SEISMOLOGICAL SERIES

of the

DOMINION OBSERVATORY

1960-2

Canadian Earthquakes - 1960

W. G. Milne and W. E. T. Smith

Seismological Service
of Canada

OTTAWA, CANADA

Department of Mines and Technical Surveys

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INTRODUCTION

The Seismological Service of Canada has, since its inception, kept records of all known Canadian earthquakes, although no complete list of these has ever been published. Papers have been produced describing the larger earthquakes, and the accumulated knowledge of large and small earthquakes was the basis for a seismic probability map for Canada produced in connection with the National Building Code in 1953.

This probability map was intended to serve as a guide to engineers and insurance underwriters. Canada was divided into four zones, ranging from zone 0 - no risk, to zone 3 - major risk. Because of the limitations of knowledge it was not possible to define the boundaries of the various zones precisely, and they were shown by straight lines to indicate that they were indefinite. This was not very satisfactory because when seismic risks had to be assessed in places close to a border, the question arose whether the higher or lower risk should be applied. The map did not lend itself to such arbitrary decisions. In order to increase the usefulness of the probability map, it was decided to prepare maps showing all known earthquakes in Canada.

For this purpose Canada has been divided into four regions: (1) the Western region, lying west of the 113th meridian and south of the 60th parallel; (2) the Eastern region lying east of the 85th meridian and south of the 60th parallel; (3) the Arctic region comprising all of Canada north of the 60th parallel, and; (4) the Central region, lying between the 113th and 85th meridians and south of the 60th parallel. Studies of these four different regions will proceed independently and earthquakes will be catalogued with independent numbering systems in the four regions and issued in the Publications of this Observatory.

Earthquake maps are already available for Western Canada in the Publications of the Dominion Observatory. Milne with various co-authors has produced papers covering the seismic history to 1951 and listing earthquakes for each year since that time. The most recent of these papers, cataloguing epicentres for the years 1955 to 1959 incl., is now in press.

The listing contained herein for Western Canada continues this catalogue.

The position in Eastern Canada is less advanced. Smith has completed a detailed survey of all historical records to the end of 1927, and a paper on these earthquakes is in preparation. Smith has also perfected a technique of epicentral location based on the network in the St. Lawrence Valley and has proved this technique by application to the earthquakes from 1954 to 1959. These epicentres will be published in the Seismological series in the immediate future.

In order that those interested in Canadian earthquakes may have an annual list without waiting until the larger project has been completed, annual papers will be issued in the Seismological series as soon as possible after the close of each year. In this first issue the earthquakes for 1960 are listed in Tables I, II and III and their epicentres are plotted on Figures 1 and 3. In these figures the size of the point indicates the magnitude of the earthquake, and the character of the point (open or closed circle) represents the quality of the epicentre. Classes "a" and "b" epicentres are shown with closed dots; "c" epicentres are shown with open circles; and "d" epicentres are not plotted. The description of the quality of an epicentre is available in the paper on 1955-1959 epicentres.

The papers of the Seismological series will not replace the more formal papers in the Publications, which will be produced only at intervals dictated by the seismic activity.

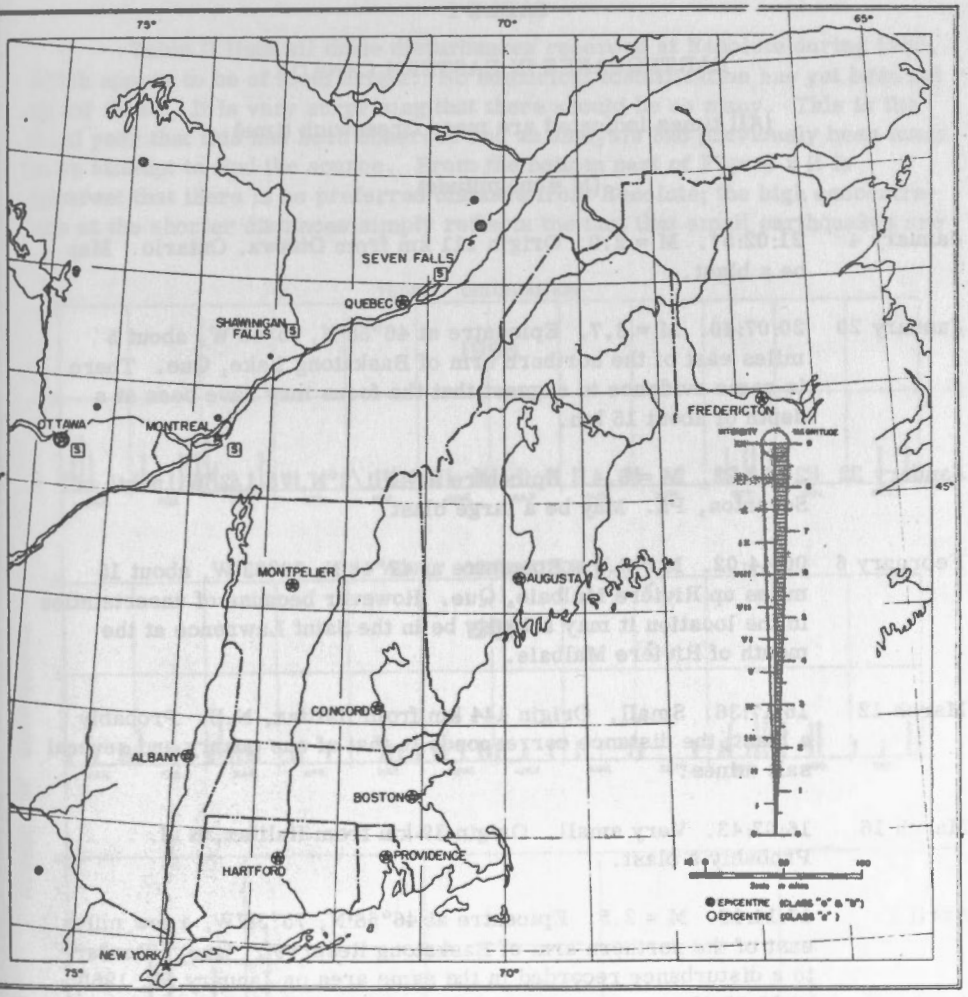
STATION CHANGES

In 1958 the Department undertook to expand the seismological network so that no point in the country will be more than 300 miles from a first-class seismograph station and all the seismograph stations will have identical equipment of the highest standard. In addition to improved seismographs, the time control at the stations is being modified through the use of crystal clocks or fork-driven chronometers; this will permit the maintenance of time accurate to better than 0.1 sec/day. This expansion program is intended partly to assist international seismology in the detection of distant earthquakes and nuclear explosions, but also to supply information on the seismicity of Canada. As part of this program a new station came into operation near Penticton, B.C., in January 1960 but because of operational difficulties it did not operate continuously until October. The station at Penticton replaced the stations at Lillooet, B.C. (discontinued in January, 1960) and at Horseshoe Bay, B.C. (discontinued April 30, 1960). Eventually the station at Alberni, B.C. will be replaced by one at Port Hardy, B.C. The consequence of this change is that the coverage of British Columbia as a whole will be much improved but that very small events, with magnitudes less than 2.5 to 3, will be missed. This effect will already be noticed in the present listing, owing to the closing of Horseshoe Bay.

As part of the expansion program, plans are well advanced for stations at Alert and Mould Bay in the Queen Elizabeth Islands, at Schefferville, Que., and at Fort St. James, B.C. The stations at Halifax and Ottawa were re-instrumented to the new standard during 1960.

EASTERN CANADA

The earthquakes recorded in Eastern Canada are listed in Table I and their epicentres plotted in Figure 1. No numerical identification has yet been set up for these. In determining these epicentres, the cooperation of Rev. M. Buist, S.J. of Brèbeuf College, Montreal, is acknowledged for supplying the records from that station on a routine basis. There have been no major earthquakes in Eastern Canada and the number of small earthquakes



is much lower than in the past. This is because many disturbances previously listed as earthquakes are now known to have been blasts. Early in the 1940s a series of disturbances began to be recorded at a distance of about 140 km from Ottawa. A study of these showed that most of them occurred during the daylight hours, which suggested that they were man-made, but it was not until January 21, 1960 that one of the disturbances was sufficiently large to record at Ottawa, at Montreal and at Shawinigan Falls. When this happened it was possible to identify the disturbance with blasts in an open-pit iron mine in northern New York State. It is a measure of the accuracy of epicentral location that the centre determined by seismic means lay within the boundaries of the open pit. Since then a number of other events in Eastern Canada have been identified with mining operations in Vermont, southern Quebec and other localities. This has drastically reduced the number of earthquakes listed per year and will of course modify the earthquake catalogue being prepared for Eastern Canada.

TABLE I

EARTHQUAKES IN EASTERN CANADA

(All times indicated are mean Greenwich time)

(M = magnitude)

January 4	21:02:57. M = 2.0. Origin 111 km from Ottawa, Ontario. May be a blast.
January 20	20:07:40. M = 3.7. Epicentre at 46°58'N, 75°40'W, about 5 miles east of the northern arm of Baskatong Lake, Que. There is some evidence to suggest that the focus may have been at a depth of about 15 km.
January 22	20:53:22. M = 3.4. Epicentre at 41 1/2°N, 75 1/2°W, north of Scranton, Pa. May be a large blast.
February 6	00:44:02. M = 3.3. Epicentre at 47°48'N, 70°23'W, about 15 miles up Rivière Malbaie, Que. However because of uncertainties in the location it may actually be in the Saint Lawrence at the mouth of Rivière Malbaie.
March 12	16:17:36. Small. Origin 144 km from Halifax, N.S. Probably a blast; the distance corresponds to that of one quarry and several salt mines.
March 16	16:07:43. Very small. Origin 39 km from Halifax, N.S. Probably a blast.
April 1	17:11:12. M = 2.5. Epicentre at 46°56'N, 75°38'W, a few miles east of the northern arm of Baskatong Reservoir, Que. Similar to a disturbance recorded in the same area on January 20, 1960 at 20:07:40.
April 23	11:47:52. M = 4.0. Epicentre at 47°32'N, 70°18'W, about 9 miles southwest of La Malbaie, Que. Felt at La Malbaie, Que.
April 28	09:28:33. Origin 148 km from Halifax, N.S. Possibly a blast.
July 9	07:34:59. M = 2.6. Epicentre at 46°18'N, 73°02'W, about 18 miles east of St. Gabriel, Que.
July 23	05:49:07. M = 2.9. Epicentre at 45°43'N, 73°40'W, about 15 miles north of Montreal, Que.
November 3	04:11:47. M = 2.7. Epicentre at 48°00'N, 74°52'W, about 15 miles west of Parent, Que., where it was felt by a few persons.
December 19	19:27:57. M = 2.9. Epicentre at 45°45'N, 75°13'W, about 10 miles west of Ripon, Que.

ARCTIC

Table II lists all those disturbances recorded at Resolute during 1960, which appear to be of local origin. No numerical identification has yet been set up for these. It is very surprising that there should be so many. This is the third year that this has been observed and an analysis had previously been made in an attempt to find the source. From the bottom part of Figure 2 it is apparent that there is no preferred distance from Resolute; the high concentration at the shorter distances simply reflects the fact that small earthquakes are

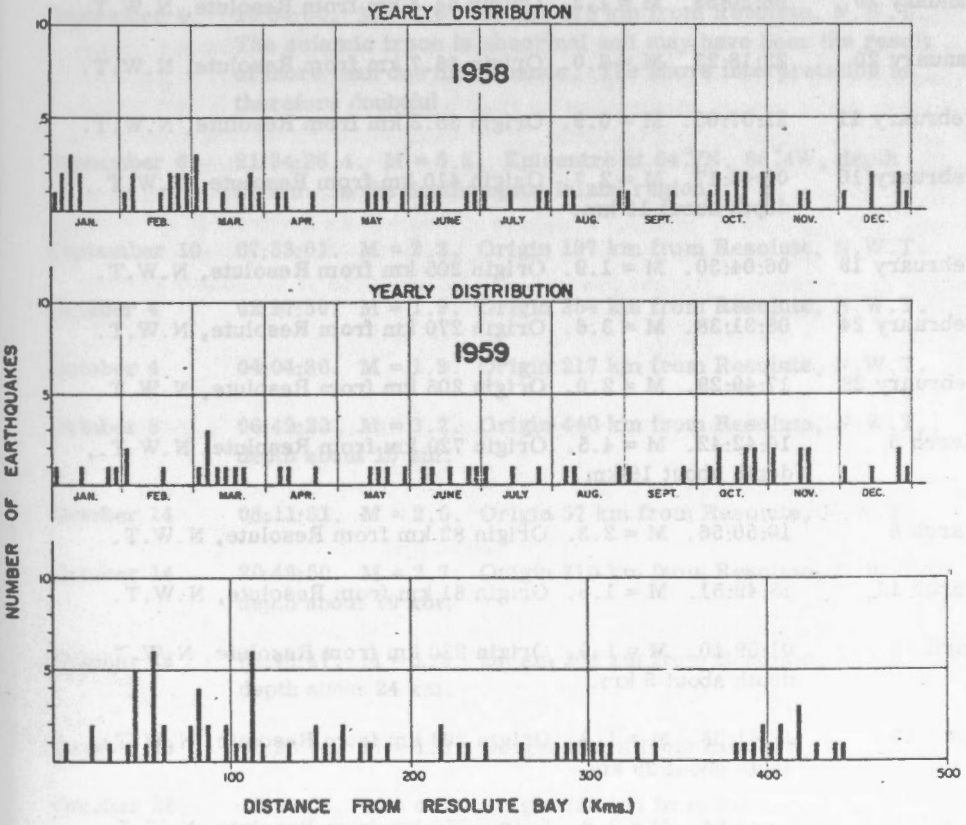


Figure 2

not recorded from the longer distances. The upper part of the figure shows that there is no favored season for these disturbances, as there would be if they were due to ice action. Despite a reluctance to believe that there is so much local seismicity in the Arctic Islands no alternative explanation can be offered. When the stations at Alert and Mould Bay come into operation late in 1961, the source of these disturbances may be determined.

TABLE II

LOCAL EARTHQUAKES RECORDED AT RESOLUTE

(All times indicated are mean Greenwich time)

(M = magnitude)

January 18	05:20:59. M = 1.4. Origin 49.2 km from Resolute, N.W.T.
January 20	06:20:59. M = 1.3. Origin 54.4 km from Resolute, N.W.T.
January 20	23:18:23. M = 2.0. Origin 46.7 km from Resolute, N.W.T.
February 11	21:07:05. M = 0.9. Origin 35.3 km from Resolute, N.W.T.
February 16	06:46:17. M = 2.7. Origin 410 km from Resolute, N.W.T., depth about 11 km.
February 19	06:04:30. M = 1.9. Origin 205 km from Resolute, N.W.T.
February 24	08:31:38. M = 3.6. Origin 270 km from Resolute, N.W.T.
February 29	17:49:29. M = 2.0. Origin 205 km from Resolute, N.W.T.
March 5	10:42:42. M = 4.5. Origin 720 km from Resolute, N.W.T., depth about 16 km.
March 6	10:50:56. M = 2.3. Origin 82 km from Resolute, N.W.T.
March 12	18:49:51. M = 1.6. Origin 81 km from Resolute, N.W.T.
April 10	01:59:10. M = 1.9. Origin 230 km from Resolute, N.W.T., depth about 5 km.
April 17	12:41:35. M = 1.8. Origin 203 km from Resolute, N.W.T., depth about 29 km.
May 17	19:15:04. M = 4.8. Origin 850 km from Resolute, N.W.T., depth about 11 km.
May 19	07:44:37. M = 2.8. Origin 198 km from Resolute, N.W.T., depth about 24 km.
May 28	11:32:52. M = 3.6. Origin 516 km from Resolute, N.W.T., depth about 31 km.
June 7	13:57:39. M = 2.0. Origin 225 km from Resolute, N.W.T., depth about 10 km.

June 19 — 00:45:15. M = 3.2. Origin 250 km from Resolute, N.W.T., depth about 32 km.

July 9 — 19:23:09. M = 2.2. Origin 115 km from Resolute, N.W.T.

August 6 — 06:22:00. M = 2.5 to 3.5. Origin 100 to 200 km from Resolute, N.W.T.

August 13 — 06:40:31. M = 1.8. Origin 97.4 km from Resolute, N.W.T.

September 4 — 10:34:04. M = 2.6. Origin 173 km from Resolute, N.W.T. The seismic trace is abnormal and may have been the result of more than one disturbance. The above interpretation is therefore doubtful.

September 6 — 21:24:26.4. M = 5.5. Epicentre at 64.°7N, 86.°4W, depth 25 km. In the Southampton Island region.

September 10 — 07:53:01. M = 2.2. Origin 197 km from Resolute, N.W.T.

October 4 — 02:27:50. M = 1.9. Origin 254 km from Resolute, N.W.T.

October 4 — 04:04:30. M = 1.9. Origin 217 km from Resolute, N.W.T.

October 8 — 06:49:20. M = 3.2. Origin 440 km from Resolute, N.W.T., depth about 15 km.

October 14 — 08:11:51. M = 2.5. Origin 57 km from Resolute, N.W.T.

October 14 — 20:46:50. M = 2.7. Origin 210 km from Resolute, N.W.T., depth about 20 km.

October 15 — 02:48:47. M = 1.5. Origin 164 km from Resolute, N.W.T., depth about 24 km.

October 19 — 00:23:04. M = 1.6. Origin 49 km from Resolute, N.W.T.

October 22 — 15:27:37. M = 4.1. Origin 730 km from Resolute, N.W.T., depth about 14 km.

November 4 — 09:54:35. M = 1.7. Origin 49 km from Resolute, N.W.T.

November 10 — 22:32:24. M = 3.3 Origin 550 km from Resolute, N.W.T.

November 16 — 08:48:58. M = 1.7. Origin 49 km from Resolute, N.W.T.

December 2 — 22:54:15. M = 2.4. Origin 174 km from Resolute, N.W.T.

December 10 — 13:02:47. M = 2.2. Origin 136 km from Resolute, N.W.T.

December 26 13:45:35. M = 2.1. Origin 166 km from Resolute, N.W.T., depth about 22 km.

December 28 19:45:40. M = 4.3. Origin 1125 km from Resolute, N.W.T.

WESTERN CANADA

Table III lists numerically earthquakes of the Western region, with epicentres plotted in Figure 3. The list is already showing the effects of the closing of the station at Horseshoe Bay, but the loss of information on the very small seismic disturbances is not regarded as serious. Earthquakes of this size can have little tectonic significance and it is always difficult to know whether they are true earthquakes or simply blasts. While all known blasts have been eliminated from the table, it is possible that some may remain. The problem has become particularly acute because of the new station at Penticton. This station is so sensitive that it shows a large number of "local" earthquakes, many of which may be blasts. A second station will be operated in the vicinity of Penticton during the summer of 1961 in the hope of locating the source of these disturbances. For the present, all disturbances of magnitude greater than 2 are listed.

TABLE III

EARTHQUAKES IN WESTERN CANADA OR ADJACENT AREAS

(Unless otherwise indicated, all times are mean Greenwich time)

(M = magnitude)

January 2 1390 12:08:02. M = 3.5. Centred about 250 miles from Victoria, probably off coast of Washington.

January 2 1391 12:41:57. Epicentre about 50 miles from Alberni, B.C.

January 2 1392 18:34:09. 48°45'N, 122°16'W. Q = a. M = 2.2. Small earthquake; origin near South Pender Island, B.C.

January 7 1393 09:16:04. 46°56'N, 122°30'W. Q = a. M = 3.6. Earthquake felt in southern Puget Sound area of Washington.

January 12 1394 07:52:55. 48°2N, 124°9W. Q = c. M = 2.3. Epicentre of this small earthquake lies off west coast of Olympic Peninsula, Washington.

Table III continued on page 10

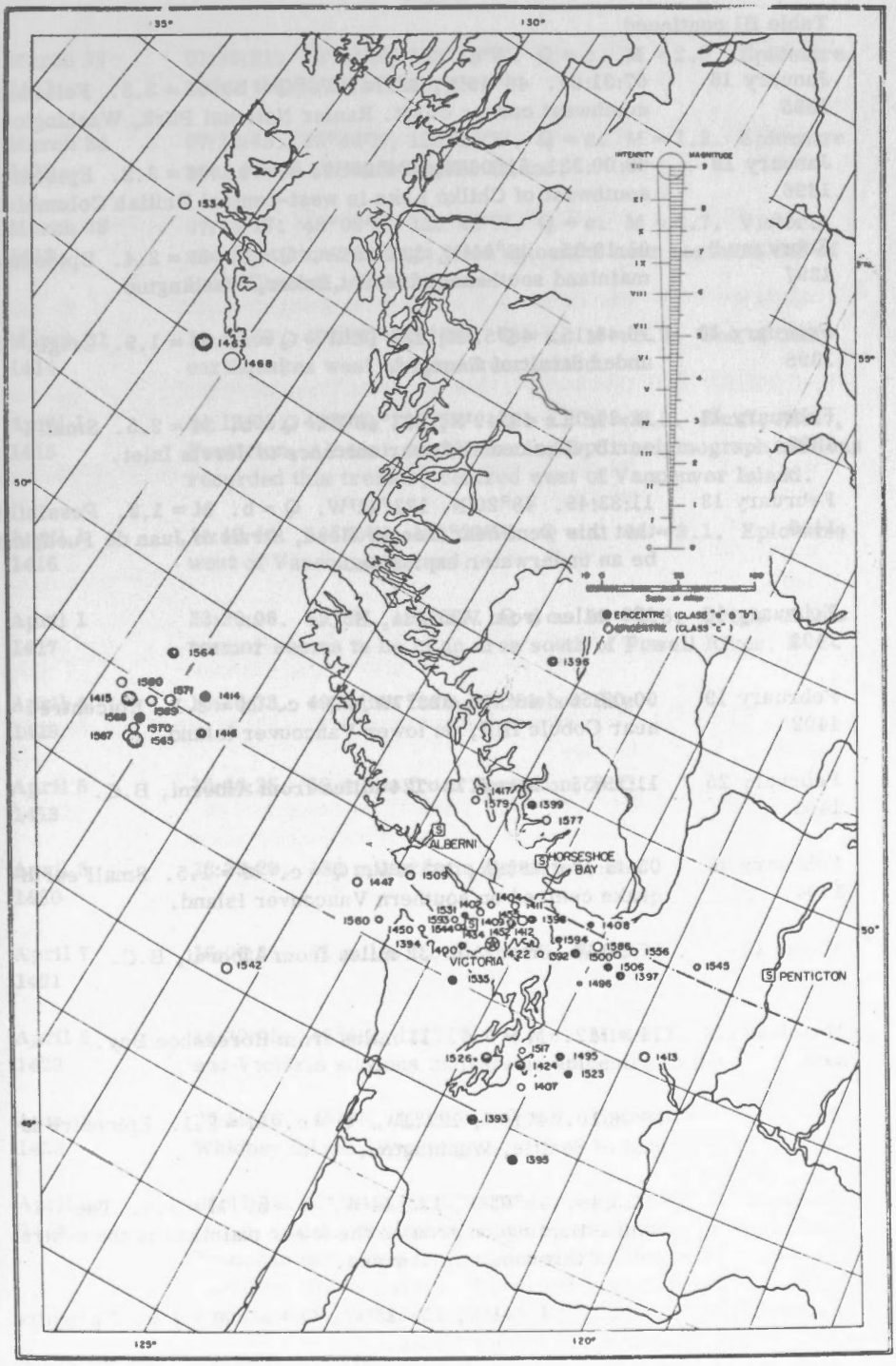

INTENSITY
MAGNITUDE
EPICENTRE (CLASS "a" & "b")
EPICENTRE (CLASS "c")
ALBERNI
HORSESHOE BAY
VICTORIA
PENTICTON

Figure 3

Table III continued

January 16 1395	07:31:01. 46°45'N, 121°47'W. Q = b. M = 3.5. Felt near southwest corner of Mt. Ranier National Park, Washington.
January 19 1396	09:00:53. 51°06'N, 124°29'W. Q = a. M = 3.3. Epicentre southwest of Chilko Lake in west-central British Columbia.
February 6 1397	01:10:35. 48°44'N, 121°32'W. Q = b. M = 2.4. Epicentre on mainland southeast of Mount Baker, Washington.
February 10 1398	16:48:15. 48°51'N, 123°00'W. Q = a. M = 1.9. Origin under Strait of Georgia.
February 11 1399	12:35:09. 49°49'N, 123°46'W. Q = b. M = 2.5. Small earthquake centred near entrance to Jervis Inlet.
February 13 1400	11:33:49. 48°20'N, 123°41'W. Q = b. M = 1.2. Possibility that this went near Beechy Head, Strait of Juan de Fuca; may be an underwater explosion.
February 16 1401	123 miles from Victoria, B.C.
February 19 1402	00:05:56. 48°.7N, 123°.7W, Q = c. M = 2.1. Epicentre near Cobble Hill, on lower Vancouver Island.
February 25 1403	11:29:58. M = 2.7. 124 miles from Alberni, B.C.
February 26 1404	05:48:47. 48°.8N, 123°.6W. Q = c. M = 1.5. Small earthquake centred on southern Vancouver Island.
March 12 1405	07:22:44. M = 2.0. 32 miles from Alberni, B.C.
March 12 1406	18:31:12. M = 0.6. 11 miles from Horseshoe Bay.
March 17 1407	18:08:10. 47°.6N, 122°.1W. Q = c. M = 2.1. Epicentre is east of Seattle, Washington.
March 22 1408	01:13:48. 49°03'N, 122°14'W. Q = b. M = 1.8. The Sumas-Huntingdon area on the lower mainland is the central area of this small earthquake.
March 22 1409	10:31:52. 48°44'N, 123°15'W. Q = a. M = 1.9. Epicentre near South Pender Island.
March 25 1410	07:02:51. 26 miles from Victoria, B.C.

March 27 1411 — 01:39:21. 48°54'N, 123°18'W. Q = c. M = 2.5. Epicentre under the Strait of Georgia.

March 28 1412 — 07:25:45. 48°44'N, 123°12'W. Q = c. M = 1.2. Epicentre near #1409 at South Pender Island.

March 28 1413 — 07:48:17. 48°08'N, 120°46'W. Q = c. M = 2.7. Victoria and Penticton readings yield epicentre near northern end of Lake Chelean, Washington.

March 31 1414 — 11:41:49. 49°.2N, 128°.6W. Q = a. M = 3.9. One of many earthquakes west of Vancouver Island.

April 1 1415 — 14:12:05. 48°.8N, 129°.5W. Q = a. M = 4.2. Banff, Alta., Penticton, Alberni, and Victoria, B.C. seismograph stations recorded this tremor, centred west of Vancouver Island.

April 1 1416 — 14:42:44. 48°53'N, 128°22'W. Q = a. M = 3.1. Epicentre west of Vancouver Island.

April 1 1417 — 23:20:06. 49°.8N, 124°.5W. Q = c. M = 1.8. Origin of this tremor seems to be in an area south of Powell River, B.C.

April 4 1418 — 15:20:33. 49 miles from Horseshoe Bay.

April 5 1419 — 10:46:25. 59 miles from Penticton, B.C.

April 5 1420 — 23:29:29. 182 miles from Penticton, B.C.

April 7 1421 — 16:06:31. 31 miles from Alberni, B.C.

April 9 1422 — 14:33:05. 48°.6N, 122°.7W. Q = c. M = 1.2. Horseshoe Bay, and Victoria stations indicate an epicentre in the above area.

April 9 1423 — 20:59:36. 48°.4N, 122°.6W. Q = b. Epicentre near Whidbey Island, Washington.

April 11 1424 — 06:47:34. 47°34'N, 122°15'W. Q = a. M = 3.3. Earthquake felt in Seattle, Redmond, Ranton, and Burian in Washington. Neumann estimates the maximum intensity as VI on the modified Mercali scale. Recorded well at Banff, Alta., Penticton, Alberni, Horseshoe Bay and Victoria, B.C.

April 12 1425 — 13:37:13. Earthquake recorded at Penticton; appears to be an aftershock of previous Seattle tremor.

April 12 1426 — 15:50:13. 95 miles from Penticton, B.C.

April 12 1427 — 17:18:26. 99 miles from Penticton, B.C.

April 14 1428 — 00:37:52. 48°5N, 130°4W. Q = d. West of Vancouver Island

April 15 1429 — 08:10:52. 103 miles from Penticton, B.C.

April 16 1430 — 00:27:21. 112 miles from Penticton, B.C.

April 16 1431 — 13:09:36. 48°4N, 122°5W. Q = b. Epicentre northeast of Whidbey Island, Washington.

April 19 1432 — 00:08:16. 110 miles from Penticton, B.C.

April 20 1433 — 17:02:06. 120 miles from Penticton, B.C.

April 20 1434 — 22:23:53. 48°5N, 123°8W. Q = c. M = 1.7. In the Gulf Islands.

April 21 1435 — 05:22:47. 124 miles from Penticton, B.C.

April 22 1436 — 22:58:39. 122 miles from Penticton, B.C.

April 23 1437 — 00:53:46. 102 miles from Penticton, B.C.

April 26 1438 — 03:49:21. 13 miles from Penticton, B.C.

April 27 1439 — 00:59:47. 13 miles from Penticton, B.C.

April 29 1440 — 02:06:19. 48°5N, 123°8W. Q = c. M = 2.1. In the Gulf Islands.

April 30 1441 — 11:38:04. 103 miles from Alberni, B.C.

May 1 1442 — 01:38:40. 39 miles from Victoria, B.C.

May 4 1443	08:27:26. 159 miles from Penticton, B.C.
May 4 1444	20:35:25. 109 miles from Penticton, B.C.
May 10 1445	17:41:37. 25 miles from Victoria, B.C.
May 13 1446	01:11:12. Origin west of Vancouver Island is indicated from the records at Victoria and Alberni.
May 14 1447	12:56:22.1. 48°4N, 125°4W. Q = c. M = 3.0. Origin of earthquake is west of Vancouver Island.
May 18 1448	02:01:02. 80 miles from Penticton, B.C.
May 18 1449	04:31:07. 8 miles from Alberni, B.C.
May 24 1450	23:15:17. 48°3N, 124°3W. Q = c. M = 2.1. Near the entrance to the Strait of Juan de Fuca.
May 25 1451	22:03:50. 35 miles from Alberni, B.C.
May 26 1452	07:32:20. 48°7N, 123°2W. Q = c. M = 2.1. Small earthquake centred north of San Juan Island.
May 30 1453	02:05:26. 144 miles from Victoria, B.C.
May 31 1454	03:45:56. 123 miles from Penticton, B.C.
June 8 1455	05:09:56. 48°8N, 123°1W. Q = c. M = 2.3. Under the Strait of Georgia, near Saturna Island.
June 13 1456	12:31:48. 162 miles from Penticton, B.C.
June 13 1457	13:44:18. 144 miles from Penticton, B.C.
June 14 1458	15:09:52. 41 miles from Alberni, B.C.
June 15 1459	20:06:14. 133 miles from Penticton, B.C.

June 21 1460 — 21:27:23. 76 miles from Victoria, B.C.

June 26 1461 — 06:33:18. 48°.9N, 122°.4W. Q = b. Epicentre northeast of Bellingham, Washington.

July 3 1462 — 11:02:31. 48°.7N, 123°.2W, or 48°.3N, 123°.6W. Q = d. The former location is north of San Juan Island, and the latter in the Strait of Juan de Fuca. On the basis of available data no choice between the two is justified.

July 4 1463 — 04:28:33. 52°N, 131°1/2W, Q = b. M = 6 1/2 - 6 3/4.

(Epicentre and magnitude by U.S.C.G.S.). Position is south of Cape St. James on the Queen Charlotte Islands. The usual questionnaires were sent out throughout the district to obtain reports for assigning intensities. From these cards a maximum intensity of V seems to have been reached at Butedale, on Princess Royal Island and at Aero Camp on Queen Charlotte Islands. The following are the intensity reports received:

IV: Queen Charlotte City, Tlell, both on the Queen Charlotte Islands.

III: Houston, Usk, Prince Rupert, Smethers, Bella Coola, Haysport.

II: Wadhams, Port Clements, Francois Lake, Burns Lake

I: Stewart, Vanderhoof, Sandspit (?).

Not Felt: Priestly, Prince George, Steena Crossing, Fort St. James, Quick, Perow, Decker Lake, Palling, Aleza Lake, Willow River. Questionnaires were sent to northern Vancouver Island towns, but the absence of replies would indicate the earthquake was not severe enough to rate much local interest.

An additional report, from R.W. Sandilands, C.G.S. "Marabell", Canadian Hydrographic Service was received. The ship was anchored in Ikeda Cove, Queen Charlotte Islands (52°18'N, 131°09'W) at the time of the earthquake and the following is a part of the report submitted by the hydrographer: "Sound heard .. likened by some to 'sonic boom', 'shot blast in a quarry', or 'generator backfiring'. The consensus of opinion was that there had been an earthquake and being in a confined anchorage with a narrow neck leading into the anchorage a close watch was kept for tidal effect .... No tidal effects were noted at the moment of the noise or later. Not even a ripple seen. No undue visible tidal motion noticed ...

This was confirmed by our tide graphs from a gauge in Carpenter Bay. (52°18'N, 131°10'W)".

The isoseismal lines drawn through the places mentioned above do not permit an accurate choice of the location of the epicentre. The Butedale report might indicate an epicentre slightly east of the official version, but no real estimate is possible. If one takes the maximum felt distance as 250 miles then this earthquake could have been felt over an area of 196,000 square miles of land and ocean.

Aftershocks and foreshocks were felt as follows: (times P.T.) Aero Camp, Queen Charlotte Islands: July 3, 23:30; July 4, 2:30, 5:30 and 11:30.

Butedale: July 3 - 16:15 mild tremor, 17:00 mild tremor, 19:00 mild tremor; July 4 - 6:14 "Medium tremor causes buildings and decks to shake. Woke people up. Windows and doors were rattling. Butedale Lake water seems to have been disturbed as well, since drinking water was very much discoloured and flaky ever since". The above is a quotation from the Butedale, Postmaster's report. It implies that this aftershock was closer to Butedale than the main shock.

The above aftershocks are those reported felt, and they may in cases be the earthquakes reported in the official recorded list which follows:

July 4 1464	08:11:50. 52°N, 131°W. Q = d. Aftershock of number 1463.
July 4 1465	08:51:20. 52°N, 131°W. Q = d. Aftershock of number 1463.
July 4 1466	11:13:17. 52°N, 130 1/2°W. Q = d. Aftershock of number 1463.
July 4 1467	12:51:47. 52°N, 131°W. Q = d. Aftershock of number 1463.
July 4 1468	13:10:05. 52°N, 131°W. Q = d. M = 6. Aftershock felt very strongly at Butedale, B.C.
July 4 1469	18:21:53. 52°N, 132°W. Q = d. Aftershock of number 1463.
July 6 1470	07:03:51. 20 miles from Victoria, B.C.
July 7 1471	20:59:15. 16 miles from Victoria, B.C.

July 10 1472 — 23:27:44. 17 miles from Victoria, B.C.

July 11 1473 — 01:31:35. 83 miles from Victoria, B.C.

July 11 1474 — 21:59:43. 99 miles from Penticton, B.C.

July 12 1475 — 05:24:04. 54 miles from Penticton, B.C.

July 12 1476 — 13:22:11. 48°4N, 125°0W. Q = c. West of Vancouver Island.

July 15 1477 — 21:07:10. 181 miles from Victoria, B.C.

July 17 1478 — 07:11:51. 31 miles from Banff, Alta.

July 18 1479 — 09:46:30. 158 miles from Victoria, B.C.

July 18 1480 — 23:23:09. 33 miles from Penticton, B.C.

July 20 1481 — 06:54:13. Weakly registered at Alberni and Victoria, B.C.

July 20 1482 — 02:12:13. 111 miles from Penticton, B.C.

July 20 1483 — 21:38:17. 107 miles from Penticton, B.C.

July 21 1484 — 00:20:50. 116 miles from Penticton, B.C.

July 21 1485 — 19:09:56. 133 miles from Penticton, B.C.

July 22 1486 — 07:18:05. M = 4.25. Location about 229 miles from Penticton, B.C. and 520 miles from the U.S.C.G.S. Hungry Horse station. This would indicate an epicentre in the State of Washington.

July 22 1487 — 14:22:44. 107 miles from Penticton, B.C.

July 22 1488 — 23:45:46. 67 miles from Victoria, B.C.

July 23 1489 — 17:54:19. 79 miles from Victoria, B.C.

July 25 1490 — 20:06:31. 92 miles from Penticton, B.C.

July 26 1491 — 18:46:31. 17 miles from Banff, Alta.

July 27 1492 — 15:36:33. 16 miles from Banff, Alta.

July 27 1493 — 16:44:--. An earthquake of undetermined but local origin, recorded at Penticton and Alberni, B.C.

July 27 1494 — 19:08:56. 16 miles from Penticton, B.C.

July 28 1495 — 07:21:54. 47°8N, 121°8W. Q = b. M = 2.2. 25 miles northeast of Seattle, Washington.

July 28 1496 — 09:10:14. 48° 1/2N, 122°W. Q = c. M = 2. Origin 25 miles southeast of Bellingham, Washington.

July 29 1497 — 00:53:18. 115 miles from Penticton, B.C.

July 30 1498 — 06:06:53. 24 miles from Penticton, B.C.

July 30 1499 — 20:25:06. 72 miles from Penticton, B.C.

August 1 1500 — 01:45:44. 48°9N, 121°7W. Q = c. M = 2. Northeast of Mount Baker, in Washington.

August 2 1501 — 03:46:30. 47 miles from Penticton, B.C.

August 2 1502 — 06:51:15. 46 miles from Penticton, B.C.

August 2 1503 — 16:51:16. 41 miles from Penticton, B.C.

August 4 1504 — 01:37:54. 169 miles from Penticton, B.C.

August 8 1505	03:24:32. 73 miles from Victoria, B.C.
August 9 1506	10:47:12. 48 3/4°N, 121 3/4°W. Q = b. M = 2 3/4. Epicentre near Mount Baker, Washington.
August 12 1507	03:38:17. 125 miles from Penticton, B.C.
August 12 1508	16:01:33. Alberni and Victoria both recorded this tremor at distances of 42 and 71 miles respectively.
August 14 1509	07:37:29. 48°7N, 124°8W. Q = c. M = 2. Location near Clo-oose Bay on the west side of Vancouver Island.
August 17 1510	06:39:18. 40 miles from Alberni, B.C.
August 18 1511	18:31:--. 141 miles from Penticton, B.C.
August 18 1512	21:11:--. 87 miles from Penticton, B.C.
August 18 1513	23:00:--. 102 miles from Penticton, B.C.
August 20 1514	21:34:57. 33 miles from Alberni, B.C.
August 23 1515	21:45:55. 23 miles from Banff, Alta.
August 24 1516	18:27:31. 107 miles from Penticton, B.C.
August 24 1517	20:10:29. 47°7N, 122°3W. Q = c. M = 2. Near Seattle, Washington.
August 24 1518	23:47:38. 90 miles from Penticton, B.C.
August 25 1519	00:31:43. 97 miles from Penticton, B.C.
August 27 1520	19:07:42. 14 miles from Victoria, B.C.
August 30 1521	16:33:03. 79 miles from Victoria, B.C.

September 5 1522 — 10:48:00. 116 miles from Penticton, B.C.

September 5 1523 — 14:31:55. 47°.7N, 121°.6W. Q = b. M = 3.0. East of Seattle, Washington.

September 6 1524 — 13:05:30. 67 miles from Victoria, B.C.

September 7 1525 — 21:52:--. 72 miles from Victoria, B.C.

September 10 1526 — 15:06:32. 47°.5N, 122°.7W. Q = b. M = 4.9. Questionnaires were distributed to centres along the Canada - U.S.A. border following this earthquake. In Canada, the earthquake was reported to be felt with maximum intensity of II at Duncan, Victoria, and Abbotsford. It was not felt at Nanaimo, Mission, Squamish or Hope.

September 10 1527 — 17:52:26. Alberni and Victoria stations alone were able to record this M = 2 earthquake. There is no means of choosing between an epicentre off Vancouver Island near Ucluetet or on Texada Island in the Strait of Georgia.

September 10 1528 — 19:21:04. Probably an aftershock of the Seattle earthquake.

September 11 1529 — 04:29:14. Alberni and Victoria alone recorded this M = 2.5 earthquake.

September 30 1530 — 03:20:20. 49°.3N, 129°.3W. L = 79 kms. (U.S.C.G.S.). Epicentre west of Vancouver Island.

October 5 1531 — 02:59:47. 48°36'N, 123°52'W. Q = b. M = 2.4. On south-western Vancouver Island.

October 8 1532 — 10:54:25. Recorded at Alberni and Victoria.

October 10 1533 — 15:06:38. 104 miles from Penticton, B.C.

October 10 1534 — 23:54:32. 53°N, 133°W. Q = d. M = 4.5. Epicentre south of the Queen Charlotte Islands.

October 12 1535 — 05:17:14. 48°.0N, 123°.6W. Q = b. M = 2.3. Origin probably southwest of Port Angeles, Washington.

October 14 1536 — 13:12:08. 59°.8W, 136°.4N. L = 32 kms. U.S.C.G.S. have placed the earthquake in southern Alaska. It was felt at Yackutal Bay.

October 27 1537 — 07:34:59. 55 miles from Penticton, B.C.

October 28 1538 — 19:55:23. 37 miles from Alberni, B.C.

October 29 1539 — 01:47:34. 94 miles from Penticton, B.C.

October 29 1540 — 23:40:57. 33 miles from Alberni, B.C.

November 1 1541 — 06:34:02. 48°42'N, 123°12'W. Q = b. M = 1.7. Epicentre in the Gulf Islands.

November 1 1542 — 08:37:23. 47°.1N, 126°.4W. Q = c. M = 3.0. Off the coast of Washington.

November 1 1543 — 16:12:41. 19 miles from Penticton, B.C.

November 2 1544 — 22:25:29. 48°28'N, 123°52'W. Q = c. M = 2.0. On southern Vancouver Island.

November 4 1545 — 00:29:14. 49°.1N, 120°.6W. Q = c. M = 1.5. There are many earthquakes at this distance from Penticton, but this was recorded on other stations so that an epicentre could be computed. The origin appears to be near Copper Mountain, B.C. at a former base-metal mine not now operating. The possibility that this, and others at a distance of near 51 miles from Penticton, may be related to caving in the old mine will bear investigation.

November 5 1546 — 03:07:31. 84 miles from Penticton, B.C.

November 7 1547 — 00:57:08. 87 miles from Penticton, B.C.

November 8 1548 — 11:00:15. 11 miles from Banff, Alta.

November 9 1549 — 00:41:44. 90 miles from Penticton, B.C.

November 10 1550 — 19:38:55. 19 miles from Penticton, B.C.

November 14 1551 — 08:03:07. 120 miles from Penticton, B.C.

November 14 1552 — 10:25:04. 94 miles from Penticton, B.C.

November 15 1553 — 20:28:25. 143 miles from Penticton, B.C.

November 15 1554 — 22:32:41. 82 miles from Penticton, B.C.

November 15 1555 — 23:25:07. 95 miles from Penticton, B.C.

November 17 1556 — 00:48:46. 49°.0N, 121°.5W. Q = c. M = 1.9. South of Hope, B.C.

November 19 1557 — 00:45:30. 88 miles from Penticton, B.C.

November 19 1558 — 06:38:30. 48 miles from Alberni, B.C.

November 19 1559 — 19:52:02. 172 miles from Penticton, B.C.

November 20 1560 — 00:23:16. 105 miles from Penticton, B.C.

November 22 1561 — 23:54:21. 111 miles from Penticton, B.C.

November 23 1562 — 17:09:09. 105 miles from Penticton, B.C.

November 25 1563 — 00:54:09. 94 miles from Penticton, B.C.

December 1 1564 — 20:45:03. 49°.4N, 129°.3W. Q = b. M = 3.6. This earthquake, west of Vancouver Island, is probably a foreshock of the following.

December 1 1565 — 20:49:46. 48°.5N, 129°.1W. Q = b. M = 6 (U.S.C.G.S.). Although not felt, this is a stronger than usual earthquake centred some 200 miles west of Vancouver Island. It was recorded at all stations including Banff, Alta.

December 1 1566 — 21:05:21. 48°11'N, 124°53'W. Q = b. M = 2.3. Epicentre southeast of number 1565, and off the coast of Washington.

December 1 1567 — 21:18:49. 48°.5N, 129°.2W. Q = c. M = 3.3. Aftershock of number 1565, together with the following 5 earthquakes.

December 1 1568 — 21:49:37. 48°.7N, 129°.2W. Q = b. M = 3.8.

December 1 1569 — 21:57:43. 48°.9N, 129°.2W. Q = c. M = 3.4.

December 1 1570 — 22:05:30. 48°.5N, 129°.2W. Q = c. M = 3.7.

December 1 1571 — 22:33:53. 49°N, 129°W. Q = d. M = 3.2.

December 1 1572 — 22:55:55. 48°.6N, 129°.2W. Q = c. M = 3.5.

December 1 1573 — 15:51:31. 55 miles from Alberni, B.C.

December 5 1574 — 13:33:50. 29 miles from Alberni, B.C.

December 5 1575 — 15:38:46. 27 miles from Victoria, B.C.

December 7 1576 — 00:42:03. 100 miles from Penticton, B.C.

December 8 1577 — 02:30:10. 49°44'N, 123°28'W. Q = c. M = 2.6. Possibly a mine blast on Texada Island.

December 10 1578 — A report from Stewart River, Yukon Territory, indicates that an earthquake was felt there at 10:30 (presumably 10:30 a.m. Y.T.). Intensity there was a maximum of II.

December 10 1579 — 23:49:03. 49°36'N, 124°30'W. Q = c. M = 1.8. Like number 1577, this may be a mine blast on Texada Island.

December 11 1580 — 18:58:40. 48°.9N, 129°.7W. M = 3.8. L = 93 kms (U.S.C.G.S.). Epicentre west of Vancouver Island.

December 11 1581 — 19:07:55. 48°.9N, 129°.7W. M = 3.7. This and number 1580 are probably aftershocks of number 1565.

December 16 1582 — 00:22:37. 105 miles from Penticton, B.C.

December 16 1583 — 23:56:40. 230 miles from Penticton, B.C.

December 17 1584 — 07:34:15. 164 miles from Penticton, B.C.

December 17 09:48:19. 164 miles from Penticton, B.C.
1585

December 17 23:32:53. 48°9N, 122°0W. Q = c. M = 2.0. Epicentre near
1586 Mt. Baker, Washington.

December 21 11:22:21. 164 miles from Penticton, B.C.
1587

December 22 23:59:17. 107 miles from Penticton, B.C.
1588

December 23 02:07:43. 174 miles from Penticton, B.C.
1589

December 23 16:29:43. 178 miles from Penticton, B.C.
1590

December 24 03:22:18. 162 miles from Penticton, B.C.
1591

December 24 08:09:50. 126 miles from Penticton, B.C.
1592

December 24 17:47:58. 48°31'N, 123°58'W. Q = b. M = 1.6. Epicentre
1593 on lower Vancouver Island.

December 24 18:50:16. 48°47'N, 122°32'W. Q = b. M = 2.1. Alberni,
1594 Penticton, and Victoria stations contributed data for this epicentre, which is near Whidbey Island, Washington.

December 25 04:23:01. 161 miles from Penticton, B.C.
1595

December 25 06:38:51. 163 miles from Penticton, B.C.
1596

December 31 21:06:25. 112 miles from Penticton, B.C.
1597

December 31 21:46:31. 132 miles from Penticton, B.C.
1598

December 31 22:23:03. 134 miles from Penticton, B.C.
1599