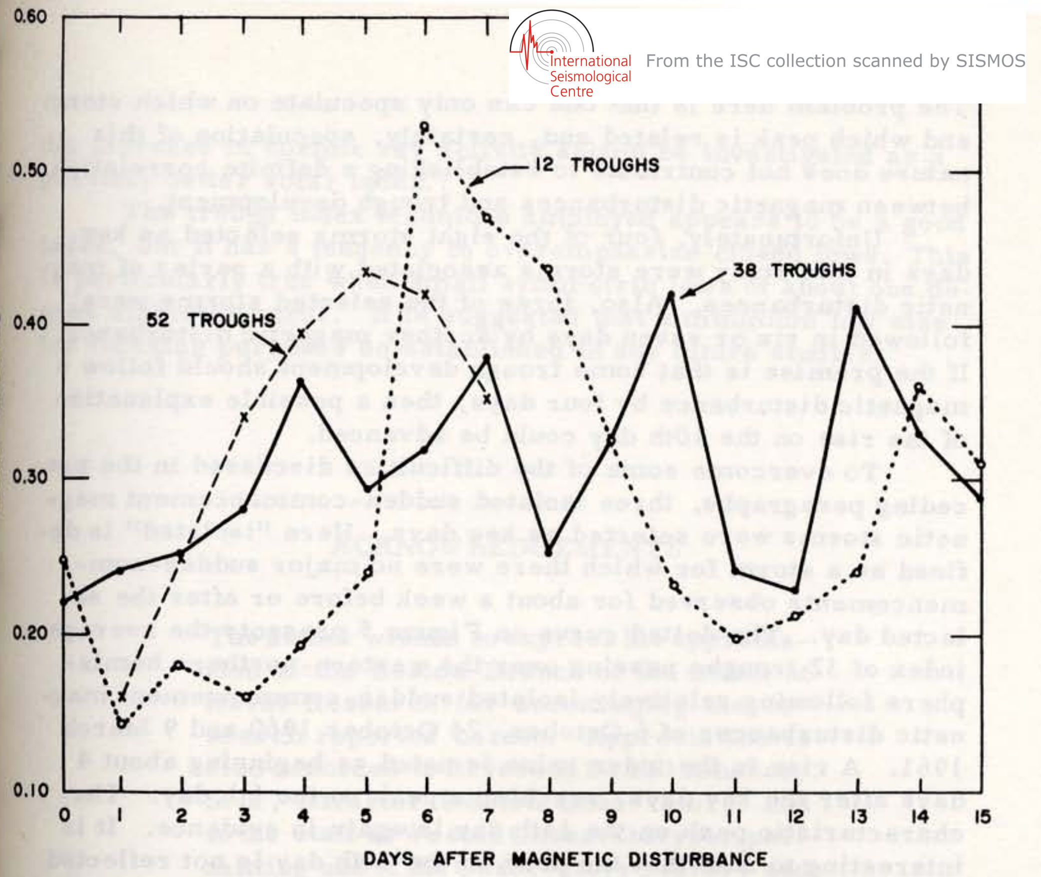


FIGURE 5. Average Trough Index, I_t of 38 Western Northern Hemisphere Troughs Following Sudden Commencement Magnetic Storm Listed in Table 2, Dashed Curve after Macdonald and Roberts. Dotted Curve for Troughs Following Isolated Magnetic Disturbance, (See Text).

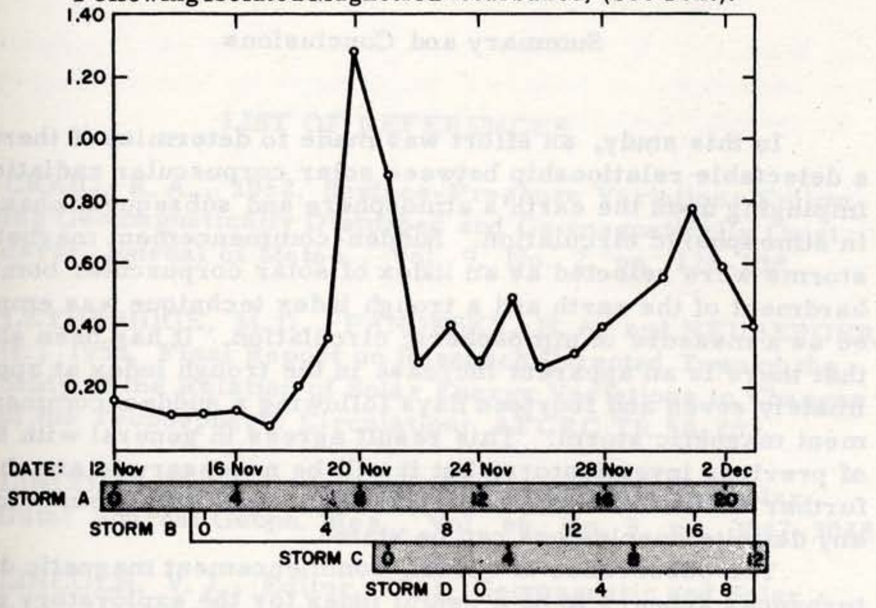


FIGURE 6. Trough 056 Intensity for the Period Following Magnetic Disturbances of 12 Nov(Storm A), 15 Nov(Storm B), 21 Nov(Storm C) and 24 Nov(Storm D).

The problem here is that one can only speculate on which storm and which peak is related and, certainly, speculation of this nature does not contribute to establishing a definite correlation between magnetic disturbances and trough development.

Unfortunately, four of the eight storms selected as key days in this study were storms associated with a series of magnetic disturbances. Also, three of the selected storms were followed in six or seven days by another magnetic disturbance. If the premise is that some trough development should follow a magnetic disturbance by four days, then a possible explanation of the rise on the 10th day could be advanced.

To overcome some of the difficulties discussed in the preceding paragraphs, three isolated sudden-commencement magnetic storms were selected as key days. Here "isolated" is defined as a storm for which there were no major sudden-commencements observed for about a week before or after the selected day. The dotted curve on Figure 5 presents the average index of 12 troughs passing over the western-northern hemisphere following relatively isolated sudden-commencement magnetic disturbances of 6 October, 24 October 1960 and 9 March 1961. A rise in the index value is noted as beginning about 4 days after the key days, reaching a peak on the 6th day. The characteristic peak on the 14th day is again in evidence. It is interesting to note that the peak on the 10th day is not reflected and this fact may give some credence to the hypothesis advanced in the preceding paragraph.

Summary and Conclusions

In this study, an effort was made to determine if there is a detectable relationship between solar corpuscular radiation impinging upon the earth's atmosphere and subsequent changes in atmospheric circulation. Sudden-commencement magnetic storms were selected as an index of solar corpuscular bombardment of the earth and a trough index technique was employed as a measure of atmospheric circulation. It has been shown that there is an apparent increase in the trough index at approximately seven and fourteen days following a sudden-commencement magnetic storm. This result agrees in general with that of previous investigators, but it will be necessary to attach further statistical basis to the findings reported herein before any definite conclusions can be stated.

The observance of sudden-commencement magnetic disturbances appears to be a useful index for the exploratory purposes of this study; however, solar variations as detected by the increase in cosmic ray activity should be investigated as a possibly better solar index.

The trough index technique employed appears to be a good index, but it has a tendency to overemphasize closed lows. This is particularly true when small symmetric lows of about one degree diameter occur. It is suggested that a minimum low size for indexing purposes be established in any future studies.

ACKNOWLEDGEMENTS

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RADIATION SOLAIRE A MONTREAL

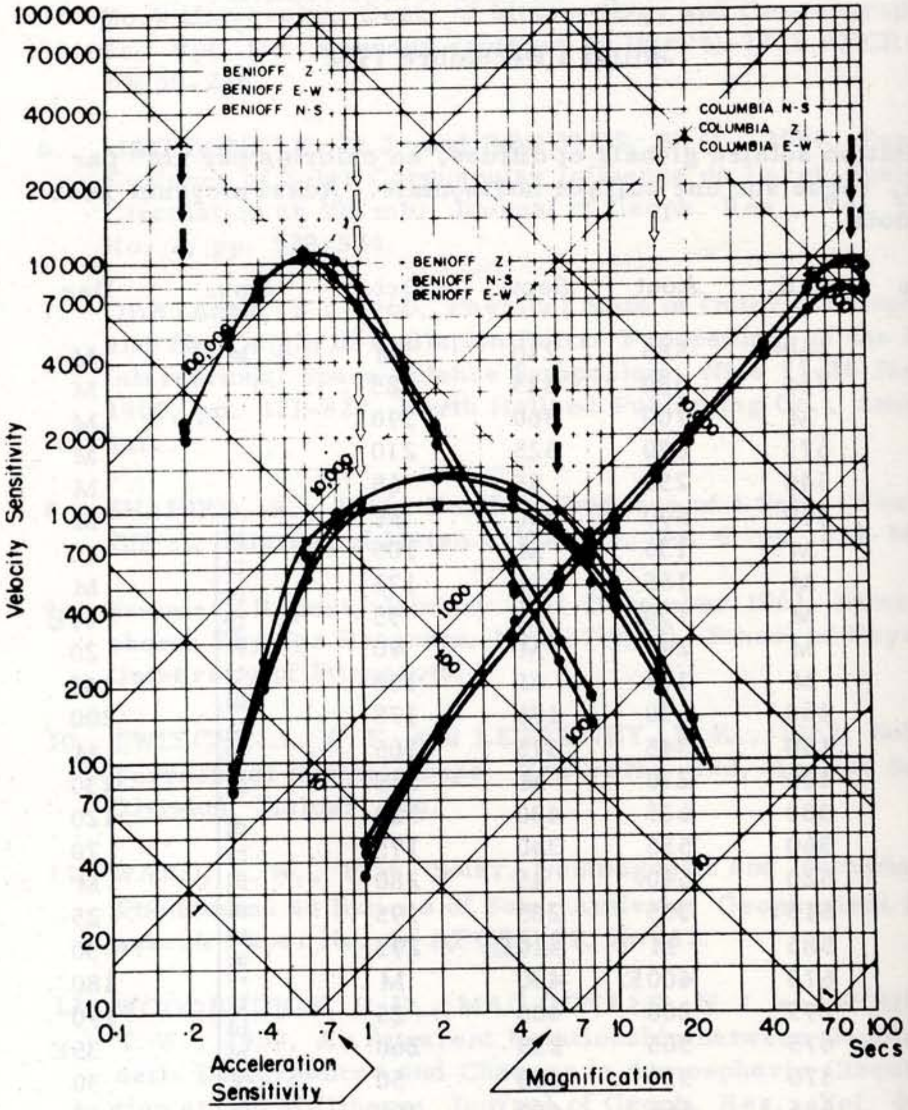
Juillet à Décembre 1962

Radiation solaire globale et diffuse, en calories par cm^2 par jour, reçue sur une surface horizontale. Aussi moyenne pour le mois.

Date	Juil.	Aout	Sept.	Oct.	Nov.	Dec.
1	660	585	210	M	M	M
2	765	680	525	425		M
3	M	700	560	390		M
4	675	620	525	210		M
5	540	250	55	65		M
6	490	590	540	M		M
7	M	135	M	105	ENREGISTREUR DEFECTUEUX	70
8	M	155	M	175		M
9	M	130	M	55		40E
10	M	245	M	90		20
11	M	155	M	135		140
12	460	640	175	175		200
13	130	345	375	365		M
14	300	230	M	355		130
15	380	635	430	320		120
16	360	555	340	175		70
17	520	540	45	280		M
18	515	355	235	195		25
19	585	M	410E	295		30
20	670	400E	430	M		180
21	295	200	400	25		190
22	675	565	235	260		35E
23	370	530	480	50		30
24	685	555	450	205		180
25	490	615	75	275		155
26	335	605	35	120		165
27	210	525	310	M		170
28	620	270	115	15		125
29	270	470	30	255		45
30	595	590	130	65	M	105
31	385	565		45		M
Moyenne	479	448	296	190	M	106

M: enregistrement manqué.

STATION : MONTREAL



φ = 45°30'09"N λ = 73°37'23"W Altitude 112M

Foundation : Ordovician Limestone (Trenton)

T_s ⇧ T_g ⬆

Date of Calibration: March - April 1962

BENIOFF'S		BENIOFF'S		COLUMBIA'S	
S.P. -Z.	Apr. 4	I.P. -Z.	Apr. 4	L.P. -Z.	Mar. 29
S.P.H. -N.S.	Apr. 4	I.P.H. -N.S.	Apr. 4	L.P.H. -N.S.	Mar. 29
S.P.H. -E.W.	Apr. 5	I.P.H. -E.W.	Apr. 5	L.P.H. -E.W.	Mar. 30

BULLETIN SEISMOLOGIQUE

INSTRUMENTS DE LA STATION

3 séismographes Benioff de 100 kg. avec 6 galvanomètres.
t_o=1 sec. t_g=0.2 sec. pour ZNE. Enregistreur, 60 mm/min.
t_g=6 sec. pour Z'N'E'. Enregistreur, 30 mm/min.
3 séismographes Sprengnether, type Columbia Z"N"E".
t_o=17 sec. t_g=100 sec. pour Z"N"E". Enregistreur, 15mm/min.

Pour les autres caractéristiques, cf. graphique.

Dans notre Bulletin, nous indiquons toujours sur quel séismogramme chaque phase a été lue en ajoutant après cette phase une des lettres suivantes: ZNE pour les séismogrammes de 0.2 sec. Z'N'E' pour ceux de 6 sec. et Z"N"E" pour ceux de 100 sec.

L'heure est inscrite à chaque minute sur les séismogrammes par la Société Radio-Canada au moyen d'une ligne téléphonique avec une précision de ±0.1 sec. à l'année. Cette Société nous fournit en même temps un courant alternatif de 60 cycles, de fréquence absolument constante pour les moteurs des enregistreurs. De plus le signal horaire de l'Observatoire du Dominion relayé par le poste local de radio CBF, à 01.00 p.m. s'enregistre automatiquement sur tous les séismogrammes.

Les positions géographiques des épicentres ainsi que l'heure d'origine et la profondeur sont toujours empreuntées à U.S.C.G.S. pour les séismes éloignés. Pour les locaux, ces données nous sont fournies par l'Observatoire du Dominion, et cela est indiqué chaque fois. Pour sauver de l'espace, nous ne mentionnons pas U.S.C.G.S. à chaque séisme.

Nous indiquons aussi quelques fois, après une phase, sur la ligne suivante, la période de l'onde du sol et son amplitude en microns.

Nous tenons à exprimer publiquement notre reconnaissance à l'Observatoire du Dominion qui envoie chaque année ses techniciens refaire l'étalonnage complet de tous les séismographes et pour toute la gamme des fréquences, par la méthode de Willmore.

M. Buist, S. J.

DU 1 JUILLET au 31 DECEMBRE 1962

2 juil. 10.3 S., 165.9 E.
Santa Cruz Isl.

h	about 50 km.		
H	08	32	37.9
iP'Z	08	51	18.7 d

3 juil. 54.6 S., 132.3 W.
S. Pacific Ocean

h	about 25 km.		
H	18	22	06.3
ePPZ"	18	41	26
ePSN"		50	48
eSSE"			57.0
eSSSE"	19		01.0

4 juil. 6 enregistrements d'ondes longues tous pareils entre 08 h. 10 et 09.59

1er	eLZ"	08	10.1
2e	eLZ"	08	56.0
3e	eLZ"	09	04.5
4e	eLZ"	09	14.8
5e	eLZ"	09	26.4
6e	eLZ"	09	58.8

4 juil 54.5 N., 36.7 W.
About 500 miles S. of Greenland

h	about 25 km.		
H	07	57	45.3
e(P)Z	08	03	31

5 juil 2 enregistrements d'ondes longues pareils à ceux du 4 juillet

1er	eLZ"	05	51.3
2e	eLZ"	06	14.5

5 juil 30.9 N., 141.4 E.
S. of Honshu, Japan

h	about 23 km.		
H	17	40	55.3
eLZ"	18	29.5	

5 juil. 23.5 N., 107.8 W.
Off Coast of Sinaloa, Mexico

h	about 25 km.		
H	20	49	23.8
eLZ"	21	10.4	

6 juil. 13.3 N., 58.0 E.
Arabian Sea E. of Socotra

h	about 30 km.		
H	02	12	19.9
eLZ"	03	04.2	

6 juil. 38.0 N., 20.2 E.
Ionian Sea

h	about 30 km.		
H	09	16	15.0
iPZ	09	27	01" ± 2"

6 juil. 60.3 N., 152.1 W.
Kenai, Penin. Alaska

h	about 67 km.		
H	18	40	59.4
iPZ	18	49	19.2 c

6 juil. 36.6 N., 70.4 E.
Hindu Kush

h	about 203 km.		
H	23	05	32.2
iPZ	23	18	19.7 c
ipPZ		19	14.5
isPZ			30
iPPZ		22	04.5
ipPPZ			49
iSKSN		28	20.5
iSKKSE'			35

7 juil 51.3 N., 178.6 E.
Rat Isl. Aleutian Isl

h	about 60 km.		
H	06	12	48.9
iPZ	06	23	24.1 d
ipPZ			38.0

7 juil. 51.9 N., 158.6 E.
Near S. coast of Kamchatka

h	about 33 km.		
H	21	20	57.7
iP	21	32	27.0 d

8 juil 14.4 S., 75.5 W.
Near coast of S. Peru

h	about 88 km.		
H	02	25	55.8
ePZ	02	35	52.5

8 juil. 51.5 N., 178.5 W.
Rat Isl. Aleutian Isl.

h	about 60 km.		
H	03	22	03.8
ePZ	03	32	38.7

8 juil. 26 S., 78.0 W.
Ecuador

h	about 21 km.		
H	05	29	12.0
ePZ	05	38	33

8 juil. 8.1 N., 38.0 W.
Mid-Atlantic Ocean

h	about 25 km.		
H	07	30	49.7
ePZ	07	39	31

9 juil. 44.0 N., 147.8 E.
Kurile Isl

h	about 66 km.		
H	13	53	00.0
eLZ"	15	09.5	

10 juil 6.5 S., 75.2 W.
Central Peru

h	about 46 km.		
H	19	21	36.9
iPZ	19	30	39.5 d

11 juil 31.8 N., 66.9 E.
Afghanistan

h	about 25 km.		
H	01	03	59.3
eLZ"	01	49	

11 juil. 53.2 N., 159.6 E.
Kamchatka

h	about 69 km.		
H	07	17	27.4
iPZ	07	28	43.1 d

11 juil eLZ" 16 16

11 juil. 3.9 S., 104.1 W.
S. Pacific Ocean

h	about 25 km.		
H	22	50	58.8
eSN"	23	08	33
eSSN"		12	14
eSSSN"		14	52

13 juil. 10.2 N., 121.7 E.
Panay, Philippines

h	about 157 km.		
H	03	32	12.6
iP'Z	03	50	50.5 c

13 juil. 56.2 N., 164.0 E.
Komandorski Isl. Region

h	about 59 km.		
H	22	19	23.3
ePZ	22	30	14.5

13 juil. 11.9 S., 71.1 W.
Peru

h	about 91 km.		
H	22	55	48.4
iPZ	23	05	28.4 d
ipPZ			55.0

14 juil. 51.5 N., 179.0 E.
Rat Isl. Aleutian Isl.

h	about 25 km.		
H	01	02	51.5
iPZ	01	13	28.4 d

14 juil. eLZ" 15 38

14 juil 40.3 N., 124.4 W.
N. California

h	about 25 km.		
H	19	43	52.6
ePZ	19	51	05 d
eSN"		56	50

14 juil.	16.9 N., 99.1 W.			
	S. Mexico			
	h	about 25 km.		
	H	20	23	14.6
	iPZ	20	30	12.8 d
14 juil.	50.2 N., 155.8 E.			
	Kurile Isl			
	h	about 60 km.		
	H	20	38	01.3
	ePZ	20	49	40.8 c
15 juil.	39.8 N., 140.9 E.			
	Honshu, Japan			
	h	about 103 km.		
	H	06	47	22.5
	iPZ	07	00	10.4
	ipPZ			36.0
	isPZ			45.0
	eSE"		10	50
	eE"		11	34
15 juil.	40.2 N., 142.4 E.			
	Honshu, Japan			
	h	about 55 km.		
	H	15	12	44.1
	ePZ	15	25	33.6
15 juil.	iPZ	19	47	38 c
16 juil.	52.1 S., 138.9 E.			
	S. of Tasmania			
	h	about 14 km.		
	H	02	04	52.6
	eLZ"	03	07	
16 juil.	11.2 S., 79.8 W.			
	Near coast of Peru			
	h	about 75 km.		
	H	04	49	21.5
	iPZ	04	58	59.0 d
	eSE"	05	06	52
	eLE"		13	
16 juil.	62.3 N., 153.1 W.			
	Alaska			
	h	about 39 km.		
	H	12	54	40.6
	iPZ	13	03	03.5 c
	ipPZ		04	18
	iPcPZ'			41
	iPPZ'			54
	eSE"		09	49
	ePSN"		10	03
	ePPSE"		10	08
	eSSE"		13	06
	iN"		13	36
17 juil.	11.6 N., 87.1 W.			
	Nicaragua			
	h	about 25 km.		
	H	04	12	45.4
	iPZ	04	19	43.0 d
	eLZ"		32	
17 juil.	43.0 S., 74.9 W.			
	Near coast of Chile			
	h	about 26 km.		
	H	05	32	08.8
	iPZ	05	44	57.9 d
	ePPZ"		48	28
	eSKSE"		55	44
	eSSN"	06	36	
	eLE"		08.2	
17 juil.	eN"	08	05.0	
	eLZ"		08.6	
17 juil.	14.8 N., 92.9 W.			
	Near coast of Guatemala & Mexico			
	h	about 120 km.		
	H	09	41	01.4
	iPZ	09	47	40.1 d
	eLZ"		57	
17 juil.	43.1 N., 144.5 E.			
	Hakkaido, Japan			
	h	about 30 km.		
	H	17	20	22.9
	iPZ	17	32	58.8 d
	pPZ		33	11.5
	eSKSN"		42	20
	eN"			40
	eSSN"		49.4	
	eLGN"		55	
18 juil.	9.6 S., 119.8 E.			
	Sumba Isl.			
	h.	about 68 km.		
	H	05	53	48.1
	eP'Z	06	13	09

18 juil.	e(P)Z	10	22	52
18 juil.	15.3 N., 148.1 E.			
	Mariana Isl. region			
	h	about 16 km.		
	H	10	10	12.7
	eP'Z	10	28	19
19 juil.	20.6 S., 68.7 W.			
	Near Bolivia and Chilean border			
	h	about 160 km.		
	H	12	02	31.3
	iPZ	12	13	03.4 d
	ipPZ			29.6
20 juil.	51.4 N., 173.6 W.			
	Fox Isl. Aleutian Isl.			
	h	about 25 km.		
	H	04	36	41.0
	iPZ	04	46	55.4 d
	eLE"	05	07.0	
20 juil.	39.5 N., 113.3 W.			
	Nevada			
	h	about 25 km.		
	H	09	02	08.3
	eLN"	09	19.6	
21 juil.	iPZ	14	25	09.0 c
22 juil.	5.9 S., 151.7 E.			
	New Britain region			
	h	about 81 km.		
	H	00	21	30.9
ou bien	3.2 S., 137.5 E.			
	Western New Guinea			
	h	about 104 km.		
	H	00	16	07.2
	eLZ"	01	24	
23 juil.	10.7 N., 86.5 W.			
	Off coast of Costa Rica			
	h	about 44 km.		
	H	01	12	52.6
	ePZ	01	19	55.0 c
	iPZ			56.6 d
	ipPZ		20	13.5
	eeSN"		25.9	
23 juil.	iPZ	06	12	19
23 juil.	22.9 S., 67.8 W.			
	N. Chile			
	h	about 193 km.		
	H	07	19	35.0
	iPZ	07	30	20.9 c
23 juil.	19.0 N., 65.1 W.			
	Virgin Isl.			
	h	about 25 km.		
	H	22	11	54.6
	ePZ	22	17	47.9 d
	iZ		18	19.5 d
	eSE		22	29
	iSE			47.0
	e(T)Z		27	21
23 juil.	10.4 N., 85.8 W.			
	Costa Rica			
	h	about 25 km.		
	H	03	59	14.4
	ePZ	04	06	18.6 c
	iPZ			19.0 d
	iZ			56
24 juil.	15.5 N., 92.5 W			
	Mexico-Guatemala border			
	h	about 129 km.		
	H	21	08	22.6
	iPZ	21	14	54.8 d
	ipPZ		15	18.8 c
	isPZ			28.6
	iPPZ		16	17.6
	eSE"		20	15
	eScRZ"		21	08
	iZ"		24	43
25 juil.	14.4 S., 76.1 W.			
	Near coast of S. Peru			
	h	about 46 km.		
	H	00	11	52.2
	ePZ	00	21	52.4
	ipPZ		22	08.4
25 juil.	18.9 N., 81.1 W.			
	W. of Jamaica			
	h	about 64 km.		
	H	04	37	50.7
	iPZ	04	43	32.1 d
	iZ			50.0
	ipPZ			54.5
	isPZ		44	06

iPPZ 25.0
iPPPE 44 36.7
iSE" 48 16
MZ" 54.0
20 sec 175 micr.

25 juil. 14.3 S., 75.5 W.
Near coast of S. Peru
h about 100 km.
H 06 05 15.9
ePZ 06 15 12.0

26 juil. 4.9 S., 81.3 W.
Off coast of N. Peru
h about 25 km.
H 02 33 15.3
iPZ 02 42 13.1 d

26 juil. 47.1 N., 153.9 E.
Kurile Isl.
h about 35 km.
H 04 23 11.9
iPZ 04 35 14.8 d

26 juil. 07.5 N., 82.7 W.
S. of Panama
h about 21 km.
H 08 14 41.8
iPZ 08 22 07.0 d
ipPN" 19
iPPN" 23 39
iPPPN 24 03
iPcPN" 24
iSN" 28 00
iPSN" 16
iPPS 39
32 sec 250 micr.
iSSE" 30 40
SSSN" 31 16
54 sec 360 micr.
fin Z" 09 12.9

27 juil. 51.6 N., 174.1 W.
Andreanof Isl. Aleutian Isl.
h about 60 km.
H 12 38 35.1
iPZ 12 48 49.7 c

27 juil. Dominion Observatory
47° 15' N., 70° 40' W.
about 15 miles S.W. of
Baie St-Paul, Qué.
H 17 56 56.5
Mag. 4.3
P_1 17 57 42
i 45.2
S_1 58 17
Δ 287 km.

27 juil. iPZ 22 06 50.0 d

28 juil. eE" 00 33.5
iE" 39.4
eLZ" 43.5

28 juil. 16.2 S., 173.2 W.
Samoa Isl. region
h about 40 km.
H 00 05 10.8
ePSE" 00 33.6
ePPSE" 34.6
eSSE" 39.4

28 juil. 4.1 S., 79.7 W.
Ecuador
h about 110 km.
H 02 32 26.0
iPZ 02 40 52.3 c
ipPZ 41 27.0

28 juil. 31.0 S., 67.8 W.
San Juan Prov. Argentina
h about 217 km.
H 06 02 24.1
ePZ 06 14 00.9 d

28 juil. 14.8 N., 93.0 W.
Near coast of Chiapa, Mexico
h about 71 km.
H 13 58 41.2
iPZ 14 05 28.0 d
eLZ" 13

28 juil. 36.9 N., 141.9 E.
Off E. coast of Honshu, Japan
h about 39 km.
H 19 43 00.3
ePZ 19 56 06.0 c

28 juil. 44.6 N., 148.6 E.
Kurile Isl.
h about 32 km.
H 20 46 26.0
iPZ 20 58 50.5 d

30 juil 2.5 S., 77.0 W.
Ecuador - Peru border
h about 146 km.
H 06 58 35.6
iPZ 07 07 32.0 d

30 juil. 3.3 S., 143.9 E.
Near N. coast of New Guinea
h about 25 km.
H 17 16 44.4
iP'Z 17 35 49.0 d
ePPZ 37 40
ePKSZ' 39 25
ePPPZ 40 04
eSKKSE" 44 44
ePPSN" 49 13
eESSN" 54 57
eSSSN" 59 14
eLGN" 18 09.5
80 sec 35 micr.

30 juil. 6.6 N., 73.0 W.
Central Colombia
h about 204 km.
H 18 57 50.7
ePZ 19 04 00.1 d
iPZ 00.8 d

30 juil 5.0 N., 73.3 W.
W. Colombia
h about 45 km.
H 20 18 49.3
iPZ 20 26 23.2 c
iPZ 23.8 d
iPPZ' 28 24
iPPPZ' 29 05
iSE" 32 28
iPSE' 33 13
iPPSE' 22
iScSE" 35 52
iSSE" 36 32
iSSSN" 37 32
iSSSN" 37 46
fin N" 00 10

31 juil. 3.2 S., 144.1 E.
Near N. coast of New Guinea
h about 20 km.
H 02 19 05.2
eP'Z 02 38 10.5
eLZ" 03 18

31 juil. 18.8 N., 120.8 E.
Near N. coast of Luzon
h about 39 km.
H 05 13 04.1
eLZ" 06 04.3

31 juil. 19.7 S., 67.7 W.
S. Bolivia
h about 270 km.
H 11 25 05.5
iPZ 11 35 20.5 c

1 Aout 5.5 N., 125.3 E.
Near coast of Mindanao,
Philippines Isl.
h about 33 km.
H 04 28 26.7
iP'Z 04 47 27.2 c

1 Aout 3.2 S., 143.7 E.
Near N. coast of New Guinea
h about 33 km.
H 04 36 57.6
iP'Z 04 56 00.0
ePPZ" 58 02
eZ" 59 24
eSKKS 05 04 52
ePPSN" 10 22
iSSE" 15 40
eLG 29.0

1 Aout 27.1 S., 176.3 W.
Kermadec Isl region
h about 33 km.
H 12 47 46.6
eLZ" 13 49

2 Aout 19.3 N., 81.0 W.
S. of Cuba
h about 47 km.
H 04 41 46.7
ePZ 04 47 35
eLN" 52.3

3 Aout 5.2 N., 76.4 W.
W. Colombia
h about 79 km.

H	04	06	08.4
iPZ	04	13	39.2 d

3 aout 51.2 N., 176.4 E
Rat Isl. Aleutian Isl

h	about 40 km.		
H	08	00	09.8
iPZ	08	10	56.5 d

3 aout 23.2 S., 67.5 W.
N. Chile - Argentina border

h	about 71 km.		
H	08	56	12.1
iPZ	09	07	10.1 d
ipPZ'			36
isPZ'			48
iPPZ'		09	45
iPPPZ'		11	26
iSE'		16	02
iScSE"			56
isSSE"		21	16
iSSSE"		23	40

4 aout 14.1 N., 93.0 W.
Near coast of Guatemala

h	about 30 km.		
H	02	49	44.7
ePZ	02	56	37.6
eLZ"	03	00.5	

5 aout 74.2 N., 52.5 E.
Novaya Zemlya (Nuclear Explosion)

h	about 0 km.		
H	09	08	45.8
eLZ"	09	34	

5 aout 13.7 S., 166.6 E.
New Hebredes Isl.

h	about 60 km.		
H	15	08	34.1
eLZ"	16	09	

6 aout 32.0 N., 40.8 W.
N. Atlantic Ocean

h	about 48 km.		
H	01	35	30.5
ePZ	01	41	25.1 d
iPZ			26.6 c
eSE"		46	17
eSSE"		47	37

6 aout 58.4 N., 25.5 W.
Sandwich Isl.

h	about 54 km.		
H	08	41	17.8
eP'Z	09	00	12

6 aout 26.9 S., 177.1 W.
Kermadec Isl.

h	about 50 km.		
H	20	51	56.8
eP'Z	21	10	37.5
ePPSE"		21	46
eSSE"		28	26
eLZ"		45.6	

7 aout 4.8 N., 127.8 E.
Molucca Passage

h	about 33 km.		
H	08	44	43.7
eP'Z	09	03	45

8 aout 52.1 N., 170.5 W.
Fox Isl. Aleutian Isl.

h	about 40 km.		
H	10	54	56.3
ePZ	11	04	56

9 aout 22.4 S., 70.0 W.
N. Chile

h	about 160 km.		
H	00	21	10.7
iPZ	00	31	49.0 d

9 aout 6.7 N., 73.1 W.
Colombia

h	about 180 km.		
H	04	21	55.4
iPZ	04	29	03.3 c
iZ			38.0
ipPZ			57.2
iPPPZ		31	48.3
eSN"		35	52

9 aout 24.1 S., 66.5 W.
Salta Prov. Argentina

h	about 33 km.		
H	06	19	51.4
iPZ	06	30	49.8 d
iZ		31	34.5
eSE"		39	42
eScSE"		41	02

eSSSE"		47.5	

9 aout 44.5 S., 73.4 W.
Near coast of S. Chile

h	about 33 km.		
H	17	24	48.5
ePZ	17	34	00.5 d

10 aout 49.4 N., 27.9 W.
N. Atlantic Ocean

h	about 33 km.		
H	21	03	59.2
iPZ	21	10	14.0 d
eSN"		15	22
eSSN"		17	20
eLZ"		17.6	

11 aout Dominion Observatory
47° 32' N., 70° 03' W.
about 10 miles W. of
Kamouraska, Que.

H	03	05	15.8
	Mag. 4.1		
P_1	03	06	13
i			47
S_1			56
	Δ 356 km.		

11 aout 15.7 S., 172.9 W.
Tonga Isl. region

h	about 157 km.		
H	06	47	41.7
eLZ"	07	43	

11 aout 25.2 N., 123.3 E.
Off N. E. coast of Formosa

h	about 140 km.		
H	08	15	43.7
eP'Z	08	34	03.7 d
iSKSN"		40	18
eSKKSN"		41	09
eSN"		41	40
eSSN"		49.6	
eSSSN"		54.3	

12 aout 12.2 N., 87.8 W.
Off W. coast of Nicaragua

h	about 33 km.		
H	05	13	33.1
iPZ	05	20	28.0 d

13 aout 21 N., 83.5 W.
about 300 miles N. W. of Ecuador

h	about 33 km.		
H	06	35	56.0
iPZ	06	44	03.3 d
eZ'			46
PcP+PPZ'		45	52
ePPPZ'		46	29
iSE"		50	34
eSSE"		53	52
iScSE"		54	10
iSSSE"		54	56

54 sec 65 micr

13 aout 14.6 N., 93.0 W.
Off coast of Chiapas, Mexico

h	about 118 km.		
H	10	09	24.9
iPZ	10	16	06.3 d
eLZ"		26.5	

1~~3~~4 aout 49.9 S., 143.0 E.
About 300 miles N. of
Macquarie Isl.

h	about 43 km.		
H	01	10	50.3
eZ"	01	52	
eLZ"	02	10.5	

15 aout 54.6 N., 161.5 E.
Near E. coast of Kamchatka

h	about 52 km.		
H	08	19	37.8
iPZ	08	30	43.8 d
eLZ"		59.0	

15 aout 37.5 S., 73.6 W.
Near coast of Central Chile

h	about 33 km.		
H	16	22	12.3
ePZ	16	33	10

17 aout 7.9 N., 71.4 W.
Venezuela

h	about 17 km.		
H	03	07	46.7
ePZ	03	15	03.0 c

17 aout 31.6 S., 67.7 W.
San Juan Prov. Argentina

h	about 33 km.		
H	03	23	31. 5
iPZ	03	35	23. 6 c
iZ			29. 5

17 aout 10. 6 N., 121. 6 E.
Panay region, Philippines Isl.

h	about 33 km.		
H	05	04	31. 5
eP'Z	05	23	25. 7 c
epPZ			39. 7
ePPZ		25	06
eSSN"		41	42
eLGZ		54	

17 aout 4. 7 S., 79. 4 W.
Peru-Ecuador border

h	about 96 km.		
H	07	26	33. 4
iPZ	07	35	20. 3 d
ipPZ			47. 2
isPZ			56. 3
iZ			04. 6

18 aout 37. 0 N., 32. 5 E.
Turkey

h	about 33 km.		
H	04	28	56. 1
iPZ	04	40	31. 2 c

18 aout 3. 5 S., 150. 5 E
New Ireland

h	about 19 km.		
H	05	42	02. 8
eLZ"	06	49	

18 aout 0. 8 N., 82. 3 W.
Off coast of Ecuador

h	about 33 km.		
H	06	59	33. 2
ePZ	07	07	55. 0

18 aout 62. 3 N., 152. 5 W.
Central Alaska

h	about 32 km.		
H	16	43	54. 3
ePZ	16	52	16. 7 d
ipPZ			27. 0
iPcPZ		53	56. 0
iPPZ		54	09. 5
eSZ"		59	02

eSS eScS }N"	17	02	20

18 aout 62. 3 N., 152. 5 W.
Central Alaska

h	about 32 km.		
H	17	46	14. 9
ePZ	17	54	36. 4
iPZ			37. 6
iPcPZ		56	15
iPPZ			28
iPPPZ		57	13
eSN'	18	01	20
ePSN'			31
eSSZ"		04	34
eZ"		05	10

18 aout 7. 3 S., 156. 1 E.
Solomon Isl.

h	about 60 km.		
H	22	49	47. 5
eLZ"	23	49. 8	

19 aout 19. 9 S., 66. 9 W.
Bolivia

h	about 240 km.		
H	00	23	03. 9
iPZ	00	33	21. 8 d
ipPZ		34	21. 0

19 aout 44. 6 N., 81. 7 E
N. W. Sinkiang Prov.

h	about 33 km.		
H	18	26	38. 6
iPZ	18	39	25. 1 d
ipPZ			36. 1
iPPZ		42	57
iSKSN"		49	47
iSN"		50	04
iPSZ"		51	04
eSSN"		55	44
MZ"	19	17. 3	

27 sec. 54 micr.

19 aout 26. 6 S., 69. 8 W.
Near coast of N. Chile

h	about 51 km.		
H	23	12	50. 4
iPZ	23	24	10. 7 d
ipPZ			28. 6
iZ			31. 3

iPcPZ		26	58
iSN"		33	28
eLN"		47. 5	

20 aout 74. 4 N., 51. 2 E.
Novaya Zemlya (Nuclear Explosion)

h	about 0 km.		
H	09	02	14. 5
eLZ"	09	27. 0	

20 aout 31. 1 N., 114. 1 W.
Gulf of California

h	about 14 km.		
H	10	43	23. 2
ePZ	10	50	12
ePPZ		51	34
eSSSN"		58. 3	
iN"		01	45
iZ"		04	25

20 aout 12. 4 S., 112. 1 E.
340 miles S. of Java

h	about 87 km.		
H	12	58	24. 1
iP'Z	13	17	58. 7 d

20 aout 13. 9 N., 92. 9 W.
Off coast of Chiapas, Mexico

h	about 33 km.		
H	13	14	59. 2
eLZ"	13	32	

20 aout 14. 7 S., 166. 6 E.
New Hebrides Isl.

h	about 52 km.		
H	23	18	39. 8
eLZ"	00	19	

21 aout 41. 3 N., 127. 1 W.
Off coast of N. California

h	about 33 km.		
H	02	12	42. 0
eLZ"	02	33	

21 aout 62. 4 N., 152. 6 W.
Central Alaska

h	about 42 km.		
H	17	30	14. 0
iPZ	17	38	35. 0 d
eLZ"		57	

21 aout 41. 5 N., 15. 4 E.
Italy

h	about 36 km.		
H	18	09	06. 8
ePZ	18	19	20 d

21 aout 41. 4 N., 15. 5 E.
Italy

h	about 34 km.		
H	18	19	33. 3
e(P)Z	18	29	48
ePcPZ		30	33
ePPZ		32	06
eSN"		38	06
ePSZ"			18
eScSN"		39	57
iZ"		45	16

21 aout 29. 6 S., 111. 9 W.
Easter Isl. region

h	about 33 km.		
H	21	09	50. 3
iPZ	21	22	10. 5 d
ePPZ"		25	34
ePPPZ"		27	26
iSE"		32	34
ePSN"		33	20
eSSN"		37	58
eSSSN"		41	22
eGN"		41	17

22 aout 28. 6 S., 176. 7 W.
Kermadec Isl.

h	about 56 km.		
H	05	29	26. 6
eLZ"	06	36	

22 aout 20. 3 S., 177. 8 W.
Fiji Isl.

h	about 55 km.		
H	09	12	49. 7
eZ"	09	27	

22 aout 28. 6 S., 176. 7 W.
Karmadec Isl. region

h	about 56 km.		
H	12	05	54. 9
eLZ"	13	21	

23 aout 62. 2 N., 152. 8 W.
Central Alaska

h	about 25 km.		
H	12	46	22. 7
iPZ	12	54	46. 2 d
eLZ"	13	11	

23 aout 22. 9 N., 120. 8 E.
Near S. coast of Formosa

h	about 17 km.		
H	15	29	46. 6
eLZ"	16	35	

23 aout 41. 8 N., 124. 1 W.
Del Norte County, California

h	about 33 km.		
H	19	29	16. 0
ePZ	19	36	15. 2
ePPZ"		37	44
eSE"		41	51

24 aout iPZ	06	20	06. 5 d

24 aout 15. 0 S., 173. 3 W.
Samoa Isl region

h	about 33 km.		
H	09	04	22. 9
eSKSE"		32 29	24
eSSE"		38	32

25 aout 44. 4 N., 148. 7 E.
Kurile Isl.

h	about 80 km.		
H	02	29	04. 9
iPZ	02	41	23. 0 d

25 aout 20. 5 S., 178. 5 W.
Fiji Isl.

h	about 561 km.		
H	08	31	48. 7
eP'Z	08	49	25
ePPZ"		50	32
ePPPZ"		53	24
eSKSE"		55	20
eSN"		57	31
eSPZ"		59	21
ePSE"	09	00	28
esSN"		01	16
eSSN"		05	50
esSSN"		09	07

25 aout iPZ	09	00	16 d

26 aout 34. 0 N., 139. 2 E.
Near E. coast of Honshu, Japan

h	about 38 km.		
H	06	48	57. 1
iPZ	07	02	19. 0 d
eSE"		13	30
eLGZ"		37. 5	

26 aout 36. 5 N., 1. 6 E.
Near coast of Algeria

h	about 15 km.		
H	16	30	47. 0
iPZ	16	40	22. 5 d

26 aout 3. 7 S., 140. 1 E.
New Guinea

h	about 50 km.		
H	23	30	38. 0
eP'Z	23	49	40
ePPZ		51	55
eSSN"	00	09. 5	
eLZ"		31	

27 aout 40. 2 N., 137. 8 E.
Sea of Japan

h	about 274 km.		
H	02	18	58. 8
iPZ	02	31	29. 3 d

27 aout 74. 7 N., 50. 3 E.
Novaya Zemlya (Nuclear Explosion)

h	about 0 km.		
H	09	00	50. 9
eLZ"	09	22. 8	

27 aout 27. 1 N., 127. 4 E.
Ryukyu, Isl

h	about 33 km.		
H	15	17	56. 9
eLZ"	16	11	

27 aout 38. 3 N., 142. 4 E.
Off E. coast of Honshu, Japan

h	about 40 km.		
H	16	20	04. 7
iPZ	16	33	02. 6 d
iZ			11. 6
iZ			28. 9
eLZ"	17	05. 5	

27 aout 06. 0 S., 149. 5 E
New Britain region

h	about 48 km.		
H	23	28	45
eLZ"	00	28. 5	

28 aout 18. 6 N., 105. 8 W.
Off Coast of Mexico

h	about 33 km.		
H	08	20	31. 5
ePZ	08	27	45. 7 d
ePPZ		29	15
eSN"		33	46
eLGZ"		39. 1	

28 aout 34. 2 N., 139. 3 E.
Near E. coast of Honshu Japan

h	about 38 km.		
H	08	13	12. 4
ePZ	08	26	38. 3 c

28 aout 38. 0 N., 23. 1 E.
Greece

h	about 120 km.		
H	10	59	58. 5
iPZ	11	10	48. 1 c
ipPZ'		11	10
isPZ'			17
iPPZ		13	26
iSN"		19	41
isSZ"		20	18
eScSE"		21	17
eSSE"		24	54
eSSSE"		27	48

28 aout eLZ"	17	15. 5	

29 aout 18. 0 N. 103. 3 W.
Near coast of Mexico

h	about 33 km.		
H	08	50	32. 0
iPZ	08	57	41. 3 c

29 aout 8. 0 S., 73. 6 W.
Peru-Brazil border

h	about 165 km.		
H	12	23	20. 8
iPZ	12	33	12. 2 d

29 aout 19. 4 S., 178. 1 W.
Fiji Isl.

h	about 582 km.		
H	19	41	03. 9
eLZ"	21	06	

29 aout 34. 1 N., 139. 1 E.
Near E. coast of Honshu, Japan

h	about 33 km.		
H	22	36	53. 9
ePZ	22	50	20. 8
eLZ"	23	22	

30 aout 17. 4 S., 69. 8 W.
S. Peru

h	about 145 km.		
H	06	22	27. 6
iPZ	06	32	39. 5 d

30 aout 41. 8 N., 111. 8 W.
Utah-Idaho border

h	about 37 km.		
H	13	35	28. 7
ePZ	13	41	13. 3 d
ePPZ"		42	03
eSE"		45	56
iZ"		46	14
iMZ"		52. 0	
	12 sec 134 micr.		

30 aout 21. 2 S., 174. 4 W.
Tonga Isl

h	about 33 km.		
H	17	17	51. 9
eZ"	17	46	51
eSSE"		53. 0	
eLZ"	18	03	

31 aout 15. 3 S., 177. 2 W.
Fiji Isl. region

h	about 59 km.		
H	09	00	04. 8
eLZ"	09	52	

31 aout 15. 4 S., 177. 3 W.
Fiji Isl region

h	about 60 km.		
H	10	33	30. 2
eSSE"	11	07	20
eLZ"		25. 3	

31 aout 51.3 N., 179.7 W.

Rat Isl Aleutian Isl

h	about 26 km.		
H	17	02	43.4
iPZ	17	13	18.0 c
iPcPZ			54
eSE"		21	54
eSSE"		26	16
eSSSE"		29	12
eLGZ"			36
eMZ"		43.4	

16 sec 105 micr

31 aout 51.2 N., 179.9 W.

Rat Isl. Aleutian Isl.

h	about 43 km.		
H	17	56	08.9
ePZ	18	06	48

1 sept 51.3 N., 179.7 W.

Rat Isl. Aleutian Isl.

h	about 25 km.		
H	03	46	05.0
ePZ	03	56	39.4 c
ePcPZ		57	15.5
eSE"		05	16
eSSE"		09	40
eSSSE"		12	36

1 sept 51.1 N., 180.0

Rat Isl. Aleutian Isl.

h	about 33 km.		
H	03	58	21.5
ePZ	04	08	57

1 sept 51.3 N., 179.9 W.

Rat Isl. Aleutian Isl.

h	about 37 km.		
H	04	41	41.5
iPZ	04	52	14.8 d

1 sept 15.9 S., 168.2 E.

New Hebrides Isl.

h	about 244 km.		
H	04	52	14.5
eP'Z	05	10	37.0 c
ePPZ		12	08

1 sept 51.3 N., 179.9 W.

Rat Isl. Aleutian Isl.

h	about 42 km.		
H	07	51	08.2
ePZ	08	01	40.7 c
eSE"		10	16
eE"		11	33
eSSE"		15	15
eSSSE"		17	36

1 sept 25.8 N., 65.3 E.

Near coast of W. Pakistan

h	about 46 km.		
H	15	01	04.6
eLZ"	15	50	

1 sept B. C. I. S.

35.63 N., 49.87 E.

Iran (12403 morts, plus de 25,000 habitations détruites

h	about 27 km. ± 9 km.		
H	19	20	39.9 ± 1.4
iPZ	19	33	11.8 c
ipPZ			22.5
iPPZ'		36	32
ePPPE'		38	34
iSN"		43	40
iPSN"		44	36
iSSE"		49	08
MZ"	20	02.8	

40 sec 400 micr.

1 sept 35.3 N., 49.6 E.

N. W. Iran

h	about 33 km.		
H	20	27	37.2
ePZ	20	40	09 c

2 sept 51.3 N., 179.8 W.

Rat Isl. Aleutian Isl.

h	about 26 km.		
H	03	02	29.3
ePZ	03	13	03
eLZ"		36	

2 sept 27.5 N., 127.0 E.

Ryukyu Isl.

h	about 58 km.		
H	05	33	05.4
eLZ"	06	29	

2 sept 10.2 S., 120.3 E.,

Soemba Isl. region

h	about 33 km.		
H	15	21	55.0
eP'Z	15	41	27
eSSE"	16	14	
eLZ"		31	

2 sept 22.4 S., 68.1 W.

Chile-Bolivia border

h	about 170 km.		
H	16	13	18.1
iPZ	16	24	00.5 d

2 sept 38.5 S., 179.8 W.

Off coast of North Isl. New Zealand

h	about 33 km.		
H	20	16	41.7
eLZ"	21	16	

3 sept	eLZ"	04	49
4 sept	eLZ"	04	22.5
4 sept	eLZ"	14	09.0

4 sept 15.0 N. 91.7 W.

Mexico-Guatemala border

h	about 217 km.		
H	15	17	42.4
iPZ	15	24	07.6 c
ipPZ			47.3

4 sept 41.0 N. 124.0 W.

near coast of N. California

h	about 48 km.		
H	17	17	27.6
ePZ	17	24	30.1
eLZ"			35.0

4 sept 24.0 N. 46.4 W.

N. Atlantic Ocean

h	about 39 km.		
H	21	46	00.7
iPZ	21	52	14.7 c
eLZ"	22	00.4	

4 sept 39.9 N., 44.2 E.,

Turkey-Armenia, S. S. R. border

h	about 33 km.		
H	22	59	19.4
eLZ"	23	32	

5 sept 6.6 N. 73.4 W.

Colombia

h	about 200 km.		
H	06	39	16.9
ePZ	06	46	22

5 sept 52.7 N., 159.1 E.,

Near E. coast of Kamchatka

h	about 101 km.		
H	08	35	56.3
ePZ	08	47	11.3

5 sept 40.7 N., 112.0 W.

Utah

h	about 14 km.		
H	16	04	29.0
eLZ"	16	19	

6 sept 31.1 S., 72.0 W.

Near coast of Central Chile

h	about 33 km.		
H	06	47	25.3
ePZ	06	59	05.6

6 sept 21.2 S. 174.5 W.

Tonga Isl. region

h	about 110 km.		
H	10	49	00.7
eLZ"	11	34	

6 sept 4.0 S., 126.4 E.

Ceram Sea

h	about 33 km.		
H	11	10	50.3
eLZ"	12	15	

6 sept 14.3 N., 90.7 W.

Near coast of Guatemala

h	about 160 km.		
H	13	39	11.2
eLZ"	13	56	

6 sept 34.5 N., 139.7 E.,

Near E. Coast of Honshu, Japan

h	about 33 km.		
H	17	38	41.4
eLZ"	18	24	

7 sept 6. 3 S. 130. 0 E.
Banda Sea region
h about 180 km.
H 07 41 51. 0
iP'Z 08 00 54. 1 d
iPPZ 04 07. 9

7 sept 39. 7 N., 78. 2 W.
Western Maryland
h about 38 km.
H 14 00 45. 9
iZ 14 04 09. 7 d

8 sept eLZ" 06 16

8 sept 22. 4 S., 171. 5 E
Loyalty Isl. region
h about 76 km.
H 07 27 06. 7
eLZ" 08 25. 5

8 sept 73. 7 N., 53. 8 E.
Novaya Zemlya (Nuclear Explosion)
h about 0 km.
H 10 17 57. 7
ePZ 10 27 38. 6
eLZ" 11 45

8 sept. 16. 9 N., 60. 9 W.
Leeward Isl. region
h about 83 km.
H 13 03 34. 7
eLZ" 13 18. 0

9 sept 15. 6 S., 73. 4 W.
Peru
h about 98 km.
H 03 21 55. 5
iPZ 03 31 58. 8 d
ipPZ 32 25. 1
isPZ 34. 9
iPcPZ 46. 0

9 sept 41. 6 N., 111. 8 W.
Utah-Idaho border
h about 37 km.
H 14 38 13. 0
eLZ" 15 01

9 sept 14. 0 N., 89. 5 W.
El Salvador
h about 89 km.
H 14 45 44. 5
iPZ 14 52 23. 6 d

9 sept 62. 4 N., 152. 4 W.
Alaska
h about 57 km.
H 19 12 37. 1
iPZ 19 20 56. 6 d
eLZ" 35

10 sept 35. 0 N., 27. 1 E.
Dodecanese Isl.
h about 33 km.
H 09 36 24. 3
iPZ 09 47 51. 3 d
ipPZ 48 01. 1
eSN" 57 22
eLZ" 10 06

10 sept 21. 1 S., 179. 2 W.
Fiji Isl.
h about 640 km.
H 15 43 59. 4
iP'Z 16 01 30. 3
ePPZ" 02 44
ePPPZ" 05 48
eSN" 09 39
eSPZ" 11 36
ePSZ" 12 48
esSPZ" 15 22
eSSN" 17 02
eSSSE" 21 48

10 sept 19. 5 S., 173. 6 W.
Tonga Isl. region
h about 33 km.
H 17 49 16. 1
eLZ" 18 44

10 sept 13. 6 S., 111. 6 W.
Pacific Ocean
h about 33 km.
H 20 07 56. 5
ePZ 20 19 01
eLZ" 42

10 sept 12. 3 N., 86. 7 W.
Nicaragua
h about 178 km.
H 21 52 26. 6
iPZ 21 59 02. 5 c
ipPZ 41

11 sept 15. 2 S., 173. 4 W.,
Samoa Isl region
h about 33 km.
H 02 24 22. 9
eLZ" 03 22

11 sept eLZ" 04 45

12 sept 7. 0 S., 12. 4 W.
Ascension Isl. region
h about 33 km.
H 04 50 14. 3
eLZ" 05 25

12 sept 23. 1 S., 68. 8 W.
N. Chile
h about 150 km.
H 12 28 16. 3
iPZ 12 39 03. 0 d
iPcPZ 30. 1
ipPZ 42. 0

12 sept 4. 4 S., 145. 4 E.
Near N coast of New Guinea
h about 32 km.
H 18 18 42. 9
eLZ" 19 17. 5

12 sept 36. 5 N., 69. 2 E.
Hindu Kush
h about 50 km.
H 20 57 00. 4
ePZ" 21 10 04
ePPZ 13 43
ePPPZ" 15 45
eSKSN" 20 32
eSN" 58
ePSN" 22 08
iSPZ" 16
MZ" 50. 3
16 sec 62 micr.

12 sept 7. 3 S., 13. 3 W.
Ascension Isl. region
h about 33 km.
H 23 58 46. 8
eLZ" 00 33

13 sept 21. 3 S., 174. 7 W.
Tonga Isl
h about 33 km.
H 05 02 22. 8
eLZ" 06 48

13 sept 47. 7 N., 157. 0 E.
Kurile Isl.
h about 31 km.
H 08 07 49. 2
ePZ 08 19 39. 3 d

13 sept 25. 6 N., 109. 6 W.
Gulf of California
h about 33 km.
H 13 59 06. 2
eLZ" 14 18

13 sept 11. 6 N., 61. 3 W.
N. of Trinidad
h about 73 km.
H 14 35 02. 0
ePZ 14 41 55
eLZ" 52

14 sept eLZ" 14 15. 0

14 sept 17. 9 S., 176.5 E.
Fiji Isl.
h about 33 km.
H 15 52 41. 2
eLZ" 16 49

15 sept 74. 4 N., 51. 5 E.
Novaya Zemlya (Nuclear Explosion)
h about 0 km.
H 08 02 13. 9
eLZ" 08 29. 0

15 sept 20. 4 S., 68. 1 W.
S. Bolivia
h about 33 km.
H 11 18 23. 0
ePZ 11 29 35

15 sept 48. 5 N., 156. 8 E.
Kurile Isl.
h about 33 km.
H 22 50 46. 3
iPZ 23 02 33. 8 c

iZ 40.0
iZ 52.4
iPPZ' 05 28
ePPPZ" 07 18
iSZ" 12 09
eSSE" 17 22

16 sept 19.3 N., 103.1 W.
Jalisco, Mexico
h about 100 km.
H 03 05 33.0
iPZ 03 12 23.2 c
ipPZ 43.7
isPZ 53.7
isPPZ 14 18
iZ 50
eSSZ" 20 44

16 sept 35.8 N., 118.1 W.
Kern County California
h about 10 km.
H 05 36 15.7
ePZ 05 43 05.5 c

16 sept 74.2 N., 51.6 E
Novaya Zemlya (Nuclear Explosion)
h about 0 km.
H 10 59 10.5
eLZ" 11 16.5

16 sept 16.7 N., 94.2 E.
Near coast of Burma
h about 33 km.
H 19 06 29.2
eLZ" 20 12 23.0 c

17 sept 64.3 N., 149.3 W.
Alaska
h about 63 km.
H 01 10 18.7
iPZ 01 18

18 sept 7.5 N., 82.3 W.
S. of Panama
h about 33 km.
H 00 29 05.2
ePZ 00 36 25.5
ipPZ 38.1
iZ 37 06.0
iPPZ 38 08.3

iPPPZ 26.3
iPcPZ 44.0
iSE" 42 27
iSSE" 44 48
MZ" 48 20
32 sec 490 micr.

18 sept 7.3 N., 82.4 W.
S. of Panama
h about 41 km.
H 05 13 37.5
ePZ 05 21 02
eLZ" 30

18 sept 2.3 N., 126.9 E.
Molucca Passage
h about 33 km.
H 06 10 26.3
eLZ" 07 20

18 sept 73.2 N., 54.7E.
Novaya Zemlya (Nuclear (Explosion)
h about 0 km.
H 08 29 02.7
eLZ" 08 56

18 sept 21.0 S., 169.9 E.
New Hebrides Isl.
h about 81 km.
H 20 11 47.5
eLZ" 21 10

18 sept 14.8 S., 178.1 W.
Fiji Isl.
h about 526 km.
H 21 47 30.9
eLZ" 22 39

19 sept 52.3 N., 171.4 W.
Andreanof Isl. Aleutian Isl.
h about 33 km.
H 01 22 35.5
iPZ 01 32 44.0 d
eLZ" 51

19 sept 73.3 N., 53.8 E.
Novaya Zemlya (Nuclear Explosion)
h about 0 km.
H 11 00 56.4
eLZ" 11 27.4

19 sept eLZ" 15 19

20 sept 15.5 S., 76.1 W.
Near coast of S. Peru
h about 33 km.
H 09 25 26.7
ePZ 09 35 36

21 sept eLZ" 08 33

22 sept 26.5 N., 97.0 E.
N. Burma
h about 33 km.
H 06 51 32.3
eSKSN" 07 16.5
eSSN" 25.5

22 sept eLZ" 16 10

23 sept 14.7 N., 45.1 W.
N. Atlantic Ocean
h about 33 km.
H 11 49 53.5
eLZ" 12 08

23 sept 14.7 N. 45.1 W.
N. Atlantic Ocean
h about 32 km.
H 12 02 34.7
ePZ 12 10 01

23 sept 60.1 N., 151.2 W.
Kenai Penin., Alaska
h about 86 km.
H 15 50 46.4
iPZ 15 59 04.0 d

24 sept 42.8 N., 145.3 E.
Near E. coast of Hokkaido, Japan
h about 33 km.
H 14 38 21.7
iPZ 14 50 58.0 d
eSE" 15 01 22

eLZ" 15.5

25 sept 55.6 S., 124.3 W.
S. Pacific Ocean
h about 67 km.
H 00 21 14.6
eSSE" 00 55.5
eLE" 01 06.8

25 sept 73.7 N., 55.0 E.
Novaya Zemlya (Nuclear Explosion)
h about 0 km.
H 13 02 31.7
eLZ" 13 28.5

26 sept 46.5 N., 153.0 E.
Kurile Isl.
h about 51 km.
H 02 53 29.9
ePZ 03 05 45

26 sept 27.5 S., 176.4 W.
Kermadec Isl. region
h about 33 km.
H 12 44 48.9
eLZ" 13 43

27 sept 31.2 S., 67.9 W.
San Juan Prov. Argentina
h about 71 km.
H 06 48 45.8
iPZ 07 00 31.2 d

27 sept 47.4 S., 34.3 E.
Prince Edward Isl. region
h about 33 km.
H 06 53 30.0
eLZ" 07 54

27 sept 17.9 S., 64.9 W.
Central Bolivia
h about 120 km.
H 07 50 28.3
ePZ 08 00 59
ipPZ 01 31

27 sept 74.3 N., 52.4 E.
Novaya Zemlya (Nuclear Explosion)
h about 0 km.

H	08	03	16.4
eLZ"		29	

27 sept 42.3 N., 142.3 E.
Hokkaido, Japan

h	about 47 km.		
H	09	18	24.9
iPZ	09	31	06.1 d

27 sept 4.0 S., 151.2 E.
New Ireland region

h	about 51 km.		
H	18	26	52.5
eLZ"	19	30	

28 sept 5.2 N., 76.2 W.
W. Colombia

h	about 127 km.		
H	18	56	08.7
iPZ	19	03	34.8 c
ipPZ"		03	58
isPZ"		04	13
iZ"		05	30
eSE"		09	38
eSSE"		12	39

28 sept 13.8 S., 76.7 W.
Near coast of Central Peru

h	about 61 km.		
H	22	14	52.7
iPZ	22	24	48 d

29 sept 20.0 S., 68.0 W.
S. Bolivia

h	about 26 km.		
H	05	21	49.6
iPZ	05	32	34.1

29 sept 27.0 S., 63.6 W.
Santiago Del Estero Prov.
Argentina

h	about 575 km.		
H	15	17	47.7
iPZ	15	28	19.4 d
iPcPZ'			34
ipPZ		30	20.1
iPPZ		31	11.6
iSN		37	03.6
iScSN			07.7
iSPZ			30
isSE"		40	30
iZ"		46	07

30 sept. 5.2 S., 152.7 E
New Britain region

h	about 33 km		
H	10	46	10.3
iP'Z	11	07	05.3 d

30 sept. 18.6 N., 120.9 E.
Near N. coast of Luzon,
Philippines

h	about 51 km.		
H	21	57	24.8
eLZ"	23	02	

1 oct. 47.3 N., 151.5 E.
Kurile Isl.

h	about 127 km.		
H	09	53	32.9
iPZ	10	05	26.0 d
eLZ"		57	

1 oct. 27.9 N., 54.9 E.
S. Iran

h	about 16 km.		
H	12	13	57.4
iPZ	12	27	12.5 d
eLZ	13	00	

2 oct. eLZ"	23	20	

2 oct. Dominion Observatory

H	23	45	32.3
iP_1Z	23	45	52
iS		46	07

Δ 123 km Mag 3.2

3 oct. 40.6 N., 29.7 W.
Azores region

h	about 33 km.		
H	01	19	22.5
eLZ"	01	32.4	

3 oct. 57.5 S., 26.7 W.
Sandwich Isl.

h	about 33 km.		
H	18	48	52
eLZ"	19	52	

4 oct. eLZ"	00	13.0	

4 oct. 40.4 N., 29.5 W.
Azores region

h	about 33 km.		
H	04	42	05.8
eLZ"	04	57.0	

4 oct. eLZ"	06	13.0	

4 oct. 40.9 N., 29.7 W.
Azores region

h	about 33 km.		
H	13	23	34.4
eLZ"	13	38.5	

4 oct. eLZ"	19	06.5	

4 oct. 38.3 N., 22.7 E.
Greece

h	about 38 km.		
H	19	46	10.1
ePZ	19	57	06
eLZ"	20	25	

4 oct. 4.1 N., 76.2 W.
Central Colombia

h	about 67 km.		
H	22	47	35.5
iPZ	22	55	16.0 c
eLZ"	23	25.5	

5 oct. 40.2 N., 29.5 W.
Azores region

h	about 33 km.		
H	04	14	39.1
eLZ"	04	30.3	

5 oct. 40.7 N., 29.8 W.
Azores region

h	about 33 km.		
H	08	39	32.2
eLZ"	08	55	

6 oct. 40.8 N., 29.5 W.,
Azores region

h	about 33 km.		
H	03	17	07.2
ePZ	03	23	37
eLZ"		31.6	

6 oct. 40.5 N., 29.5 W.
Azores region

h	about 33 km.		
H	03	54	58.3
eLZ"	04	08.5	

6 oct. 17.4 S., 167.7 E.
New Hebrides Isl.

h	about 33 km.		
H	04	23	24.1
eP'Z	04	42	20
ePPZ"		43	50
eSKSE"		49	16
eSKKSE"		50	54
ePSE"		53	44
eSSE"	05	00.5	
eSSSE"		04.9	

6 oct. 17.4 S., 167.9 E.
New Hebrides Isl.

h	about 33 km.		
H	07	56	20.4
eLZ"	08	54	

6 oct. 17.4 S., 167.8 E.
New Hebrides Isl.

h	about 17 km.		
H	11	59	42.3
eLZ"	12	03.4	

6 oct. 17.6 S., 168.0 E.
New Hebrides Isl.

h	about 33 km.		
H	18	01	05.4
eLZ"	19	04.5	

6 oct. 17.5 S., 167.6 E.
New Hebrides Isl.

h	about 42 km.		
H	23	31	27.7
eP'Z	23	50	17
ePSE"	00	01	48

8 oct. 24.3 N., 121.7 E.
Near E. coast of Formosa

h	about 29 km.		
H	21	56	22.2
eP'Z"	22	15	18
eSKSN"		21	30
eN"		22	24
eN"		24	42

9 oct. 3.2 S., 148.2 E.
Bismark Sea

h	about 33 km.		
H	20	14	38.3
eLZ"	21	01	

10 oct. 8.9 S., 110.3 E.
Off S. coast of Java

h	about 33 km.		
H	13	33	10.3
iP'Z	13	52	40.5 d

10 oct. 34.9 S., 70.1 W.
Mendoza Prov. Argentina
h about 137 km.
H 20 53 34.5
ePZ 21 05 31.3 c

10 oct. 15.1 S., 173.3 W.
Samoa Isl. region
h about 33 km.
H 21 52 36.8
eLZ" 22 42

11 oct. 1.4 S., 80,6 W.
Near coast of Central Ecuador
h about 33 km.
H 06 22 45.9
iPZ 06 31 15.4 c

12 oct. 20.4 S., 68.9 W.
N. Chile
h about 139 km.
H 07 56 08.4
iPZ 08 06 39.0 d
ipPZ 07 07.0

13 oct. 35.5 N., 49.8 E.
N. W. Iran
h about 33 km.
H 10 23 38.2
eLZ" 11 10

13 oct. 12.6 S., 166.6 E.
Santa Cruz Isl.
h about 33 km.
H 18 47 44.5
eLZ" 18 48

16 oct 51.6 N., 175.8 W.
Near Isl., Aleutian Isl.
h about 27 km.
H 18 02 32.9
iPZ 18 12 54.5 d
ePPZ 15 17
eSE" 21 15
eSSSE" 28.4
eLGE" 30

18 oct. 8.9 S., 117.0 E.
Sumbawa
h about 33 km.
H 04 06 00.4
iP'Z 04 25 27.3 d

18 oct. 46.5 N., 149.6 E.
Kurile Isl.
h about 140 km.
H 08 40 55.5
ePZ 08 52 55

18 oct. 16.2 N., 93.5 W.
Chiapas Mexico
h about 179 km.
H 19 49 59.2
iPZ 19 56 52.4 d

19 oct. 31.0 S., 69.4 W.
San Juan Prov., Argentina
h about 120 km.
H 04 13 03.6
iPZ 04 24 40.5 c
ipPZ 25 10.0

19 oct. 18.9 S., 66.0 W.
Bolivia
h about 211 km.
H 14 44 56.2
ePZ 14 55 23

19 oct. 19.8 N., 108.3 W.
Off W. coast of Jalisco, Mexico
h about 53 km.
H 21 21 48.8
ePZ 21 29 05
eLZ" 43

20 oct. 6.7 S., 130.1 E.
Banda Sea
h about 167 km.
H 05 30 42.2
eP'Z 05 49 46

21 oct. 61.1 N., 149.7 W.
Vicinity Anchorage, Alaska
h about 80 km.
H 02 05 22.7
ePZ 02 13 32.3
iPcPZ 15 10
eSN" 20 32
eSSN" 23 36

22 oct. 3.4 S., 145.3 E.
Bismark Sea
h about 36 km.
H 04 34 38.9

eLZ" 05 34

22 oct. 73.4 N., 54.9 E.
Novaya Zemlya
(Nuclear Explosion)
h about 0 km.
H 09 06 10.1
eLZ" 09 33

22 oct. 49.8 N., 155.8 E.
N. Kurile Isl
h about 19 km.
H 15 23 32.9
ePZ 15 35 18
ipPZ 31.8
eLZ" 59

23 oct. 9.5 N., 73.3 W.
N. Central Venezuela
h about 33 km.
H 09 02 02.2
iPZ 09 09 04.4 c

24 oct. 19.4 N., 108.2 W.
Off coast of Jalisco, Mexico
h about 33 km.
H 06 24 16.3
ePZ 06 31 49

25 oct. 3.0 N., 126.7 E.
Molucca Passage
h about 33 km.
H 09 34 14.6
eP'Z 09 53 19.0 d
eLZ" 10 34

25 oct. 8.4 N., 82.5 W.
Panama - Costa Rica border
h about 51 km.
H 15 52 29.2
iPZ 15 59 43.3
ePPZ" 16 01 18
eSN" 05 30
eSSE" 08 04
eSSSE" 40

25 oct. 61.4 S., 154.9 E.
S. W. of Macquarie Isl
h about 33 km.
H 20 06 10.0
eP'Z 20 25 51.5 d
eSSE" 48 40
eSSSN" 54.0

26 oct. 17.7 S., 167.5 E.
New Hebrides Isl.
h about 33 km.
H 07 20 25.8
eP'Z 07 39 18.5 c
eSSN" 57.6

26 oct. ePZ 10 33 26

26 oct. 33.7 N., 27.9 E.
E. Mediterranean Sea
h about 33 km.
H 11 26 12.4
ePZ 11 37 47.0 d

26 oct 55.5 S., 26.5 W.
Sandwich Isl.
h about 33 km.
H 15 58 34.8
eLZ" 16 55

27 oct. 14.0 N., 90.4 W.
Guatemala - El Salvador border
h about 107 km.
H 10 08 24.5
iPZ 10 17 05.4 d
iZ 20.5

27 oct. 11.5 N., 86.4 W.
Near W. coast of Nicaragua
h about 80 km.
H 13 52 51.2
iPZ 13 59 42.8 c
ipPZ 14 00 05.0
eLZ" 08.5

28 oct. 0.1 N., 123.6 E.
N. Celebes
h about 61 km.
H 15 01 17.0
iP'Z 15 19 26 c

28 oct. 16.0 N., 93.6 W.
Chiapas, Mexico
h about 110 km.
H 22 53 01.3
ePZ 22 59 37 d
eLZ" 23 09.5

29 oct. 7.1 N., 82.6 W.
Off S. coast of Panama

h	about 21 km.		
H	00	19	39.7
iPZ	00	27	07.8 d
ipPZ			16.2
iPPPZ		29	16

29 oct. 13.0 N., 88.4 W.
Near coast of El Salvador

h	about 43 km.		
H	10	53	29.9
iPZ	11	00	19.9 c

30 oct. 12.5 N., 88.0 W.
Off W. coast of Nicaragua

h	about 80 km.		
H	08	31	51.8
iPZ	08	38	38.8
eSN"			44.1

30 oct. 26.6 N., 93.3 E.
E. India

h	about 33 km.		
H	16	13	25.6
eLZ"	17	07	

31 oct. 5.6 N., 82.6 W.
S. of Panama

h	about 33 km.		
H	11	32	29.0
ePZ	11	40	05.5
iPZ			06.7 d
ipPZ			19.6
iPPZ		41	42.5
iPPPZ		42	10.5
iZ			31.0
eSN"		46	16
eSSE"		49	04

1 nov. 1.5 S., 77.8 W.
Ecuador

h	about 181 km.		
H	11	31	48.7
iPZ	11	40	02.5 c

1 nov. 43.9 N., 145.2 E.
Kurile Isl.

h	about 131 km.		
H	23	20	59.6
iPZ	23	33	24.0 c
ipPZ			52.5

2 nov. 10.0 S., 117.8 E.
S. of Sumbawa

h	about 33 km.		
H	14	46	39.2
eP'Z	15	06	11
eLZ"		51	

3 nov. 6.7 S., 104.7 W.
S.W. of Galapagos Isl.

h	about 33 km.		
H	01	35	10.6
ePZ	01	45	09.7

4 nov. 43.2 S., 75.6 W.
Off coast of S. Chile

h	about 33 km.		
H	22	53	34.2
iPZ	23	06	27.7 c

6 nov. 28.0 N., 55.6 E.
S. Iran

h	about 33 km		
H	00	09	47.2
eLZ"			55.5

6 nov. 45.8 N., 122.5 W.
Washington - Oregon border

h	about 44 km.		
H	03	36	46.9
ePZ	03	43	38 c
eSSN"			51.5

7 nov. 20.0 S., 169.5 E.
Loyalty Isl.

h	about 91 km		
H	11	44	37.3
eLZ"	13	09	

7 nov. 7.8 S., 119.8 E.
Flores Sea

h	about 156 km.		
H	16	03	04.1
eP'Z	16	22	11

8 nov. 15.1 S., 75.6 W.
Near coast of S. Peru

h	about 33 km.		
H	00	02	08.6
iPZ	00	12	16.6 c

8 nov. 4.4 S., 105.5 W.
1700 km. S.W. of Galapagos Isl.

h	about 33 km.		
H	00	33	13.8
ePZ	00	42	59 c
eS		51	00
eSS			54.8

9 nov. 33.4 N., 47.2 E.
Iraq - Iran border region

h	about 33 km.		
H	01	11	02.1
ePZ	01	23	36 d

9 nov. 35.8 N., 140.3 E.
Near E. coast of Honshu, Japan

h	about 33 km.		
H	09	21	30.8
ePZ	09	34	44

10 nov. 43.8 N., 147.2 E.
Kurile Isl

h	about 60 km.		
H	01	33	19.0
iPZ	01	45	43.8 c
ipPZ		46	08

10 nov. ePZ	19	12	07

11 nov. 55.8 N., 113.1 E.
Lake Baikal region U.S.S.R.

h	about 33 km.		
H	11	31	44.5
iPZ	11	43	53.7 d
eLZ"	12	09	

11 nov. 12.9 S., 166.5 E
Santa Cruz Isl.

h	about 77 km.		
H	16	09	57.6
eSSE"			46.8
eGN"	17	00.4	

11 nov. 48.9 N., 128.8 W.
Vancouver Isl, region

h	about 33 km.		
H	21	45	20.5
ePZ	21	52	28

11 nov. 43.2 S., 76.0 W.
Off coast of S. Chile

h	about 33 km.		
H	22	14	18.7
iPZ	22	27	08.5 d
ePPZ"		30	40
eSE"		37	55
eSSN"			44.0
eGE"			50.5

12 nov. 51.5 N., 178.4 W.
Andreanof Isl. Aleutian Isl.

h	about 57 km.		
H	19	32	38.0
eLZ"	20	01	

13 nov. 42.0 N., 141.9 E.
Off coast of Hokkaido, Japan

h	about 61 km.		
H	08	54	39.1
ePZ	09	07	20.0

14 nov. 35.7 N., 140.8 E.
Central Honshu, Japan

h	about 61 km.		
H	07	48	05.5
ePZ	08	01	15 d

14 nov. 20.3 N., 45.9 W.
N. Atlantic Ocean

h	about 33 km.		
H	16	11	08.4
eLZ"	16	27	

14 nov. 0.3 S., 93.2 E.
N. Celebes

h	about 92 km.		
H	21	59	16.1
eP'Z	22	18	19
iZ		22	13

15 nov. 8.7 S., 79.8 W.
Near coast of N. Peru

h	about 45 km.		
H	23	25	15.7
iPZ	23	34	38.2 c
iSE"		42	16
eSSSE			48.0

16 nov. 1.0 S., 78.6 W.
Ecuador

h	about 33 km.		
H	06	39	08.2

iPZ	06	47	38.5 c

16 nov. 32.3 S., 111.1 W.
Easter Isl. region

h	about 43 km.		
H	07	18	37.3
iPZ	07	31	07.0 c
iSE"		41	40
ePSN"		42	34
eSSE"		47	14

16 nov. 13.5 N., 93.2 E.
Adaman Isl.

h	about 33 km.		
H	21	10	01.8
iP'Z'	21	28	59
ePSN"		40	20
eSSN"		47.2	

17 nov. 19.6 S., 68.8 W.
Bolivia

h	about 209 km.		
H	00	00	21.5
iPZ	00	10	52.0 c
iZ		11	19.0

17 nov. 16.3 N., 98.2 W.
Oaxaca, Mexico

h	about 12 km.		
H	11	07	15.4
iPZ	11	14	15.0 c
iPPZ		15	41
eSN"		20	06
eScSN"		24.5	

18 nov. 0.2 S., 125.1 E.
Molucca Sea

h	about 56 km.		
H	06	43	08.3
iP'Z	07	00	38.0 c

19 nov. 6.7 N., 73.0 W.
Colombia

h	about 135 km.		
H	14	30	29.1
iPZ	14	37	42.5 d

20 nov. 55.6 N., 158.8 E.
Kamchatka

h	about 33 km.		
H	06	54	04.1
iPZ	07	05	13.1 c

20 nov. 56.2 N., 159.3 E.
Kamchatka

h	about 33 km.		
H	07	32	42.9
iPZ	07	43	48.3 c

22 nov. 14.3 N., 92.7 W.
Near coast of S. Chiapas, Mexico

h	about 33 km.		
H	01	30	02.5
eLZ"	01	51	

22 nov. 1.6 S., 77.1 W.
Peru - Ecuador border

h	about 147 km.		
H	06	53	34.5
iPZ	07	02	33.0 d

23 nov. 15.1 S., 75.3 W.
Near coast of S. Peru

h	about 33 km.		
H	00	30	04.5
iPZ	00	40	12.6 c
iPcPZ		41	07.5
iSE"		48	28
eScSE"		50	05
eSSSE"		55.3	

23 nov. 15.0 S., 75.7 W.
Near S. coast of Peru

h	about 40 km.		
H	00	44	51.2
iPZ	00	54	57.2 d

24 nov. 49.5 N., 155.8 E.
Kurile Isl. region

h	about 85 km.		
H	15	52	20.1
ePZ	16	04	00.3 d

24 nov. 9.8 N., 40.7 W.
Mid-Atlantic Ocean

h	about 33 km.		
H	16	19	44.9
ePZ	16 ~~17~~	28	03.7

25 nov. 11.7 S., 77.3 W.
Near coast of Central Peru

h	about 33 km.		
H	12	48	44.3
iPZ	12	58	19.0 c

25 nov. 16.3 N., 94.2 W.
Near Coast of Chiapas, Mexico

h	about 100 km.		
H	17	34	43.4
ePZ	17	41	15.6
epPZ			39.5

26 nov. 39.8 N., 77.2 E.
Sinkiang Prov, China

h	about 14 km.		
H	05	29	30.2
eLZ"	06	12.6	

27 nov. 12.2 N., 143.8 E.
Mariana Isl.

h	about 33 km.		
H	16	50	27.7
eLZ"	17	43	

28 nov. 12.1 N., 143.7 E.
Mariana Isl.

h	about 33 km.		
H	02	35	48.8
eLZ"	03	29.0	

28 nov. 22.4 S., 10.5 W.
S. Atlantic Ocean

h	about 33 km.		
H	05	02	36.1
eLZ"	05	50.0	

29 nov. 17.3 S., 168.5 E.
New Hebrides Isl

h	about 33 km.		
H	19	06	37.6
eSSE"	19	44.0	
eLZ"	20	02.8	

30 nov. 17.4 N., 99.6 W.
Guerrero, Mexico

h	about 51 km		
H	21	51	22.9
iPZ	21	58	15.3 d
iZ			25.5
ePPE		59	44
iZ	22	03	11
eSE'		03	54
eSSE'		06	12
eGZ"		08.4	

1 déc. 52.4 N., 170.1 W.
Fox Isl Aleutian Isl.

h	about 38 km.		
H	01	50	20.4
iPZ	02	00	17.3 d
ipPZ			28
eSE"		08.5	
eLZ"		16.0	

1 déc. 30.8 S., 71.3 W.
Central Chile

h	about 68 km.		
H	13	32	24.8
iPZ	13	44	19.5 c

1 déc. Dominion Observatory
45° 34' ± 25' N., 69° 08' ± 30' W.,
Central Maine

Mag 3.0			
H	21	29	33
e	21	31	07
i			09
Lg			12
	Δ 350 km.		

2 déc. 9.9 S., 159.9 E.
Solomon Isl.

h	about 34 km.		
H	05	30	53.8
eLZ"	06	29.5	

4 déc. 10.1 N., 103.6 W.
Off coast of Guerrero, Mexico

h	about 33 km.		
H	03	29	40.8
iPZ	03	37	48.0 c
eSE"		44	16

4 déc 21.8 S., 65.6 W.
S. Bolivia

h	about 300 km.		
H	07	23	04.2
iPZ	07	33	28.2 d

5 déc. 39.9 N., 104.6 W.
Colorado

h	about 33 km.		
H	13	48	00.4
eLZ	14	00	

7 déc. 29.2 N., 139.2 E.

Bonin Isl region

h	about 411 km.		
H	14	03	37.0
iSKSE"	14	26	34
iSE"		27	30
eSPN"		29	02
ePSN"			58
eSSE"		34	44
eSSSE"		38	30

8 déc 23.6 S., 69.4 W.

Near coast of N. Chile

h	about 100 km		
H	18	00	41.1
iPZ	18	11	36.5 c
ipPZ } PcPZ }			59.5
isPZ		12	09.7

8 déc 15.2 S., 173.7 W.

Tonga Isl region

h	about 33 km.		
H	18	18	29.1
eSKSE"	18	43	24
ePSE"		46	33
eSSE"		52	32

8 déc. 25.8 S., 63.4 W.

Salta-Santiago Del Estero Prov border, Argentina

h	about 620 km.		
H	21	27	22.2
iPZ	21	37	43.9 d
ipPZ'		39	45.5
iSE"		46	18
32 Sec 75 micr.			
isSE"		49	50
iSSE"		50	44
iSSSE"		54	15

8 déc. 50.5 N., 176.8 W.

Andreanof Isl. Aleutian Isl

h	about 33 km.		
H	22	55	01.2
iPZ	23	05	29.5 c
eSN"		14	04

9 déc. 43.5 N., 147.3 E.

Kurile Isl. region

h	about 34 km.		
H	10	17	39.5
ePZ	10	30	08

9 déc 17.7 S., 173.6 W.

Tonga Isl. region

h	about 60 km.		
H	20	54	13.7
eLZ"	21	50	

10 déc. 28.3 S., 62.7 E.

Indian Ocean

h	about 33 km.		
H	04	56	19.4
eP'Z	05	15	43 d
eLZ"	06	03	

12 déc. 4.8 S., 153.8 E.

New Britain

h	about 94 km.		
H	10	08	48.5
eP'Z	10	27	34
eSSE"		45	44
eSSSE"			50.0

12 déc. 4.6 S., 96.5 E.

Sumatra

h	about 138 km.		
H	22	56	45.8
eP'Z	23	15	39.8 d
iZ		18	55.8

13 déc. 63.3 N., 149.7 W.

S. Central Alaska

h	about 47 km.		
H	04	21	21.2
iPZ	04	29	30.7 d

13 déc. 61.4 N., 147.2 W.

Kenai Penin. Alaska

h	about 69 km.		
H	14	57	27.9
ePZ	15	05	28

15déc. Dominion Observatory

Probably about 15 miles from Sept-Iles, Que. Where it was felt with intensity IV. Mag. 4.6

H	00	58	32
Pn	01	00	05
Sn	01	01	13
Lg	01	01	50
	about 715 km.		

17déc. 2.1 N., 122.9 E.

Celebes Sea

h	about 393 km.		
H	11	00	16.0
iP'Z	11	18	41.4 d
ipP'Z		20	22.0
iSKPZ		21	25.0
ipPPN		22	08.0

18 déc. 21.6 N., 143.1 E.

Mariana Isl. region

h	about 306 km.		
H	02	54	47.1
eP'Z	03	13	46

18 déc. 35.2 S., 104.8 W.

Easter Isl. region

h	about 33 km.		
H	07	48	36.6
eLZ"	08	31	

20 déc. Dominion Observatory

52.8° ± 1.0° N., 59.4° ± 1.5° W. about 60 miles S.E. of Goose Bay, Labrador

Mag 4.4			
H	04	23	12
eLg	04	29	12

21 déc. 9.0 S., 112.4 E.

Near S. coast of Java

h	about 64 km.		
H	00	44	19.7
iP'Z	01	03	46.9 c
iPPZ		06	44
ePKSN"		07	23

21 déc. 52.5 N., 168.7 W.

Fox Isl. Aleutian Isl.

h	about 33 km.		
H	06	27	49.1
ePZ	06	37	42.0 c
ipPZ			53
eLN"		57	

21 déc. 52.4 N., 168.5 W.

Fox Isl. Aleutian Isl.

h	about 33 km.		
H	08	42	48.3
ePZ	08	52	40
pPZ			51.5
iSE"		00	42
eScSE"		02	28
eSSSE"		07	10

21 déc. 52.8 N., 168.1 W.

Fox Isl. Aleutian Isl

h	about 33 km.		
H	08	50	08.2
ePZ	09	00	00

21 déc. 52.4 N., 168.5 W.

Fox Isl. Aleutian Isl.

h	about 33 km.		
H	09	00	41.4
iPZ	09	10	33.5 d
iZ			53

21 déc. 52.5 N., 168.5 W.

Fox Isl.

h	about 33 km.		
H	09	10	01.6
ePZ	09	19	53.3

21 déc. 42.4 N., 142.3 E.

Near S. coast of Hokkaido, Japan

h	about 27 km.		
H	09	33	15.5
iPZ	09	45	58.3 d

21 déc. 22.8 S., 66.5 W.

Bolivia-Argentina border region

h	about 200 km.		
H	09	42	46.0
iPZ	09	53	27.4 d
ipPZ		54	20.8

21 déc. 0.9 S., 80.9 W.

Near coast of Central Ecuador

h	about 33 km.		
H	21	27	51.6
iPZ	21	36	19.8 d
eSN"		43	06

22 déc. 22.0 S., 170.1 E.

Loyalty Isl region

h	about 33 km.		
H	00	52	23.4
eP'Z	01	11	16
eSSE"			30

22 déc. 9.2 S., 112.4 E.

Near S. coast of Java

h	about 69 km.		
H	01	59	50.3
eP'Z	02	19	18 d

22 déc. 1.1 S., 81.0 W.

Near coast of Ecuador

h	about 33 km.		
H	06	35	57.1

ePZ	06	44	43

22 déc. 47 N., 125.7 E.
Near S. coast of Mindanao, Philippine

h	about 18 km.		
H	14	09	29.7
iP'Z	14	27	38.7 d

22 déc. 52.5 N., 168.8 W.
Fox Isl. Aleutian Isl.

h	about 47 km.		
H	15	20	31.0
iPZ	15	30	22.3 d
iPPPZ		33	57
iSE"		38	23
eScSE"		40	12

24 déc. 73.6 N., 57.5 E.
Novaya Zemlya (Nuclear Explosion)

h	about 0 km.		
H	11	11	42.0
eLZ"	11	38	

25 déc. 36.2 S., 100.2 W.
S. Pacific Ocean

h	about 33 km.		
H	12	09	45.6
eLE"	12	46	

26 déc. 39.3 N., 10.6 W.
Off coast of Portugal

h	about 19 km.		
H	08	58	11.1
iPZ	09	06	33.5 c
eGN"		18.0	

26 déc. 53.9 N., 168.7 E.
Komandorski Isl.

h	about 33 km.		
H	22	25	15.5
iPZ	22	36	09.5 d
iSE"		45	03
eScSE"		46	08
eSSE"		49	24
eSSSE"		52	42
eGE"		54	20

26 déc. 54.0 N., 168.8 E.
Komandorski Isl.

h	about 33 km.		
H	23	46	14.7
iPZ	23	57	07.5 c

27 déc. 28.6 S., 67.4 W.
Near coast of Central Chile

h	about 33 km.		
H	11	13	38.2
ePZ	11	25	42

28 déc. 39.9 N., 142.0 E.
Near W. coast of S. Honshu, Japan

h	about 36 km.		
H	18	18	42.0
iPZ	18	31	34.9 d
ipPZ		50	
eLN"		59	

29 déc. 20.0 S., 69.9 W.
N. Chile

h	about 46 km.		
H	10	41	04.1
iPZ	10	51	43.5 c
ePPZ"		54	21
iSE'	11	00	26

30 déc. 4.7 S., 153.7 E.
New Britain

h	about 116 km.		
H	18	16	21.4
eLN"	19	07.5	

31 déc. 47.1 N., 122.0 W.
Pierce County, Washington

h	about 33 km.		
H	20	49	35.3
eZ	21	05	49

1 jan. 6.9 N., 73.1 W.
1963
Colombia

h	about 151 km.		
H	04	05	27.5
iPZ	04	12	38.0

M. Buist. S. J.

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Bulletin de Géophysique

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SOMMAIRE

Observatoire de Géophysique

COLLÈGE JEAN-DE-BRÉBEUF

MONTRÉAL

OBSERVATOIRE DE GEOPHYSIQUE
COLLEGE JEAN-DE-BREBEUF
3200 Chemin Ste-Catherine
Montreal 26, Canada.

Directeur: M. Buist, S.J.
Directeur des Recherches: E. Gherzi, S.J.

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NOTE ON THE RADIO PROPAGATION OF A "LORAN" STATION

by Ernest GHERZI, S. J.

Many articles have been written on the manifold geophysical phenomena observed at sunrise.

As a matter of fact, the temperature of the air, the electric potential of the atmosphere, the wind, the turbulence, etc, all show a decided change when the sun is over the horizon. The ionosphere is also greatly affected at that time, and the formation of the so called D-layer is one of the consequences of the direct solar action.

While many observations and measurements have been made at sunrise, only a few have been made at sunset. We failed to find any complete description of the behaviour of the ionosphere at sundown. Of course, our documentation may have been at fault.

We have been receiving during two months, (from June 19th to August 19th 1962) the pulses transmitted on the standard 2Mc frequency by a Loran station located on the Atlantic sea-coast, more than 400 miles from Montreal.

Although we feel that further studies of these radio waves must be done before venturing any conclusions, we thought it would be of immediate interest to publish some of the results already obtained. This phenomenon has not received adequate attention, and our observations show some unexpected behaviour.

Our antenna is a large Delta system, vertically polarized. The receiver is a Marconi superheterodyne set, crystal-controlled and with stabilized power. The sensitivity on the 2Mc band is around 5 microvolts, and the input impedance 300 ohms at room temperature.

As it is commonly admitted, during daylight hours the presence of the D-layer will interfere with the propagation of the 2Mc radio waves by the absorption that it causes. On the contrary during the night hours, the reception of the 2Mc radio waves will be made possible by the presence of an unobstructed and reflecting E-layer, since the daytime D-layer will have either greatly decreased or even disappeared. Mariners who make use of the Loran pulses for ascertaining their position at sea, know that at night the sky wave is received very far away and that it is difficult to isolate the ground wave for their measurements.

The disappearance of the D-layer is consequent to a partial or a total recombination, due to the cessation of a direct solar action. We have examined how fast that D-layer dissolves at sundown and how fast it forms again at sunrise.

The recordings (Fig. 1) show a very interesting phenomenon. At sunset the D-layer fades away rather sharply and the Loran pulses come in suddenly, while at sunrise, the reverse happens, i-e: the reception decreases slowly.. The time required for the signal received with maximum intensity to fade out completely and to disappear in the receiver's noise is approximalely twice longer than the time required at sunset fot the signal to emerge from the noise and reach its peak value.

Since during the daylight hours the Loran waves are not received, although the station is transmitting 24 hours a day, some change must happens in the ionosphere at sunset: namly, as we said, the E-layer is no more obstructed by the dense and absorbing D-layer.

Nevertheless, once in a while, there has not been much difference in the time required for the signal to reach its maxvalue or to fade out completely. When many more data are obtained, it will become possible to make a statistical analysis and to see whether or not this phenomenon corresponds to any special ionospheric event.

The lenght of time during which the signal was received seems to coincide with the night hours, Fig. 2. At the summer solstice, it lasted from 6 to 7 hours and in the middle of August, it reached 10 and 11 hours on some days. It has been found difficult to ascertain these times with an accuracy greater than ten minutes. Sferics do interfere, and while at night the arrival is clearly noticable, in the morning hours disappearance is not so apparent, because the curve decreases slowly, Fig. 3.

Unfortunately continuous soundings are not made in Montreal, and no measurements of the refractive index of the troposphere are at hand. Measurements are made in Toronto and in Cttawa, but cannot be used because of the distance from our station. Meteorology in the Province of Quebec is still in the making. In these circumstances, the peculiar fadings and the sudden increases in the intensity of the recordings cannot be examined in a plausible way.

No complete reports of Auroral phenomena over our skies are available for the two months of our study. Only once, on the 4th of July, was a bright aurora visible over our region. No special modification of the reception curve of the Loran pulses is apparent at that date

Local thunderstorms with their sferics have masked occasionally the exact time of the arrivals and disappearances of the radio waves. Nevertheless, the reception has been sometimes so strong that, although on the lower frequency of 20Kc the thunder discharges were very numerous, the 2Mc Loran trace remained undisturbed and steady.

We have been able to check with ionospheric soundings that, when the Loran transmission on the 2Mc band was received, a steady E-layer was present. Unfortunately, we are not equipped for getting the D-layer reflections. The D-layer is still a controversial subject, (1) and to get reflections from it, is a rather difficult enterprise. But granted that this layer is formed by the photoionization of NO by the solar Lyman-alpha flux, (2) we are entitled to conclude that, when this direct action of the sun has ceased, this layer must decrease in such a way as to become transparent to the 2Mc frequency. The unobstructed E-layer would then be responssable for the sky wave from the Loran station under study.

Nevertheless, we are well aware that theoretically, according to the diurnal variation of the E-layer ionization, this layer also should disappear at night. Actually, as Mitra says, "this residual ionization density of the E-layer at night hours has been observed to be greater than expected."(3) These words would confirm our statement that the reception of the Loran pulses at dusk is due to the action of the E-layer. And we have to report that, when pulsing on the 2Mc frequency, although we detected the E-layer, we failed to get any F-layer reflection. That E-layer appeared to be the normal E-layer and not the sporadic Es. So much so that we agree with the statement that "the D-region exists practically only in day time" (4). The sferics reflected at night by a layer at a height at 75-95 Km, which were studied by Dr. J. Rieker in a very interesting publication, were of a very low frequency: 27Kc. (5). They might have been reflected by a diffused night D-layer. We have had many similar recordings on 20Kc. Nevertheless we feel safe in saying that on 2Mc and on 27Kc things are different: night receptions of these two frequencies cannot be attributed to a same reflecting layer.

A more pertinent problem is to consider whether we have been receiving only the surface wave with great intensity, or the sky wave? Although the striking aspect of the sudden arrival of the pulses at sundown, and their slower disappearance at dawn, would yet remain to be clarified, we are not inclined to accept as an explanation of the whole phenomenon the prevailing influence of the ground wave.

R. Naismith and E. Bramley have published some years ago (1951) a paper concerning the time dealy between the arrival of the sky wave and the arrival of the ground wave (6). They have also studied Loran pulses transmissions. While admitting that we have possibly received either the ground wave simultaneously with the sky wave or only the ionospheric reflections, we nevertheless note that the two authors reported that "the signal-noise ratio for the sky wave had a maximum at night whereas for the ground wave it was maximum during day-time". Since in Montreal the day-time reception of the Loran pulses was null, the logical consequence of the chosen statement by the British scientists, seems to be that the night reception in Montreal was due mostly to the sky wave.

The same authors attribute the existence of the sky wave to the E as well as to the Es-layers. At times, they would even accept that the F-layer had been the reflecting one. We agree that even in our case such a possibility should be admitted. Since the purpose of their research was to find out by how many microseconds the ground wave had arrived before the sky wave, they did not notice, as we have been able to do, that at sundown the reception of a distant Loran transmission comes in much more suddenly than it disappears at sunrise.

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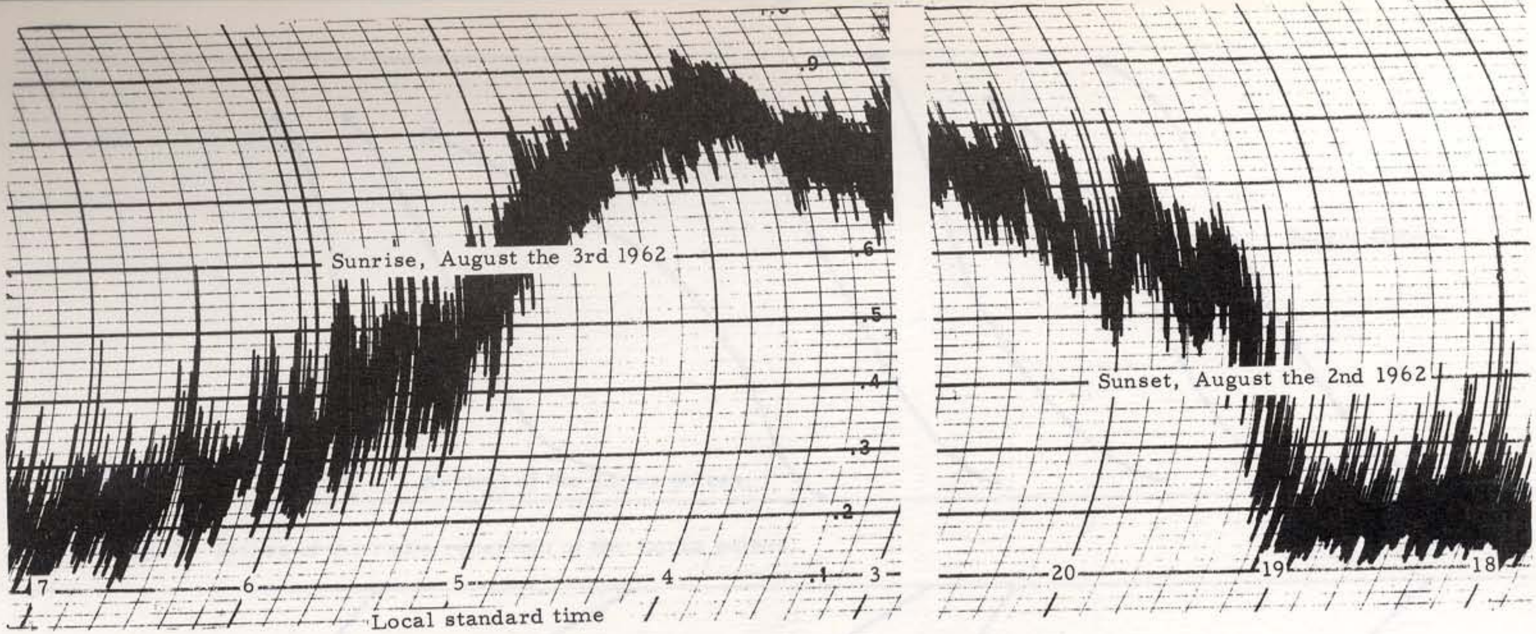
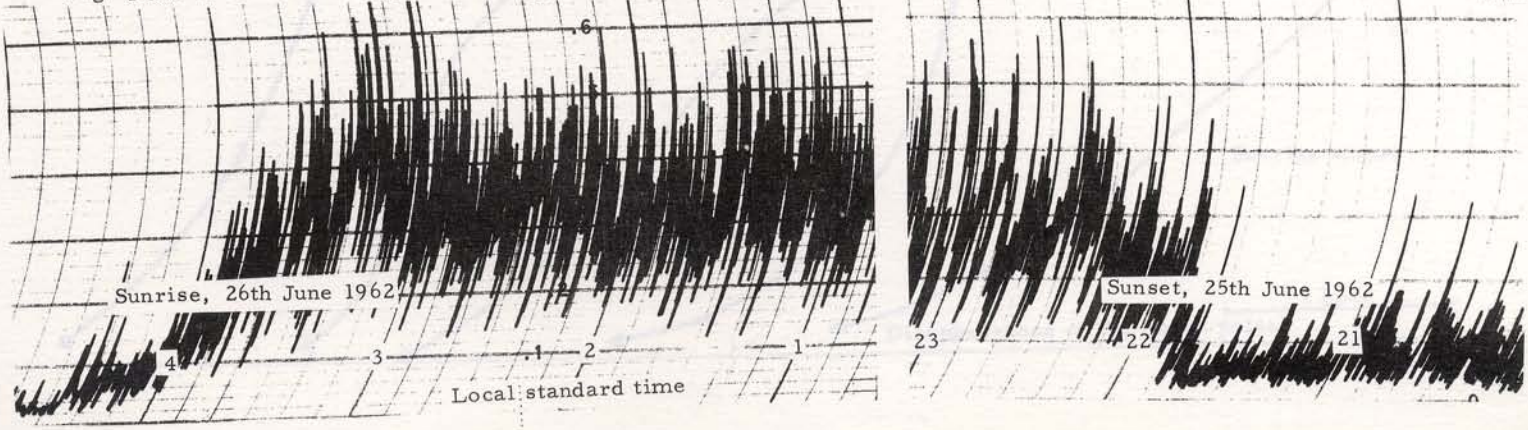


Fig. 1 and 2. Esterline-Angus recordings of the Loran pulses.



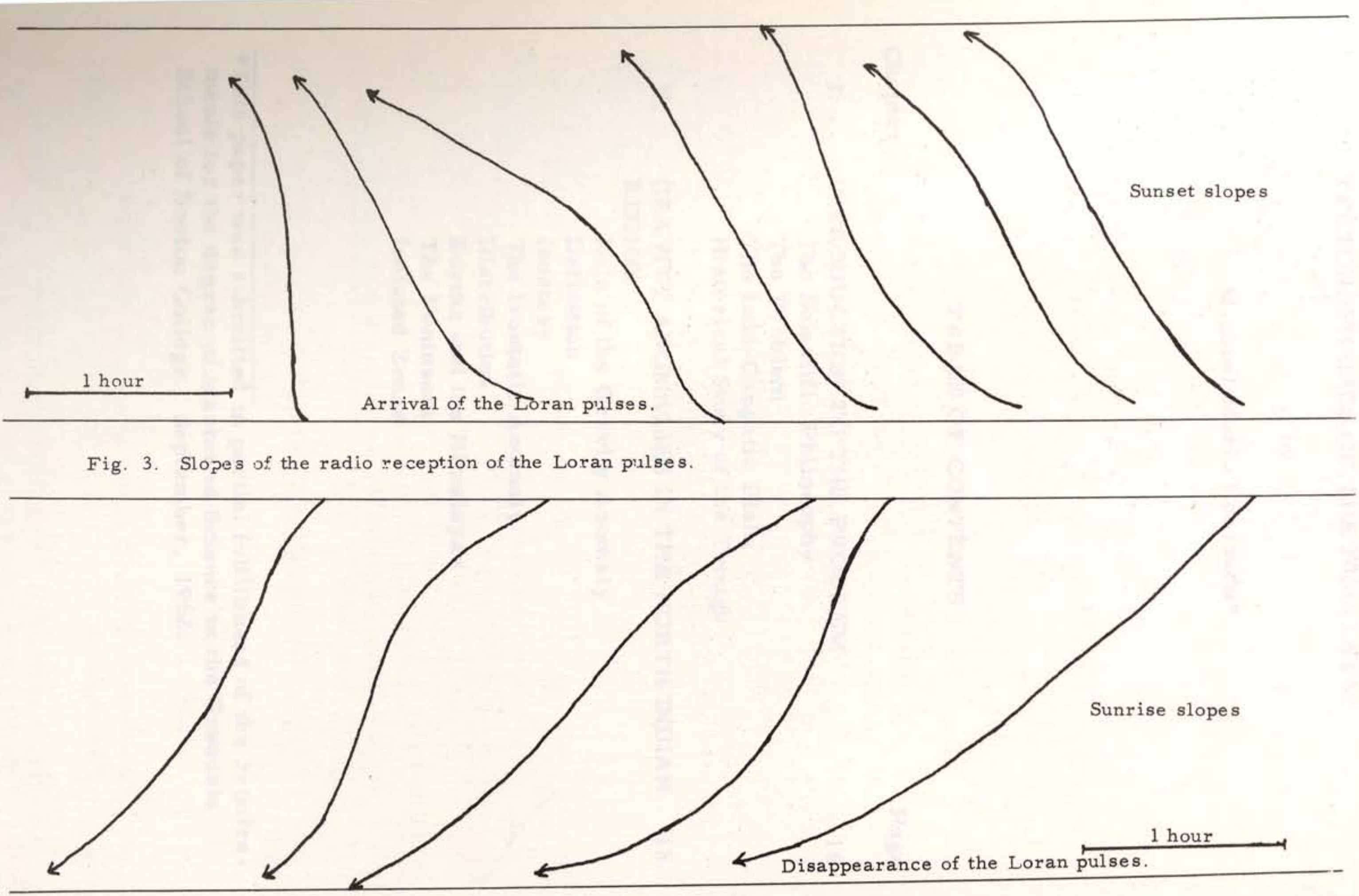


Fig. 3. Slopes of the radio reception of the Loran pulses.

TECTONOPHYSICS OF THE HIMALAYAS

by

Michael Mario Peerzada*

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*This paper was submitted in partial fulfillment of the requirements for the degree of Master of Science in the Graduate School of Boston College. September, 1962.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

The Scientific Philosophy

In a study of the Universe, or any part of it, the observer is impressed by a single governing principle. This unique factor is the apparently perpetual motion of its various parts. Motion is recorded in space and time, and though it seemingly has little regard for these dimensions this behaviour is only apparent on our scale of observation. The sciences have shown that natural laws are unique at each dimensional level and by intuition we understand that the whole system of laws are interdependent - also in a unique manner. Thus in the last analysis scientists are obliged to probe the natural laws and relate them, rather than attempt to explain phenomena recorded at different levels of observation by any one set of laws.

The Problem

In recording observations on the surface, geologists are obliged to maintain a working hypothesis.

Indian geology is subject to the hypothesis of a "drifting" Indian Peninsula, based on such gross features as the distorted Himalayan and Burmese Mountain Arcs.

There is geological evidence for the subsidence of the northern edge of the Indian Peninsula in Tertiary Epochs. This corresponds to the last stages of Himalayan diastrophism. The subsidence described above and consequent formation of the Indo-Gangetic Trough is used in support of the hypothesis.

The writer is of the opinion however that the Trough formation loses impetus as support of the "drift" hypothesis when a proposed hypothesis of Himalayan diastrophism, on a lesser scale and based on systematic definition from the view-point of tectonics, reveals no unified "drift" of the Indian Peninsula.

The problem is complicated by the absence of any geologic studies in vast portions of the Sino-Tibetan area. (Pl. 2)

The Indo-Gangetic Plain

Attention is thus drawn to the zone lying between East Longitude 68 and 96 degrees and in the vicinity of North Latitude 27 degrees. (Pl. 1) This area corresponds to the central portion of India and Pakistan and consists of the alluvium-filled valleys of the Rivers Indus, Ganges and Bramaputra forming an almost continuous plain for some 2700 kilometers. The width of the plain decreases from West to East being an average of 500 km. in the Indus valley, 300 km. in the central Ganges valley and 75km. in the narrow Bramaputra valley.

Historical Study of the Trough

In 1911, Burrard (of the Geologic Survey of India) is known to have made gravity studies in Peninsula India. He ascribes this depression to be a "fore-deep" with sediments estimated at 50, 000 ft. (1) The implication apparently is that this area represents an existing geosyncline in which diastrophism is inevitable. Wadia, a pioneer in Indian Geology, is similarly intrigued by the structure and significance of this region. (2) Geophysical measurements in 1934, show the Bihar area (25 N 84 E) to have a depth of 6000 ft. of sediments. To the west, Pre-Cambrian out-liers well within the depressed zone, indicate a shallow depth to basement.

Most recently, Krishnan states in this connection (3) that "the general direction of the Tethyan geosynclinal belt from Iraq through Iran . . . . . points directly towards Sumatra and is "violently distorted and pushed to the north by the foreign mass of India . . . . "

On the basis of this hypothesis he computes the migration to be "about 13 or 14 degrees of Latitude or some 800 miles." He also describes the Punjab and Assam areas as "wedges" (with the connotation of independent movement) such that "the effect of these wedges is felt as far north as the Pamir region in the North-West and South-West China in the North-East," by way of the "conspicuous sharp bends" in these locations. Thus he attributes the "bending down of the Northern edge of India" to the "Opposition of the Central Asian mass."

There is evidence, however, in East Central Asia, that some in the Pre-Cambrian, Variscan and Mesozoic have a similar tectonic sequence as the zone in question. This indicates that the present zone is not unique from the point of view of geologic time and hence does not warrant the unique theory of the disruption and migration of a wholly Archean Gondwanaland.

CHAPTER II

GRAVITY ANOMALIES OF THE INDIAN REGION

Role of the Gravity Anomaly

Gravity anomalies are important in the hypothesis that is advanced herein. Frequently the interpretation of gravity measurements is subject to controversy, so that an analysis is undertaken to determine the extent to which it may be used with reasonable confidence.

Definition

The earth as a whole has a quasi-spherical shape and cannot be precisely represented by a geometrical configuration. A close approximation however is the ellipsoid of rotation about the minor polar axis. If 'a' be the minor axis and 'b' the major axis of the ellipsoid of rotation the flattening of the figure is defined as $f = \frac{b-a}{b} = \frac{1}{297}$ (approximately).

The theoretical value (4) of gravity at an equipotential surface corresponding to this figure is given by

$$g_o = g_e \left[1 + \left(\frac{5}{2} - \frac{17}{14} f\right) \frac{w^2 b}{g_e} \text{Sin } \theta - \frac{f}{8} \left(\frac{5 w^2 b}{g_e} - f\right) \text{Sin } 2\theta + \ldots \right]$$

where g_e = gravity at sea-level at the equator, w = angular velocity of the earth's rotation and θ = geographic latitude.

The theoretical value (so obtained) is compared with the measured value, at the appropriate latitude, after corrections have been made to the latter quantity so as to approach the theoretical configuration. The difference between these two is defined as the gravity anomaly.

The most obvious of these corrections is the elevation of the point of observation above the equi-potential surface at sea-level (the geoid). This is the free-air reduction. It ignores the effect of mass (or absence of mass) in the intervening space between the point of observation and the geoid, as also, the effect of the mass (if there be any) above the station elevation. A correction made for the latter factor is the terrain correction. These two corrections are entirely valid and in accordance with the approach to the theoretical geoid.

Pierre Bouger proposes the idea of the removal of the effect of the mass between the station and the geoid for positive elevations (Termed here as the "elevation mass"). This amounts to a virtual removal of the "elevation mass" itself, as far as gravity observations are concerned. Similarly, a correction of this type (the Bouger correction) results in the virtual placement of mass or negative elevations. The difference between the observed gravity (so corrected) and the theoretical value is the Bouger anomaly. It is found that this quantity has the consistent property of being strongly positive over the oceans and strongly negative over mountainous regions. This in turn reflects mass excess in the former and mass deficiency in the latter. However, the very correction itself virtually places "elevation mass" in the oceans and virtually removes the same from mountainous regions. The conclusion is that the Bouger anomaly is created by the Bouger correction.

Isostasy

This leads to the idea that mountain masses and oceanic basins are required in order to maintain equilibrium. Thus the concept of a vitreous layer emerges, which tends to move so that equilibrium of the topography (isostasy) is maintained. The concept has been strengthened by the rapid uplift of Fenno-Scandia (100 cm. per century in the Baltic) since the decline of the last continental ice sheet.

The Isostatic Anomaly

To correct the Bouger anomaly various hypothesis have been proposed on the common basis of perfect isostasy.

Pratt assumes different (but constant) densities of the crust in mountainous and oceanic areas. Airy proposes a crust of constant density. Density and mass corrections are applied therefore, on the basis of these and other hypotheses, to the lower part of the crust.

The corrected Bouger anomaly is defined as the Isostatic anomaly. Its value is evidentally dependent on the isostatic hypothesis used. In other words, it is dependent on the existence of isostasy as well as the degree of approximation whereby the density distributions assumed in the hypothesis approach reality.

Distribution

World-wide gravity studies have shown that a mean value of only 19 milligals from zero are in evidence (5). The interpretation (on a gross scale of observation) is that isostasy has been attained, as suggested by the Bouger anomaly, and that density assumptions (based on Pratt's theory) approach reality on this scale.

On a smaller scale however, the hypotheses make assumptions as to the local variation in density of the masses involved at depth. This is demonstrated by a comparison of isostatic anomalies based on different hypotheses, for a given type location, which results in differences of 10 (or more) milligals. (6)

Actual values of gravity anomalies apparently lose significance with a reduction in scale. This reduction emphasizes the local depth of density anomalies (not accounted for by the hypotheses), which factor is negligible on a world-wide scale.

Without regard to the hypothesis used however, large gravity anomalies can be traced on either side of the Nicobar-Andaman arc. (Fig. 1) Apparently therefore local differentials in the gravity anomalies, based on any isostatic hypothesis, have significance.

The conclusion is reached that local gravity differentials are related to the local depth to density anomalies.

Burma and the Himalayas

Linear zones of large negative differentials are traced from the Sunda Arc into Burma. (Fig. 1) There is a suggestion that the linearity is not continuous near the Assam Syntax. Beyond this the trend resumes. There are evidences (7) of a linear zone of free-air anomalies beyond the crystalline axis of the Great Himalaya in the order of 150 milligals. These linear zones of high negative differentials are characteristically associated with oceanic trenches of modern Island Arcs. Sediments of a relatively small density are demonstrated to explain the gravity anomalies in the Puerto Rico trench. (8) The local depth of density anomalies is thus associated with the trench sediments. Linear zones of high negative differentials in the Indian Region are therefore intepreted to delineate sediment-filled trenches and are essentially surface phenomena.

The upper edge of the Central Indo-Gangetic Trough displays high negative zonal anomalies. (Fig. 1) These are likewise attributed to sediments.

The Peninsula

The Peninsula of India displays a differential of some 60 milligals along Latitude 20N. where a broad positive zone south of the Indo-Gangetic Trough comes into juxtaposition with the negative belt. (Fig. 1) Geological evidence indicates a tertiary and recent uplift of this zone along Latitude 23N. (9) A sub-crustal movement is therefore ascribed to this differential

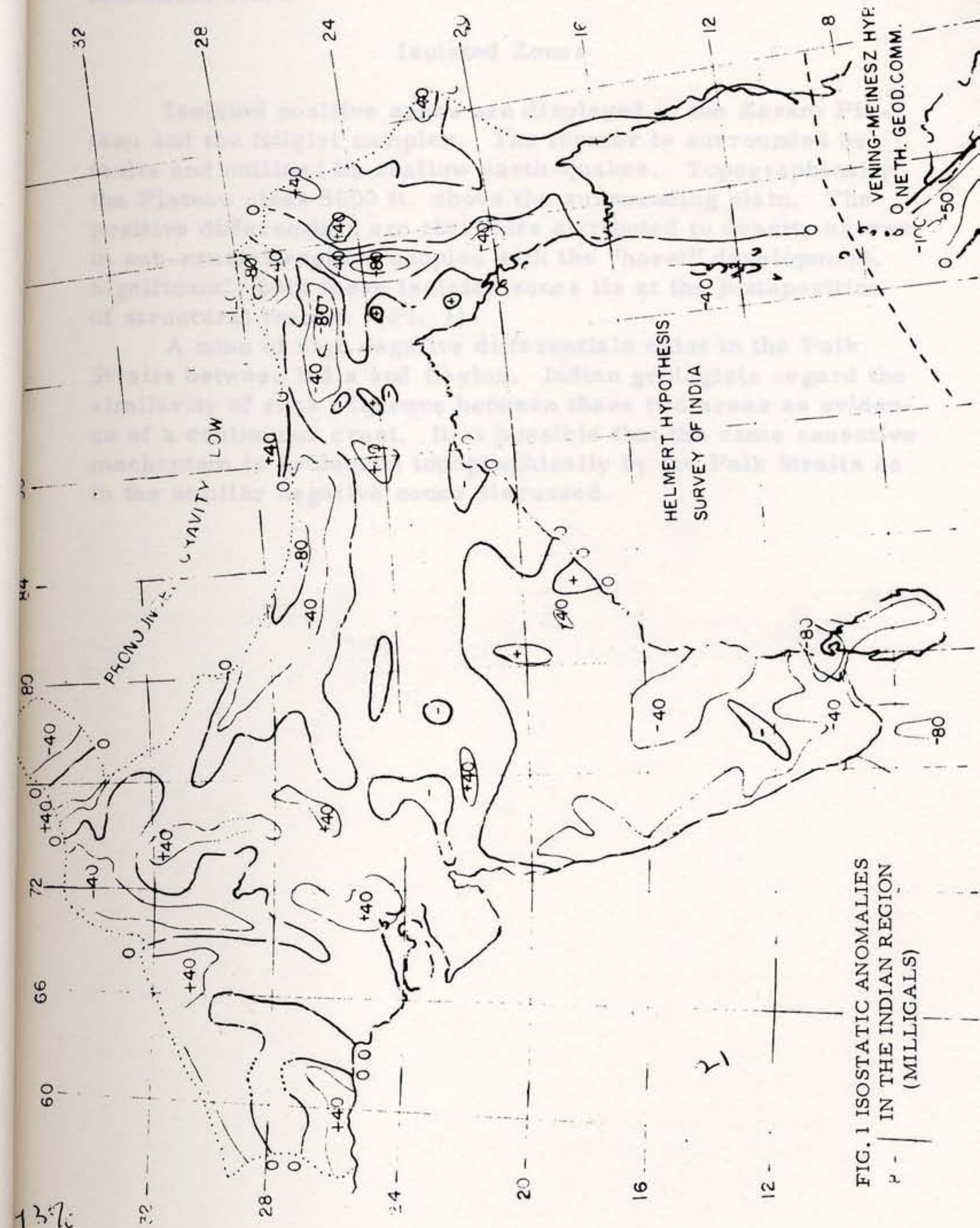

FIG. 1 ISOSTATIC ANOMALIES IN THE INDIAN REGION (MILLIGALS)

and dense material below the crust is attributed to be in comparative excess. Towards the syntax even higher positive differentials exist.

Isolated Zones

Isolated positive zones are displayed in the Assam Plateau and the Nilgiri complex. The former is surrounded by faults and outlined by shallow earth-quakes. Topographically the Plateau rises 5000 ft. above the surrounding plain. The positive differentials are therefore attributed to density excess in sub-crustal regions coupled with the "horst" development. Significantly both these isolated zones lie at the juxtaposition of structural trends. (Pl. 1)

A zone of high negative differentials exist in the Palk Straits between India and Ceylon. Indian geologists regard the similarity of rock sequence between these two areas as evidence of a continuous crust. It is possible that the same causative mechanism is evidenced topographically by the Palk Straits as in the similar negative zones discussed.

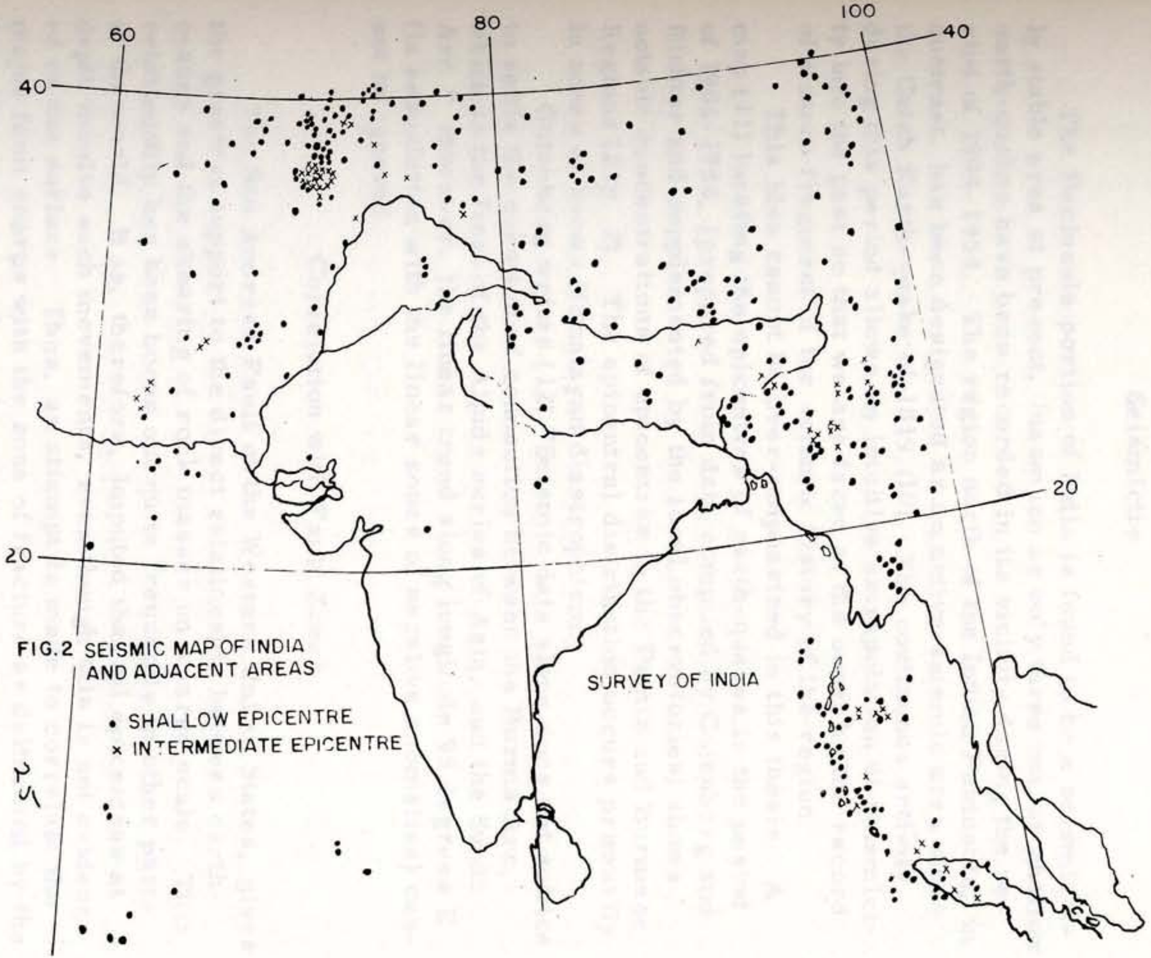

FIG. 2 SEISMIC MAP OF INDIA AND ADJACENT AREAS

CHAPTER III

A SEISMIC STUDY OF INDIA AND ITS NORTHERN ENVIRONMENT

Seismicity

The Peninsula portion of India is found to be a seismically stable area at present, inasmuch as only three major shallow earth-quakes have been recorded in its vicinity during the period of 1904-1954. The region north of the Indian Peninsula, in contrast, has been designated as an active seismic area since the Cutch Earth-quake of 1819 (10). The continuous activity during this period allows an intuitive extrapolation of seismicity into the past so that we are faced at the onset by the record of a mere fragment of the seismic history of the region.

This idea cannot be over-emphasized in this thesis. A map (11) locating the epicentres of earth-quakes in the period of 1904-1954, (prepared from data compiled by Gutenberg and Richter and supplemented by the local observatories) shows notable concentrations of epicentres in the Pamir and Burmese Regions (Fig. 2). The epicentral distribution occurs primarily in zones of knows Himalayan diastrophism.

Gutenberg writes (12) "Seismic data alone does not suffice to settle the question of connection between the Burma Arc, which is the first of the Alpide series of Asia, and the Sunda Arc." However, the linear trend along longitude 95 degrees E (in association with the linear zones of negative anomalies) cannot be ignored.

Correlation with Fault Zones

The San Andreas Fault of the Western United States, gives the greatest support to the direct relationship between earthquakes and the shearing of rock masses on a large scale. This relationship has been borne out quite frequently in other parts of the world. It is, therefore, imputed that all epicentres at depth involve such movements, even though this is not evidenced on the surface. Thus, an attempt is made to correlate the major fault scarps with the zone of fracture as delineated by the foci of recorded earth-quakes in the Pamir and Burma areas. The data compiled by Gutenberg and Richter is used because it is the most complete and systematic (13).

Tables 1 and 2 list the shallow and intermediate epicentres which have been located (Pl. 2) on a geologic map. (14)

These authors warn "that great caution is required. . . in attempting detailed correlations between. . . epicentres and geological structures" but recognize for the Pamir that "Locations in this region are very good. . . " (15).

Burma

Three intermediate epicentres (nos. 4, 5, and 6) occur in a small area, (24. 5 N 95 E), so that the line of section is drawn close to this and perpendicular to the structural trends. Only epicentres in the southern vicinity are considered. The resulting section (Fig. 3A) indicates a fracture zone which is correlated with the Halflong-Disang and Naga Thrust Zone on the surface. The angle maintained is 26 degrees.

The Pamir

The epi-central pattern is somewhat more clear in this region. The zone of intermediate earth-quakes is correlated with the fracture zone in the Pamir Trough (16). The angle maintained is 28 degrees (Fig. 3B).

Correlation of this type is, at best, a first approximation as it involves an arbitrary choice of epi-centres and apparent dip. However, the values obtained are comparable to the fracture zones of shallow dip for the Kamchatka-Kurile Arc and the South American zone, where the value obtained by Benioff are 34 degrees and 23 degrees respectively (17).

28

The Mohorovicic(M) and Conrad(C) Discontinuities

These discontinuities have been determined, to some degree of approximation, in the Region North of India from a comparison of the travel-times of longitudinal and transverse waves (18). Use was made of earth-quakes and artificial explosions in reflection and refraction methods (Table 3). The Pamir indicates M=60± (km.) and C-45km. while the region in the North-East India indicate values for M=46km. and C=25km.

The "Seismic Limit"

A remarkable feature of the intermediate earth-quakes in these areas is the consistent depth at which they occur. Lines are drawn to indicate these boundaries beneath which there is no evidence of activity (Fig. 3A and B). Apparently that the material is incapable of fracture under the existing conditions. The term "Seismic Limit" is used here as a result to designate a zone below which no earth-quakes have been determined up to

TABLE 3

MOHOROVICIC AND CONRAD DISCONTINUITIES IN THE NORTH INDIAN REGION

"Granite" layers		C (km)	"Gabbro" layers		N (km)	"Ultra-basic" layers		Region	Method	Reference
V	v		V	v		V	v			
5.6	3.4	25	6.6	3.9	46	7.9	4.5	NE India	Eb	Anonymous (1955)
5.7	3.4	20	6.2	3.6	50	8.0	-	Central Asia	Ab	Bune & Butovskaya (1955)
5.5	-	15	6.4	-	55	8.1	-	Lake Issyk-Kul	Ab, Eb	Gamburtsev and Veytsman (1956)
5.5	-	20	6.4	-	35	8.1	-	SE of L. Balkash		
5.5	-	16	6.4	-	38	8.1	-	NW of L. Issyk-Kul		
5.5	-	18	6.4	-	40	8.1	-	SW of L. Balkash		
-	-	45	-	-	60±	-	-	N. Pamir		Veytsman et al (1957)

V = Velocity of Longitudinal Wave
v = Velocity of Transverse Wave

A = Artificial Explosion
E = Earth-quake
a = Reflection Method
b = Refraction Method

the present. Based on these ideas the depth of "Seismic Limit" in Burma and the Pamir are 130 km. and 260 km. respectively. This may be compared with a value of 720 km. derived on a similar basis for the Sunda Arc.

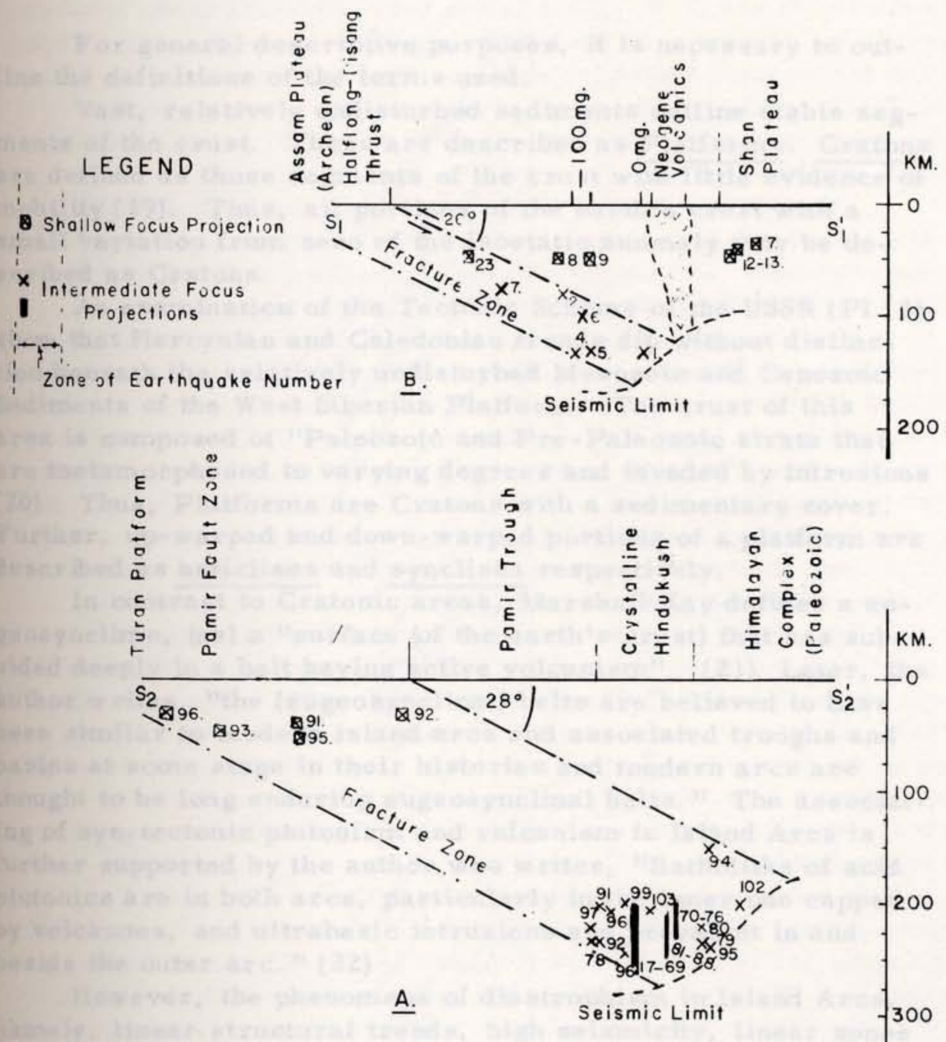

FIG. 3 TECTONIC PROFILES OF BURMA AND THE PAMIR (TO SCALE)

CHAPTER IV

OUTLINE OF GEOTECTONICS OF INDIA AND EAST-CENTRAL ASIA

Definitions

For general descriptive purposes, it is necessary to outline the definitions of the terms used.

Vast, relatively undisturbed sediments outline stable segments of the crust. These are described as Platforms. Cratons are defined as those segments of the crust with little evidence of mobility (19). Thus, all portions of the earth's crust with a small variation from zero of the isostatic anomaly may be described as Cratons.

An examination of the Tectonic Scheme of the USSR (Pl. 1) show that Hercynian and Caledonian trends dip without distinction beneath the relatively undisturbed Mesozoic and Cenozoic Sediments of the West Siberian Platform. The crust of this area is composed of "Paleozoic and Pre-Paleozoic strata that are metamorphosed to varying degrees and invaded by intrusions (20). Thus, Platforms are Cratons with a sedimentary cover. Further, up-warped and down-warped portions of a platform are described as anticlises and synclises respectively.

In contrast to Cratonic areas, Marshall Kay defines a eugeosynclime, (as) a "surface (of the earth's crust) that has subsided deeply in a belt having active volcanism". (21) Later, the author writes, "the (eugeosynclinal) belts are believed to have been similar to modern island arcs and associated troughs and basins at some stage in their histories and modern arcs are thought to be long enduring eugeosynclinal belts." The associating of syn-tectonic plutonism and volcanism in Island Arcs is further supported by the author who writes, "Batholiths of acid plutonics are in both arcs, particularly in the inner one capped by volcanoes, and ultrabasic intrusions are prevalent in and beside the outer arc." (22)

However, the phenomena of diastrophism in Island Arcs, namely, linear structural trends, high seismicity, linear zones of high negative isostatic anomalies and deep sea troughs, permit easier correlation in comparison with volcanism in eugeosynclimes.

The Indian Peninsula

The peninsula of India exposes Archean rocks in more than half its area. No comparable area of such exposure is found in East Central Asia. The oldest Archean formation is at present believed to be the Bundelkhand Gneiss. (Pl. 1) Surrounding this area, the structural trends in the Archean zones divide themselves into four distinct trends. The Aravalli trend in the north-western portion of the peninsula has a characteristic strike to the N. E. At the Gulf of Cambay it diverges with trends to the North and N. W. This latter trend persists in the Dharwar trends which merge in the Nilgiri complex in south India. From here the Eastern Ghats trend follows the east coast with a general N. E. strike. This trend persists in the eastern portion of the Archean Assam Plateau. The fourth major trend, the Satpura, strikes E. N. E.

The relative ages of these trends has not been definitely established. It is believed that the Satpura trend is the most newly formed. Uraninite-bearing pegmatites in this trend indicate ages in the order of 955 ± 40 million years. (23)

The Cuddapah depression is occupied by Late Proterozoic Cuddapah and Kurnool sediments. (Fig. 4) The Cuddapahs are folded on their eastern margin parallel to the Eastern Ghats trend while the later Kurnool formations are relatively undisturbed. The Vindhyan depression is occupied by the disturbed and folded Semri series and the overlying Upper Vindhyans composed largely of undisturbed gypsiferous sandstones and shales. This latter system is correlated with the Kurnools of the Cuddapah basin by Indian Geologists.

The Vindhyan area comprises some 40, 000 square miles and is strategically located in the central part of the Peninsula with respect to the Cuddapah area in the south. The generally stable character of the Peninsula has thus, been established since the beginning of the Paleozoic. Block faulting is however in evidence from the 'graben' of the Mahanadi and Godavari rivers in which Gondwana sediments of Carboniferous age have accumulated.

In west central India, extrusive sheets of Deccan Trap occupy some 200, 000 square miles. Dike clusters, from which the material is believed to have been extruded, strike in the general E. W. direction along the Satpura trend and also parallel to the west coast as far north as the Kathiawar Peninsula. Thicknesses of the Traps have been estimated at 6000 feet in the west coast, but average about 2000 feet in the east. The age of the Traps are considered Eocene from a study of plants, fish and foraminifera found in the intercalated sedimentary beds. (24) In general, the flows are practically horizontal (25) but have been subject to monoclinal folding and block faulting especially along the dike trends.

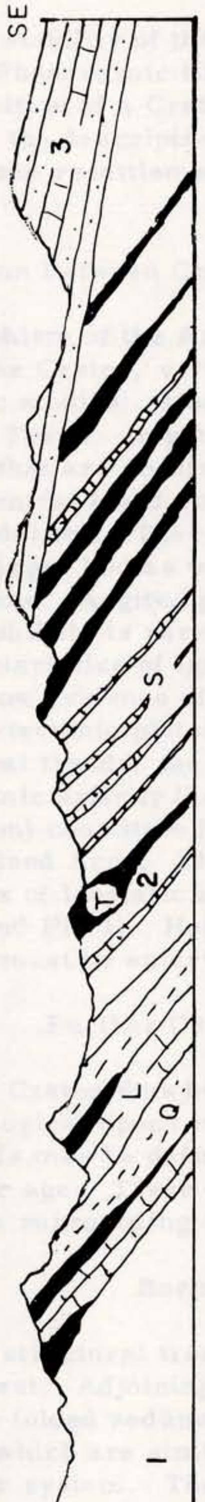

FIG. 4. A STRUCTURAL (SKETCH) SECTION ILLUSTRATING THE RELATION OF CUDDAPAH AND KURNOOL ROCKS IN THE CUDDAPAH BASIN

1 Dharwar Schists (Huron.) 2. Cuddapah Traps (T), Limestone (L), Quartzite (Q) & Shale (S) (Algon.) 3. Kurnool ss. (L Torr.)

The general stability of the Peninsula is seen to have persisted throughout Phanerozoic time and it may be defined as a Craton. The definition of a Craton, however, undergoes a modification whereby the descriptive usage of 'general stability' does not preclude the resettlement of a highly block-faulted Craton.

Correlation Between Cratons and Island Arcs

The diastrophism of the Archean formations composing the main body of the Craton, will not be deciphered without detailed petrographic studies. Most progress has been made in the Eastern Ghats Trend. In general, they are composed of felspathic schists that are consistently in evidence of plutonic bodies along the central trend zones. These are the Charnockites and the Khondalites. They are composed of hypersthene granulites in the larger bodies with ultrabasic members of enstative - hypersthene. Augite, garnets and blue quartz are distinctive but amphibole is rarely found (26). They exhibit in general the characteristics of igneous intrusives. (27) At the same time they show evidence of being folded (28). Thus, there is evidence of syn-tectonic plutonism in the Eastern Ghats.

The structural trends, the syn-tectonic plutonism and the possibility of seismic activity (as evidenced in a highly fractured Peninsula Craton) constitute factors which approach modern diastrophism in Island Arcs. There is even a suggestion near the Nilgiri complex of isostatic anomalies parallel to the trend (compare Fig. 1 and Pl. 1). Hence, the conversion of Island Arcs into Cratons must be entertained in any study of the latter.

Further Definitions

The age of a Craton thus becomes of importance and is defined as the geological epoch in which it was formed. In this connection, Massifs may be defined as old Cratons surrounded by those of younger age. These are invariably limited in size in comparison with surrounding Cratons. (Pl. 1)

Burma

The general structural trends in this region are distinctly arcuate to the east. Adjoining the Assam Plateau are Paleogene and Mesozoic folded sediments in a zone of high negative anomalies (Pl. 2) which are similar to the outer arc of the Andaman - Nicobar system. The Halflong - Disang Thrust marks the western extremety of Eocene Disang Series in North Burma. Parallel thrusts to the north-west are in evidence (29).

East of the sedimentary zone and parallel to it there occurs a volcanic zone. Geological evidence shows that these volcanoes were active in the upper Miocene and Pleistocene times (30). Neogene sediments surrounding these volcanics indicate the submergence of the zone at the period of active volcanism. To the east and closely parallel to the volcanics are the folded and faulted Paleozoics of the Shan Plateau. (Fig. 5)

The Himalayas

This region has not been studied completely. However, traverses made at isolated areas allow a sub-division (31) of the Himalayas into four broad tectonic zones. (Fig. 6)

Adjoining the Siwalik System to the north is an apparently continuous overthrust zone of Paleozoic and Cenozoic sediments. The Soan Basin and the Kashmir Valley represent this zone (Figs. 7A and 7B). These two areas enclose the awe-inspiring Himalayan syntax. (Pl. 1) The Assam Syntax is similarly enclosed by two thrust zones but little else is known about this area.

The Great Himalaya lies to the north and is composed of meta-sediments with granite plutons. Further north lies the Tethyan zone of folded Paleozoic and Mesozoic sediments with allocthonous Cretaceous limestone overthrust from Tibet.

The extreme zone of Himalayan diastrophism is bounded on the north by the Tarim Massif and Cratonic areas formed during the Paleozoic.

Correlation Between Island Arcs and Cratons

There is much evidence to indicate that the Burmese region is an erstwhile Island Arc. The sequence of fracture zone, large negative anomalies (which have been associated with trenches) and recent volcanics may be aligned with similar phenomena in the modern Nocobar-Andaman Arc System.

The arcuate structure of the Pamir is also well distinguished (Pl. 1). The relative location of the fault zone with respect to the Pamir Trough and Plutonism bear a strong relationship to the Burmese Arc. (Fig. 3A and 3B)

Nonetheless Arcs, which represent the final stages of diastrophism, exhibit structural trends and syn-tectonic plutonism. These factors are also determined in even the most ancient cratonic areas (Pl. 1).

Hence, the concept of the conversion of Island Arcs into Cratons must be entertained for a more thorough understanding of diastrophism.

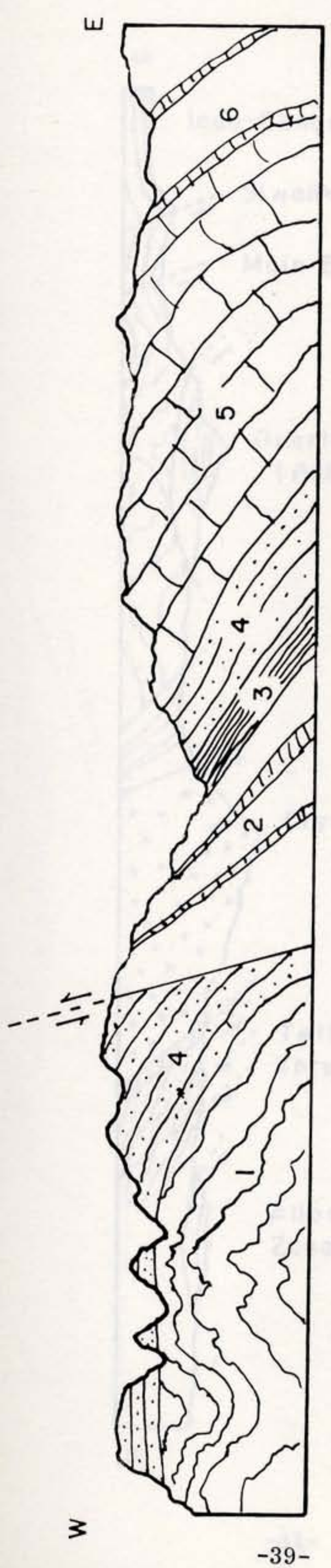

FIG. 5. A STRUCTURAL (SKETCH) SECTION ILLUSTRATING THE PALEOZOIC SYSTEMS OF THE SHAN PLATEAU (After La Touche G.S.I.)

1. Chaung Magyi Series (Є)
2. Naungkangyi Beds (O)
3. Graptolite Beds (Lower Sil.)
4. Namshim ss. (Upper Sil.)
5. Plateau Limstone (D–P)
6. Namyau Beds (J)

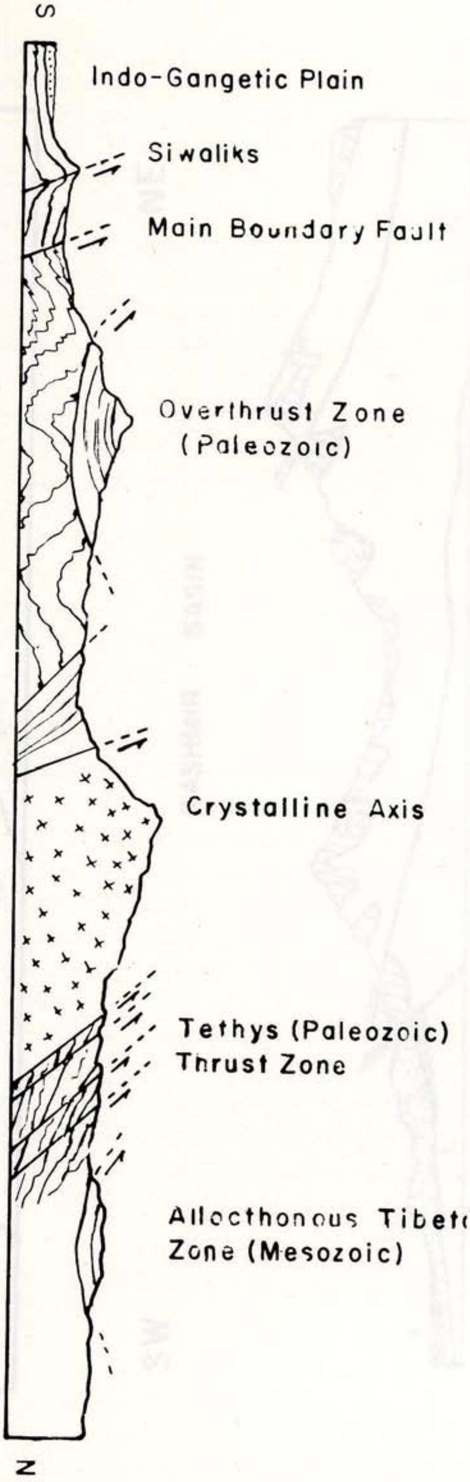

FIG.6 A STRUCTURAL (SKETCH) SECTION OF THE HIMALAYAS