APPENDIX 2E

HISTORICAL EARTHQUAKES IN THE SITE VICINITY

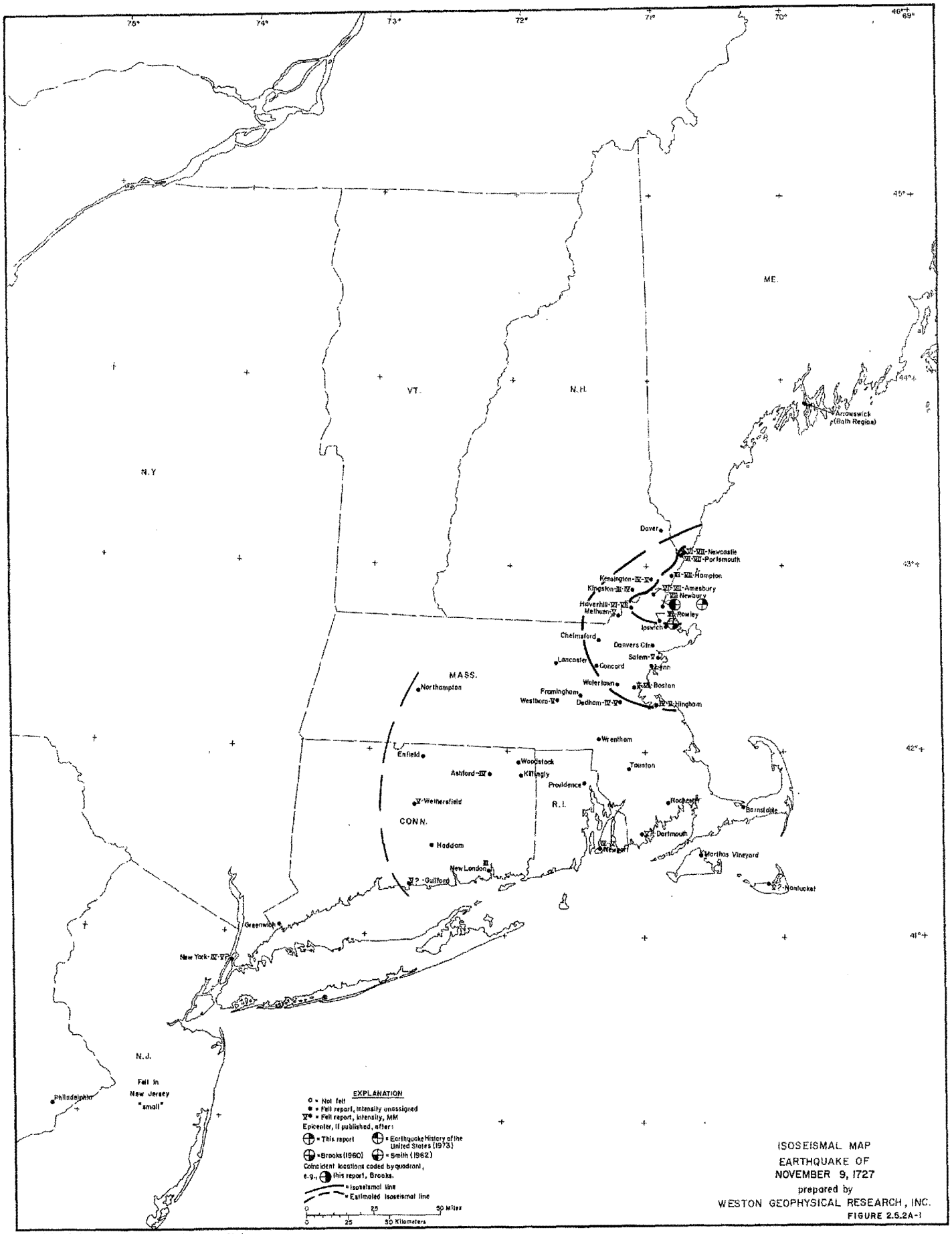
The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

APPENDIX 2.5.2A

PART I

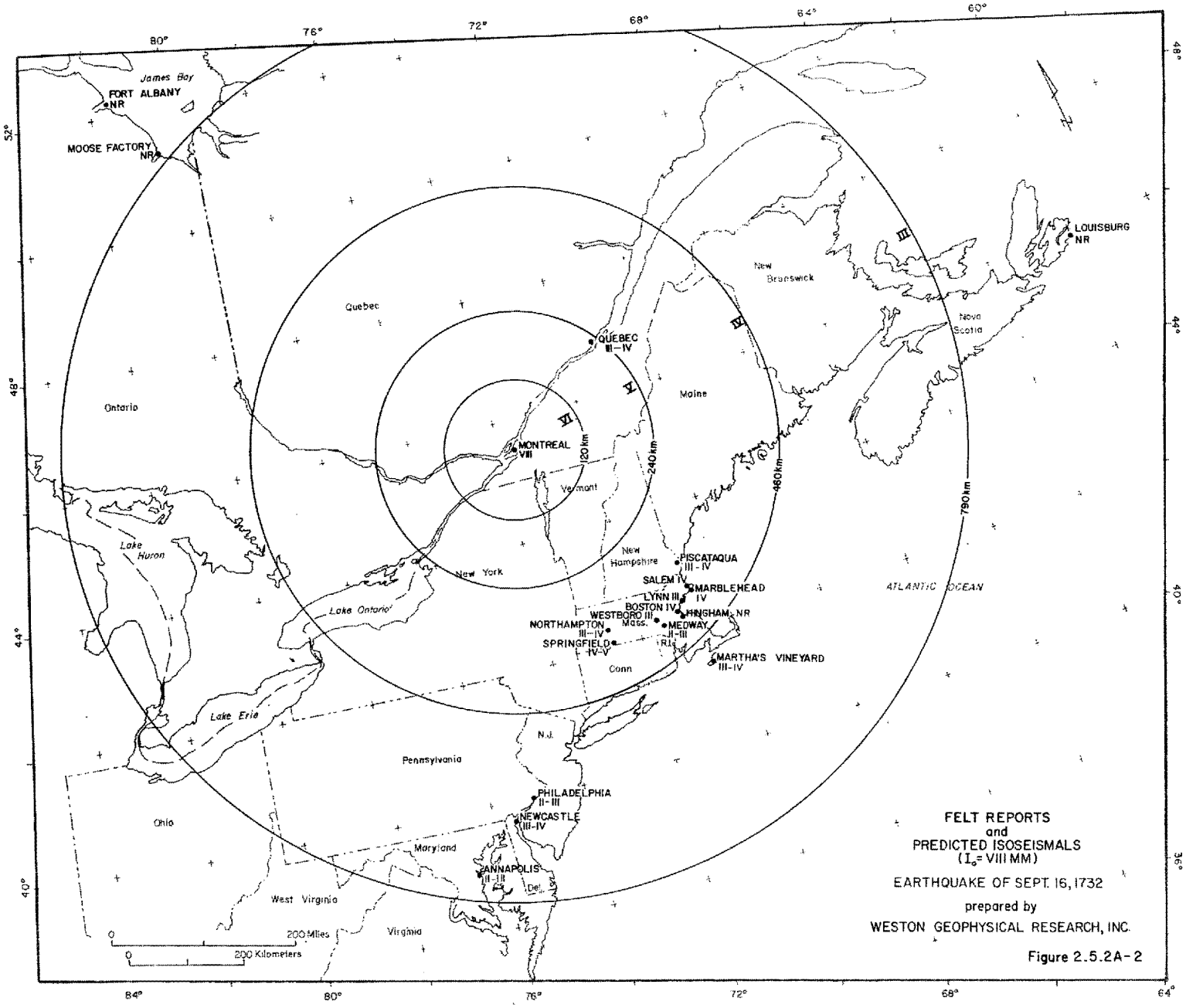
LIST OF ISOSEISMAL MAPS

DATE	FIGURE NO.
1727 NOV 09	2.5.2A-1
1732 SEP 16	2.5.2A-2
1744 JUN 14	2.5.2A-3
1755 NOV 18	2.5.2A-4
1755 NOV 22	2.5.2A-5
1761 MAR 12	2.5.2A-6
1791 MAY 06	2.5.2A-7
1810 NOV 09	2.5.2A-8
1811 DEC 16	2.5.2A-9
1814 NOV 28	2.5.2A-10
1817 OCT 05	2.5.2A-11
1823 JUL 23	2.5.2A-12
1846 AUG 25	2.5.2A-13
1947 AUG 08	2.5.2A-14
1852 NOV 27	2.5.2A-15
1854 DEC 11	2.5.2A-16
1857 DEC 23	2.5.2A-17
1872 NOV 18	2.5.2A-18
1880 MAY 12	2.5.2A-19
1882 DEC 19	2.5.2A-20
1884 AUG 10	2.5.2A-21
1884 NOV 23	2.5.2A-22
1886 SEP 01	2.5.2A-23
1891 MAY 01	2.5.2A-24
1905 JUL 15	2.5.2A-25
1905 AUG 30	2.5.2A-26
1907 OCT 16	2.5.2A-27
1918 AUG 21	2.5.2A-28
1925 JAN 07	2.5.2A-29
1925 MAR 01	2.5.2A-30
1925 OCT 09	2.5.2A-31
1926 MAR 18	2.5.2A-32
1927 MAR 09	2.5.2A-33
1929 AUG 12	2.5.2A-34
1929 NOV 18	2.5.2A-35
1931 APR 20	2.5.2A-36
1940 DEC 20/24	2.5.2A-37
1944 SEP 05	2.5.2A-38
1957 APR 26	2.5.2A-39
1963 OCT 16	2.5.2A-40
1973 JUN 15	2.5.2A-41a and b



ISOSEISMAL MAP
EARTHQUAKE OF
NOVEMBER 9, 1727
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.
FIGURE 2.5.2A-1

From: "Historical Seismicity of New England" (report RE-507601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471


FELT REPORTS
and
PREDICTED ISOSEISMALS
(I_o = VIII MM)
EARTHQUAKE OF SEPT. 16, 1732
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.
Figure 2.5.2A-2
James Bay
FORT ALBANY NR
MOOSE FACTORY NR
LOUISBURG NR
QUEBEC III-IV
MONTREAL VIII
PISCATAQUA III-IV
SALEM IV
MARBLEHEAD IV
LYNN III
BOSTON IV
HINGHAM NR
WESTBORO III
MEDWAY II-III
NORTHAMPTON III-IV
SPRINGFIELD IV-V
MARTHA'S VINEYARD III-IV
PHILADELPHIA II-III
NEWCASTLE III-IV
ANNAPOLIS III-III
Quebec
Ontario
New Brunswick
Nova Scotia
Maine
Vermont
New Hampshire
New York
Mass.
R.I.
Conn
N.J.
Pennsylvania
Maryland
Del.
Virginia
West Virginia
Ohio
Lake Huron
Lake Ontario
Lake Erie
ATLANTIC OCEAN
120 km
240 km
480 km
790 km
0 200 Miles
0 200 Kilometers

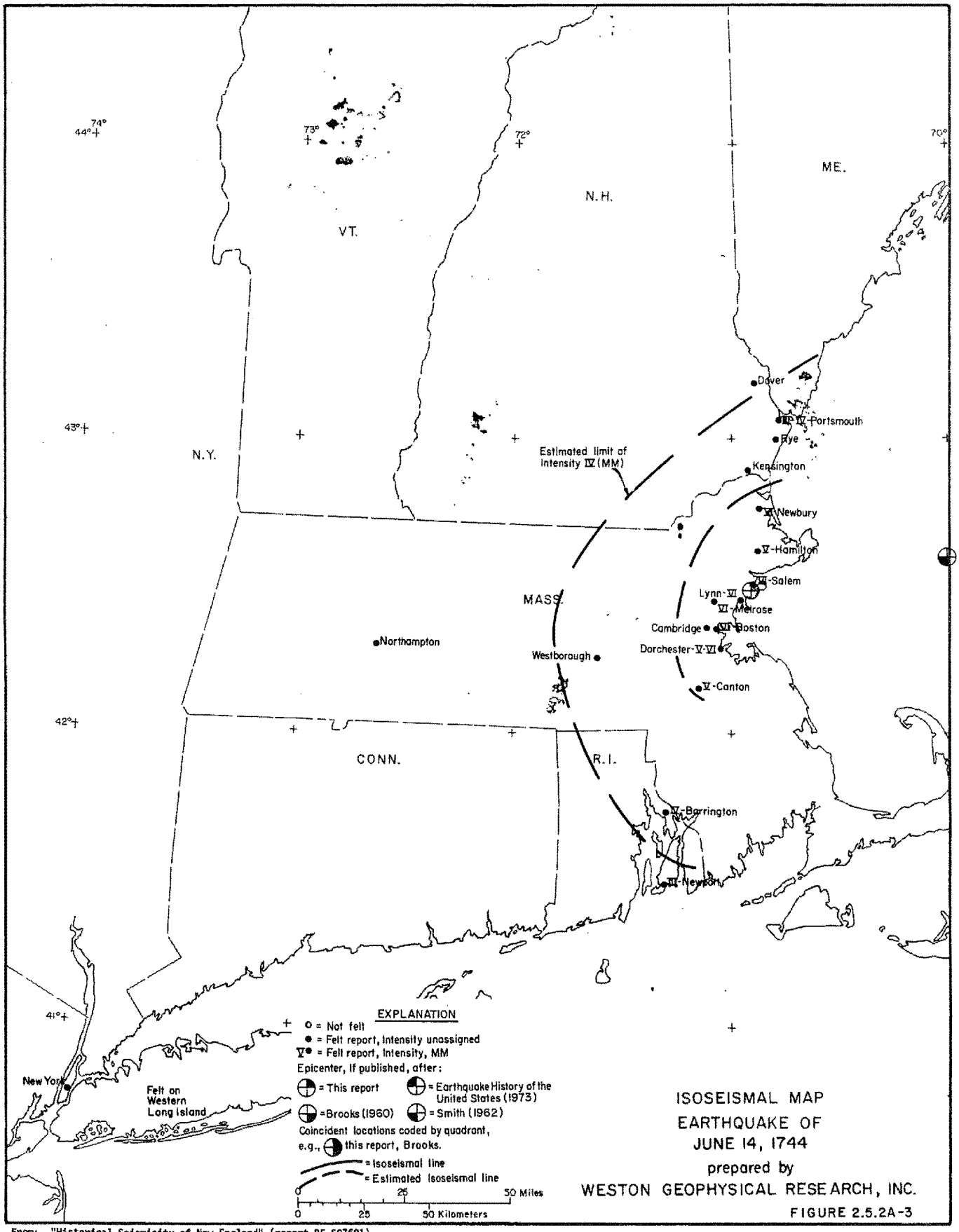


FIGURE 2.5.2A-3

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

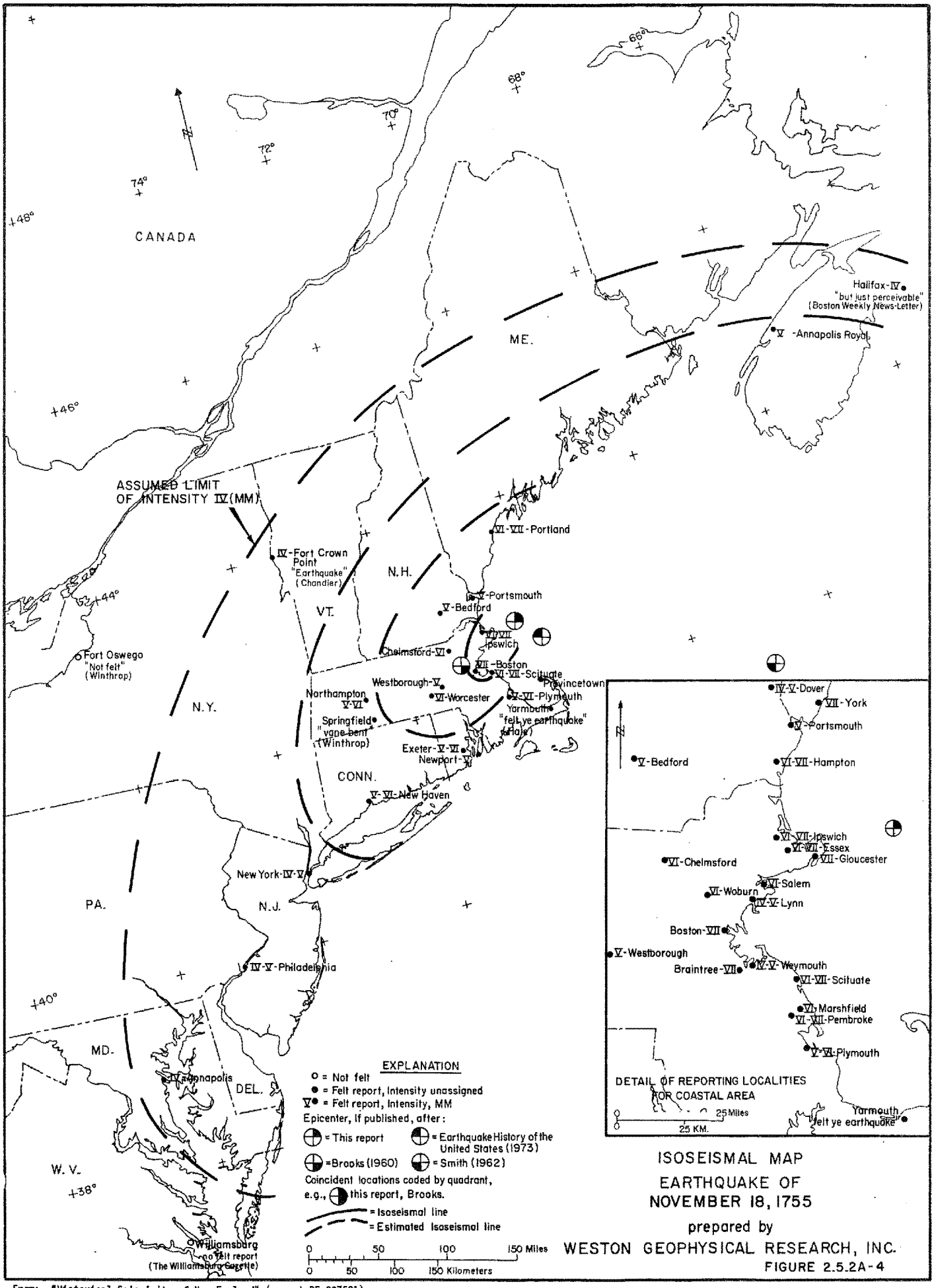
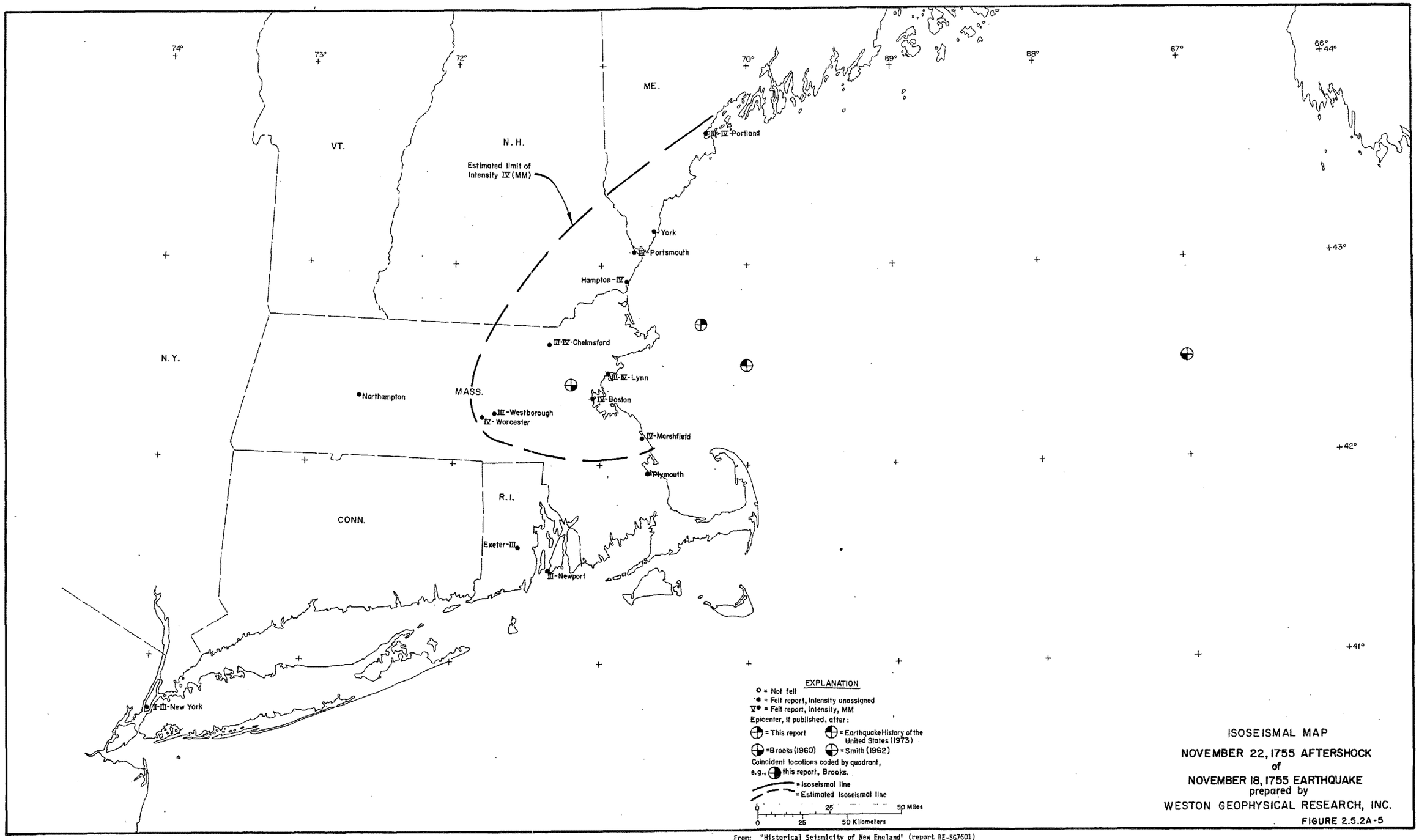


FIGURE 2.5.2A-4

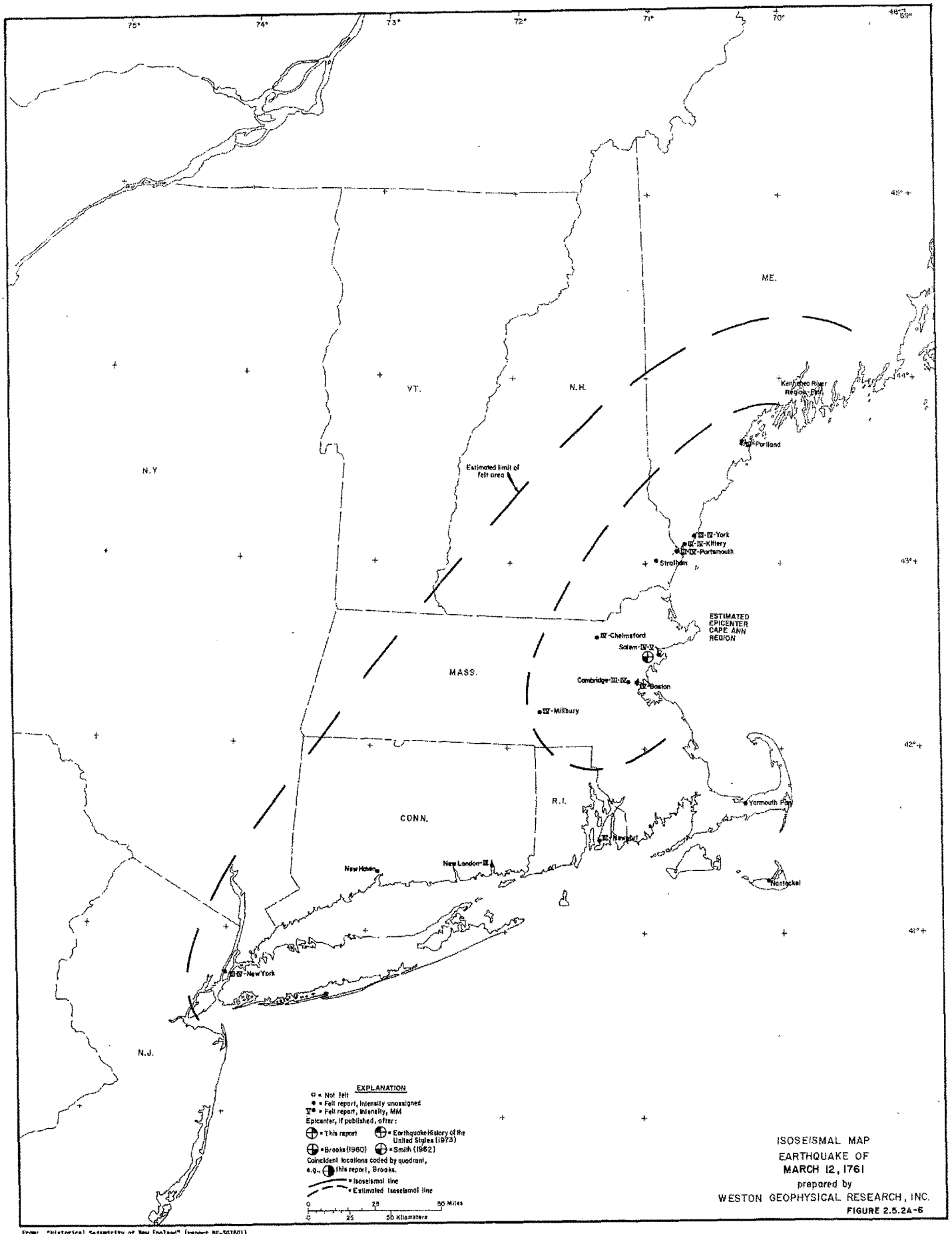
From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
NOVEMBER 22, 1755 AFTERSHOCK
of
NOVEMBER 18, 1755 EARTHQUAKE
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-5

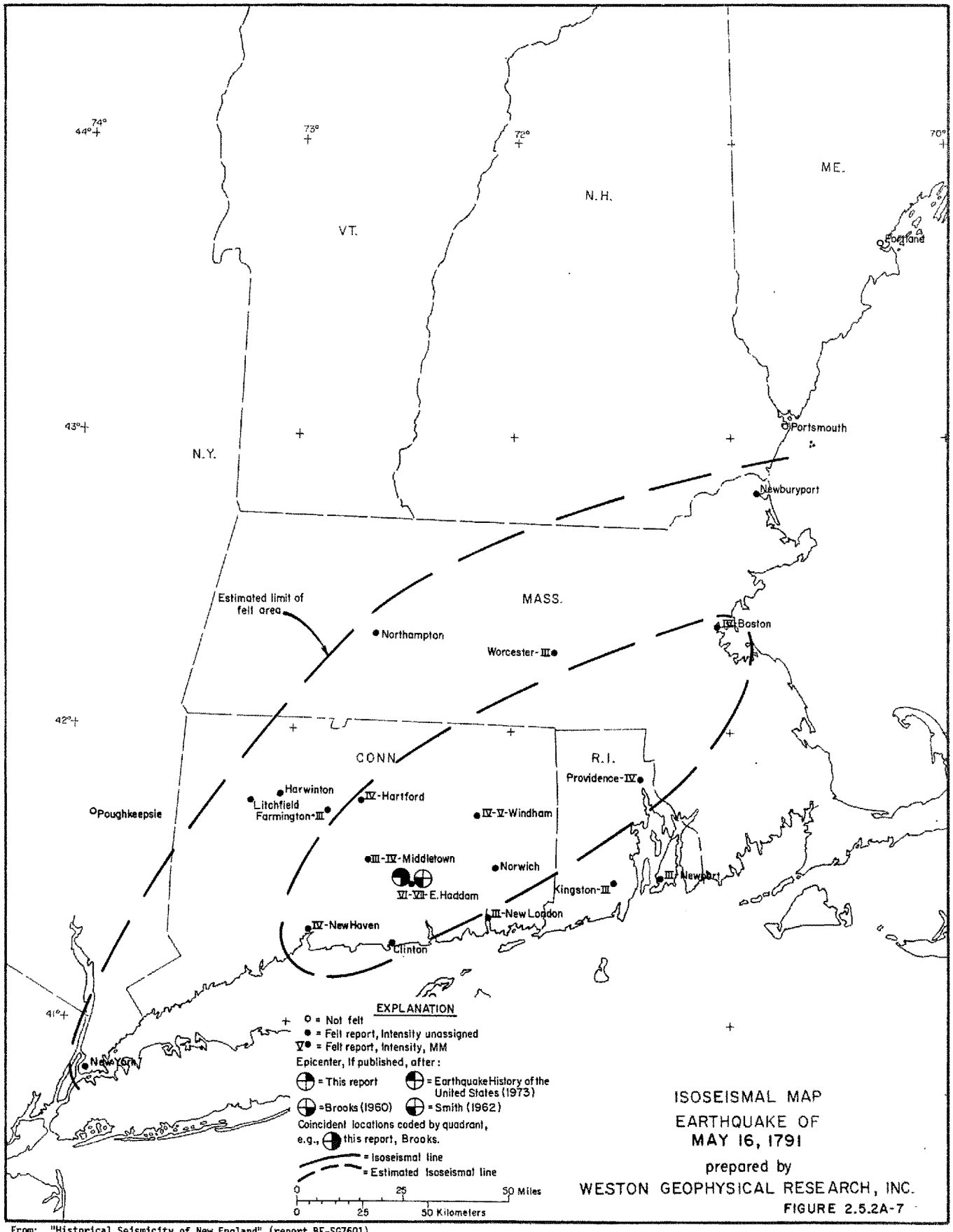
From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
MARCH 12, 1761
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-6

From: "Historical Seismicity of New England" (report BE-3076B1) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
MAY 16, 1791

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-7

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

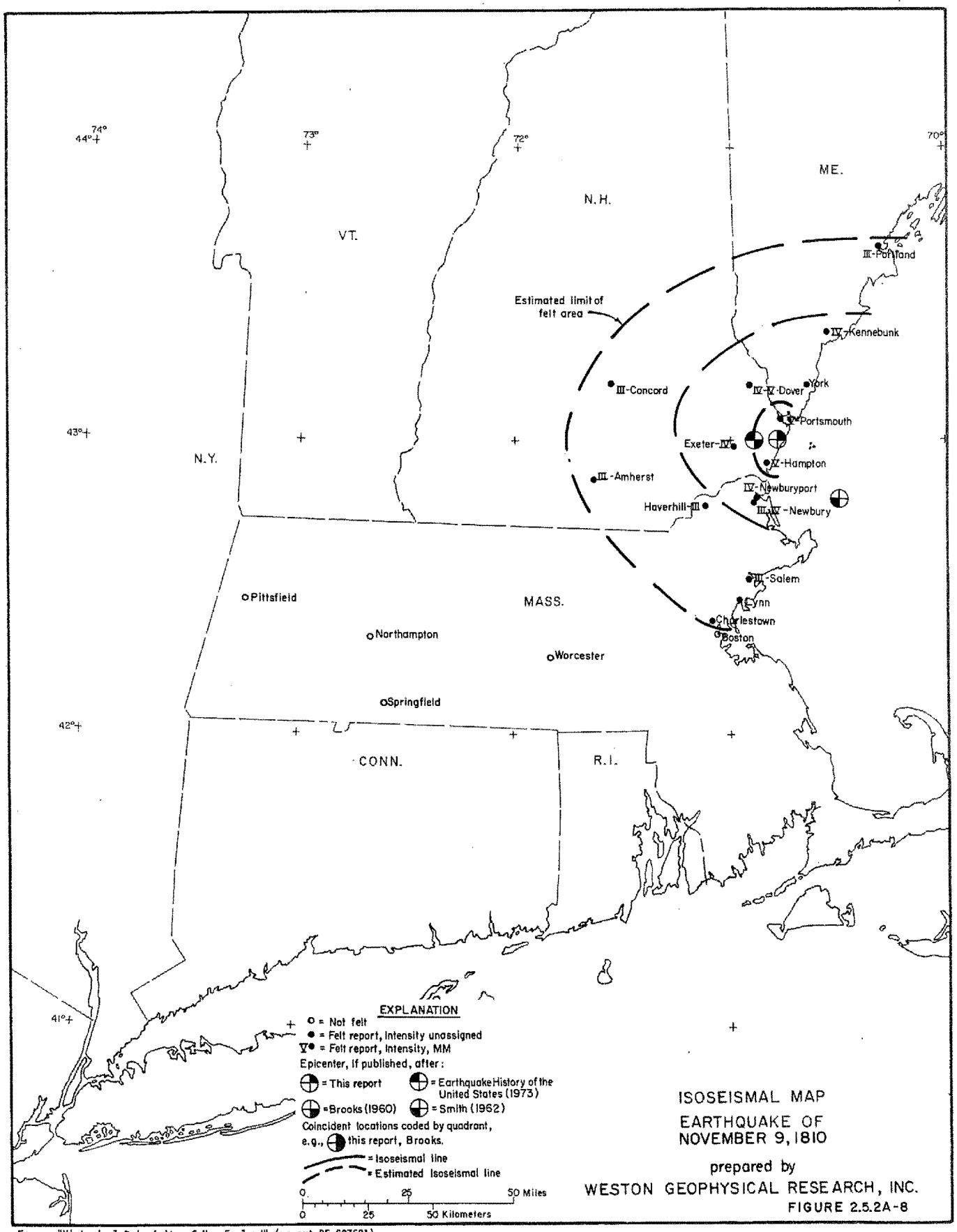
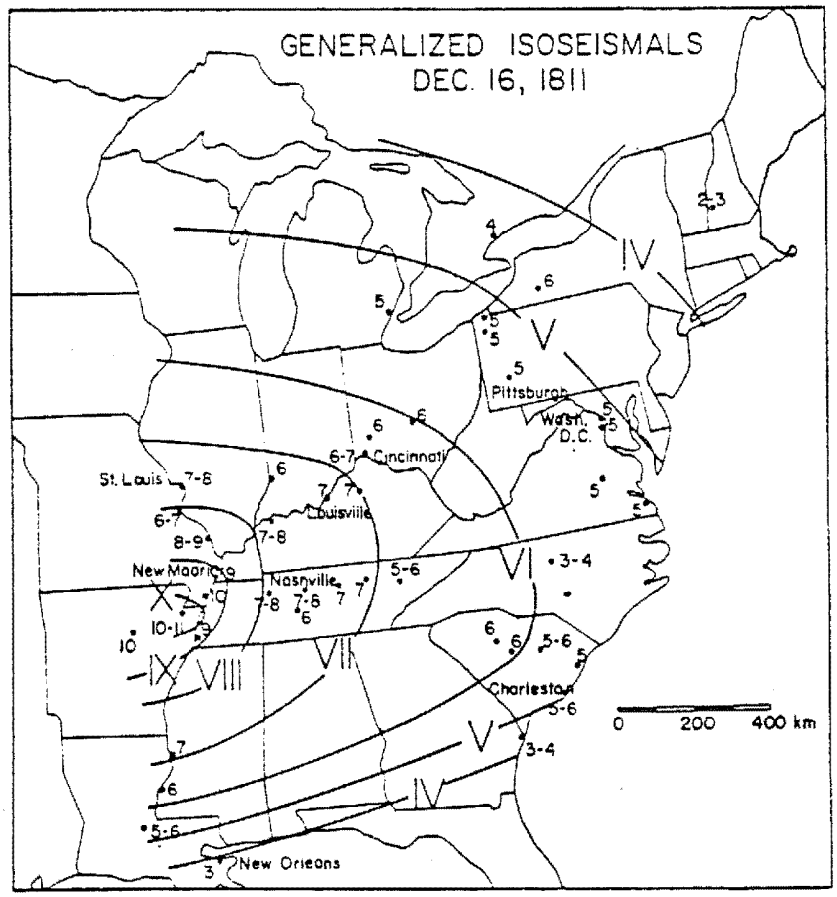


FIGURE 2.5.2A-8

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



Generalized isoseismal map of the earthquake of December 16, 1811 at 08h15m GMT. MM intensity values at individual points are given in Arabic numerals (see Table 1 for sources of information). The isoseisms, labeled with Roman numerals, indicate the outer bound of the region of specified intensity.

Nuttli, Otto W., 1973, The Mississippi Valley Earthquakes of 1811 and 1812: Intensities, Ground Motion and Magnitudes, B.S.S.A., Vol. 63, No. 1, pp. 227-248.

Figure 2.5.2A-9

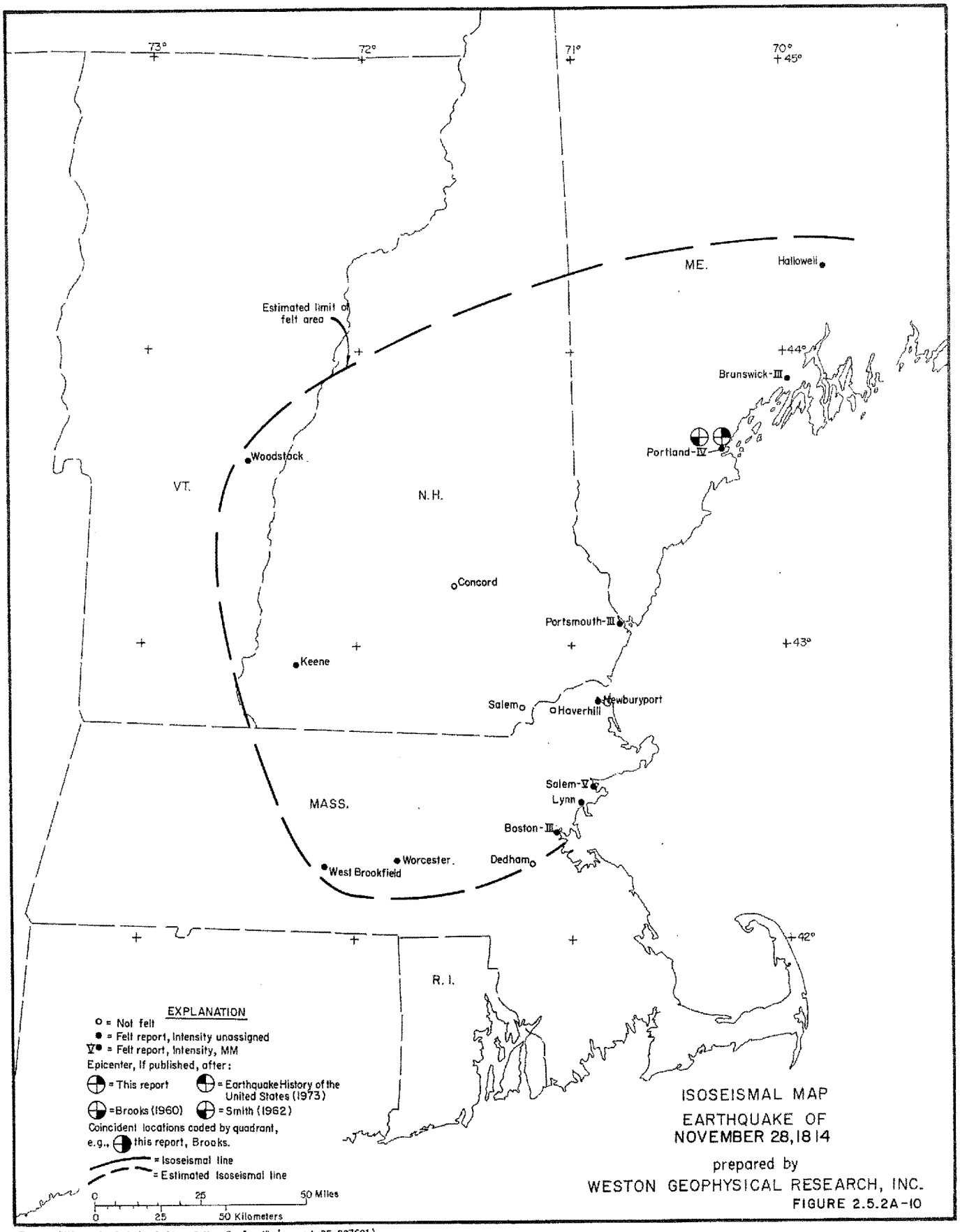
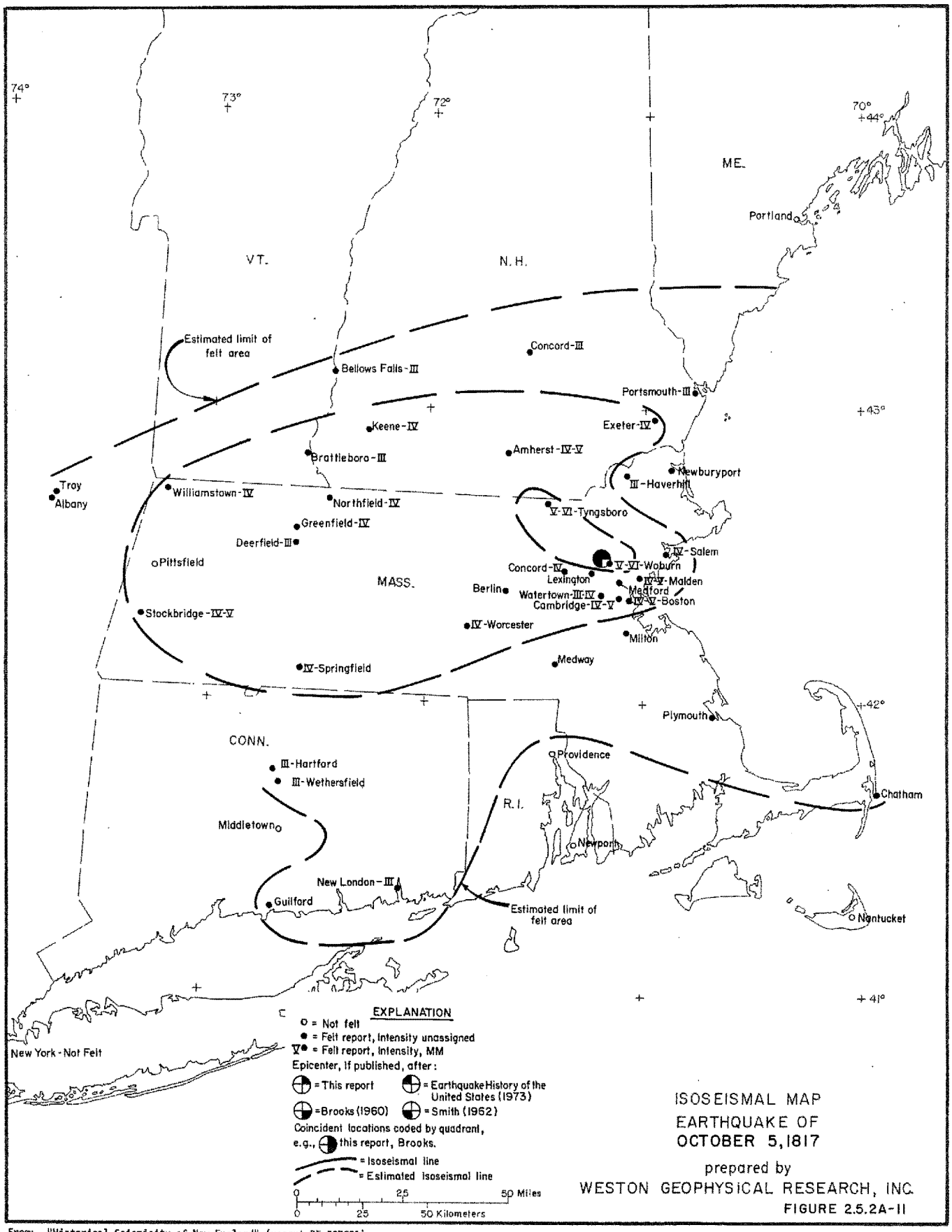


FIGURE 2.5.2A-10

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
OCTOBER 5, 1817

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-11

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

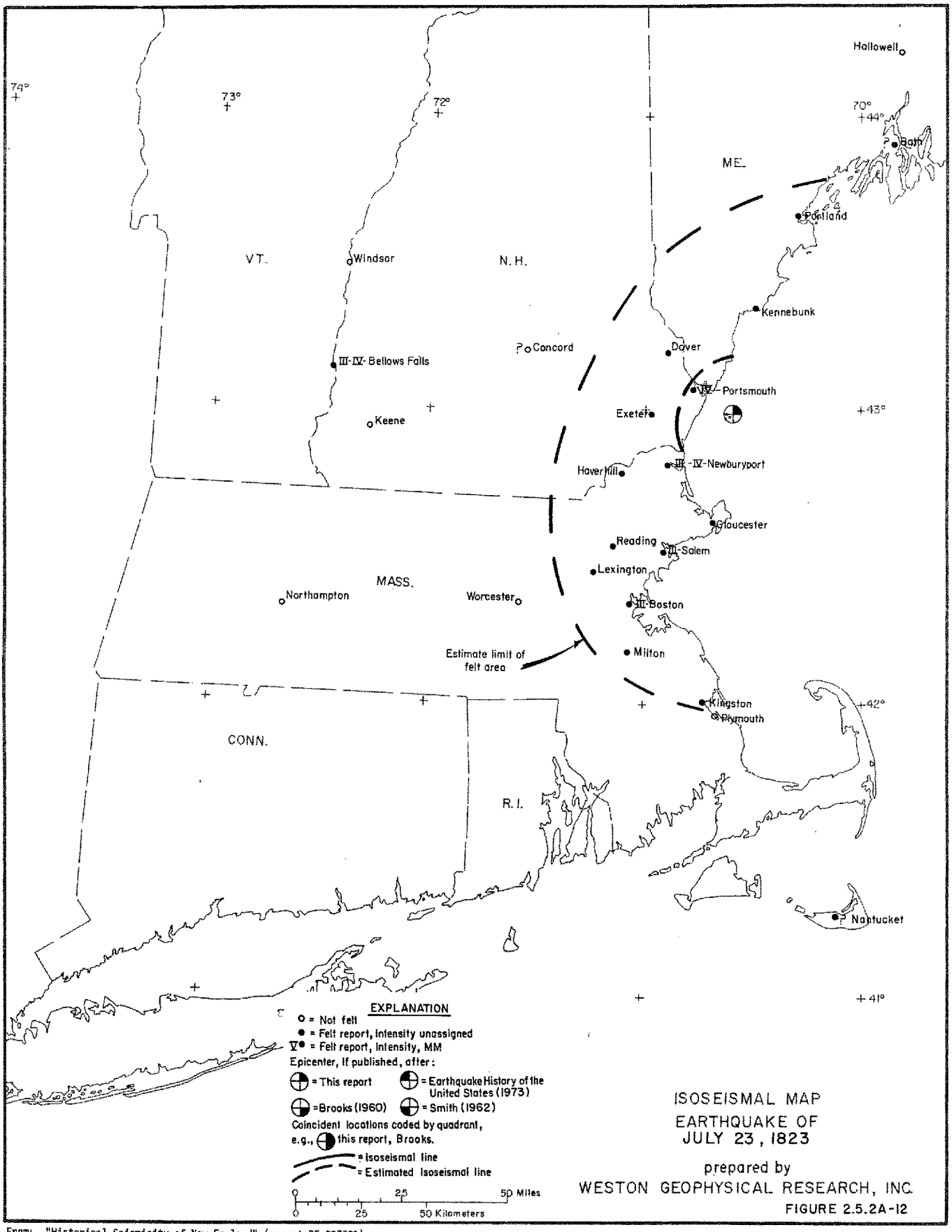
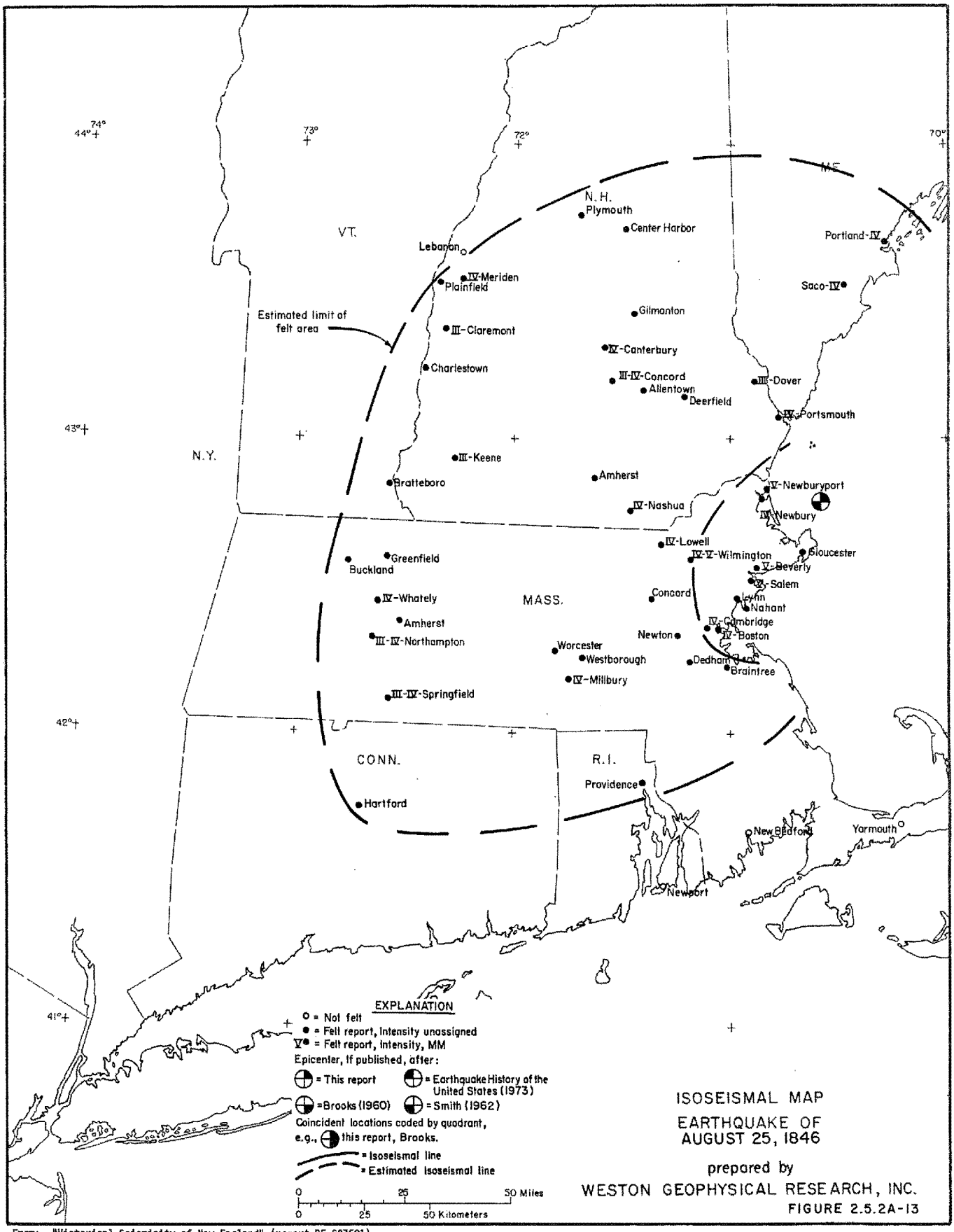


FIGURE 2.5.2A-12

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

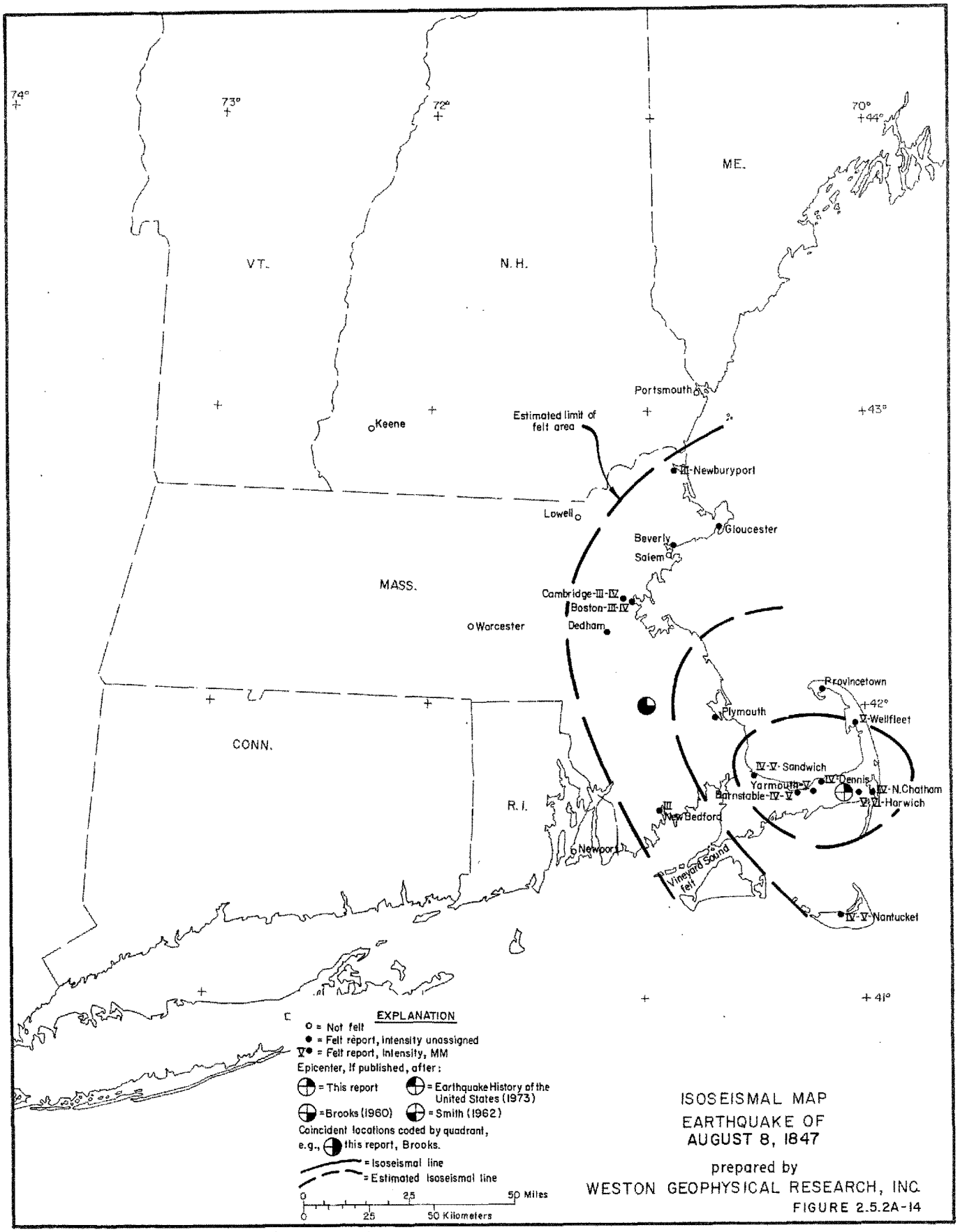


ISOSEISMAL MAP
EARTHQUAKE OF
AUGUST 25, 1846

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-13

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
AUGUST 8, 1847

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-14

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

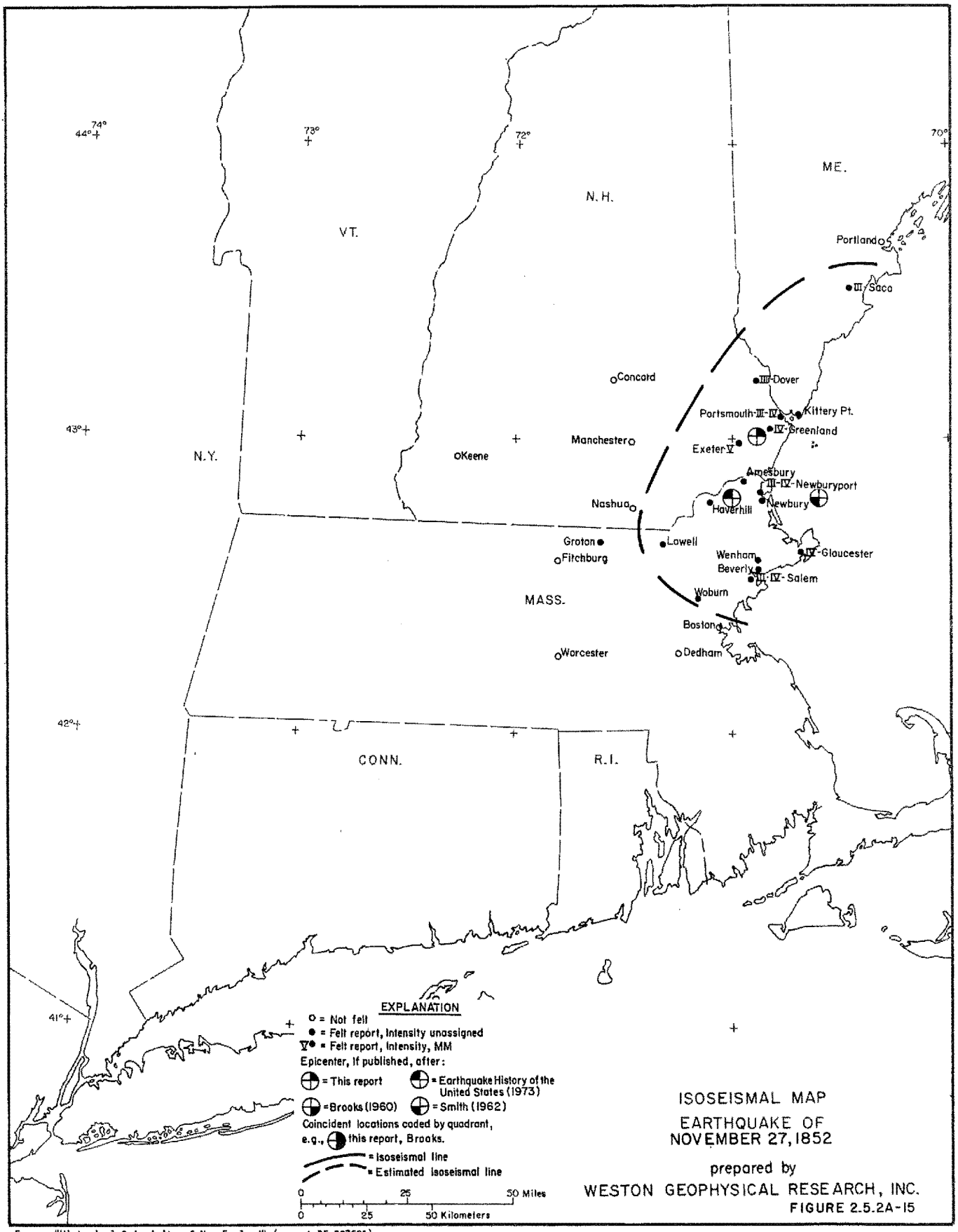


FIGURE 2.5.2A-15

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

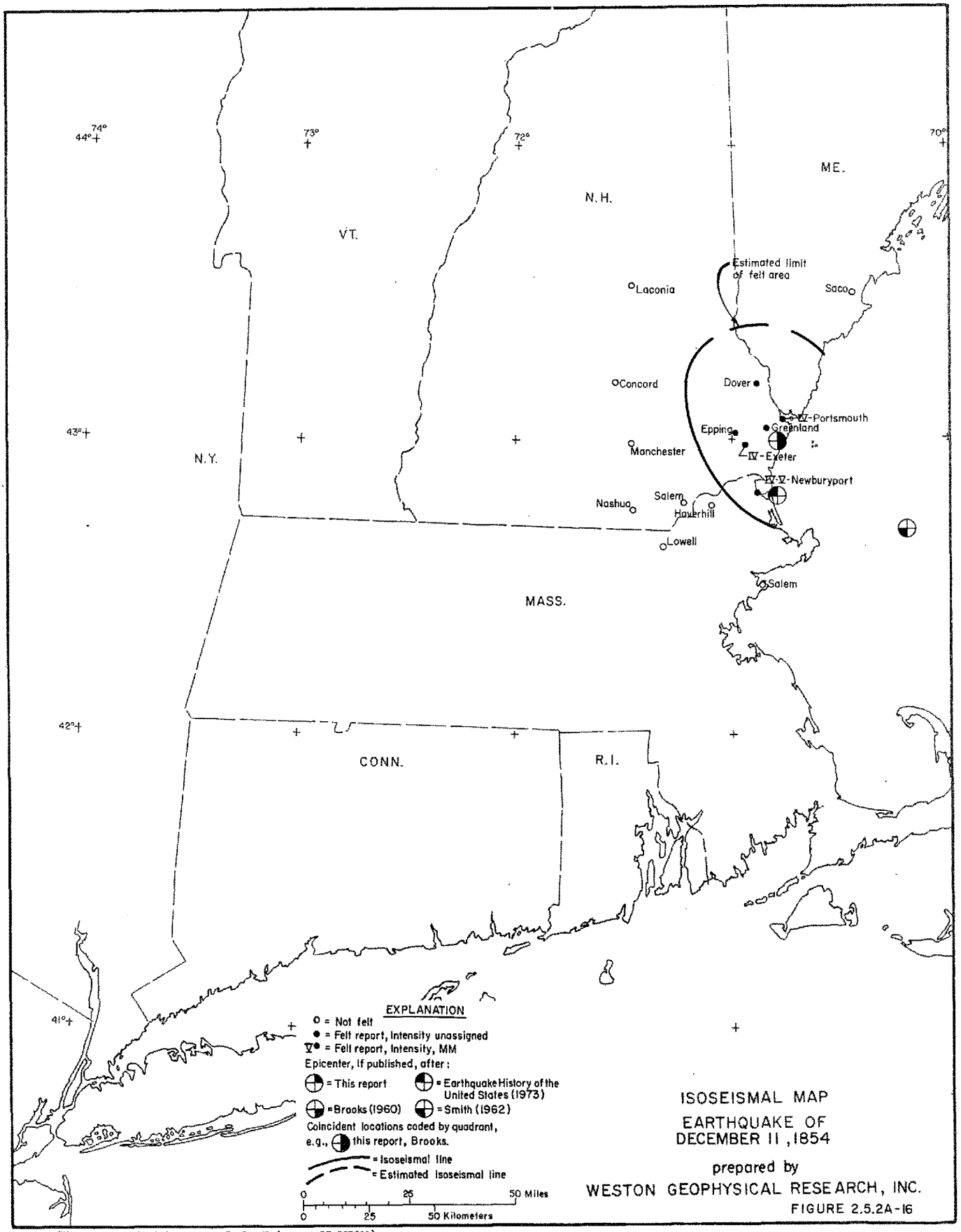
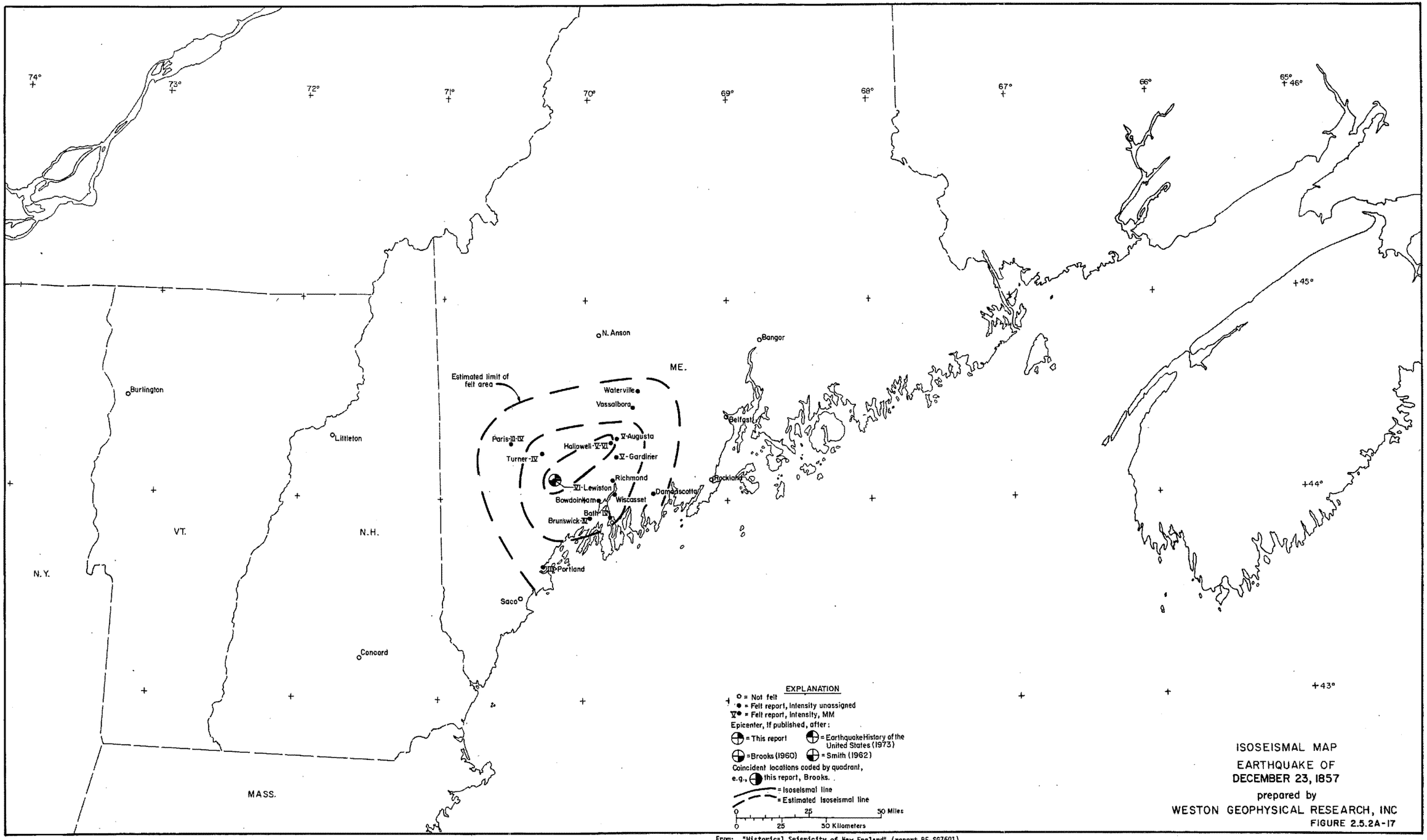


FIGURE 2.5.2A-16

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
DECEMBER 23, 1857
prepared by
WESTON GEOPHYSICAL RESEARCH, INC
FIGURE 2.5.2A-17

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

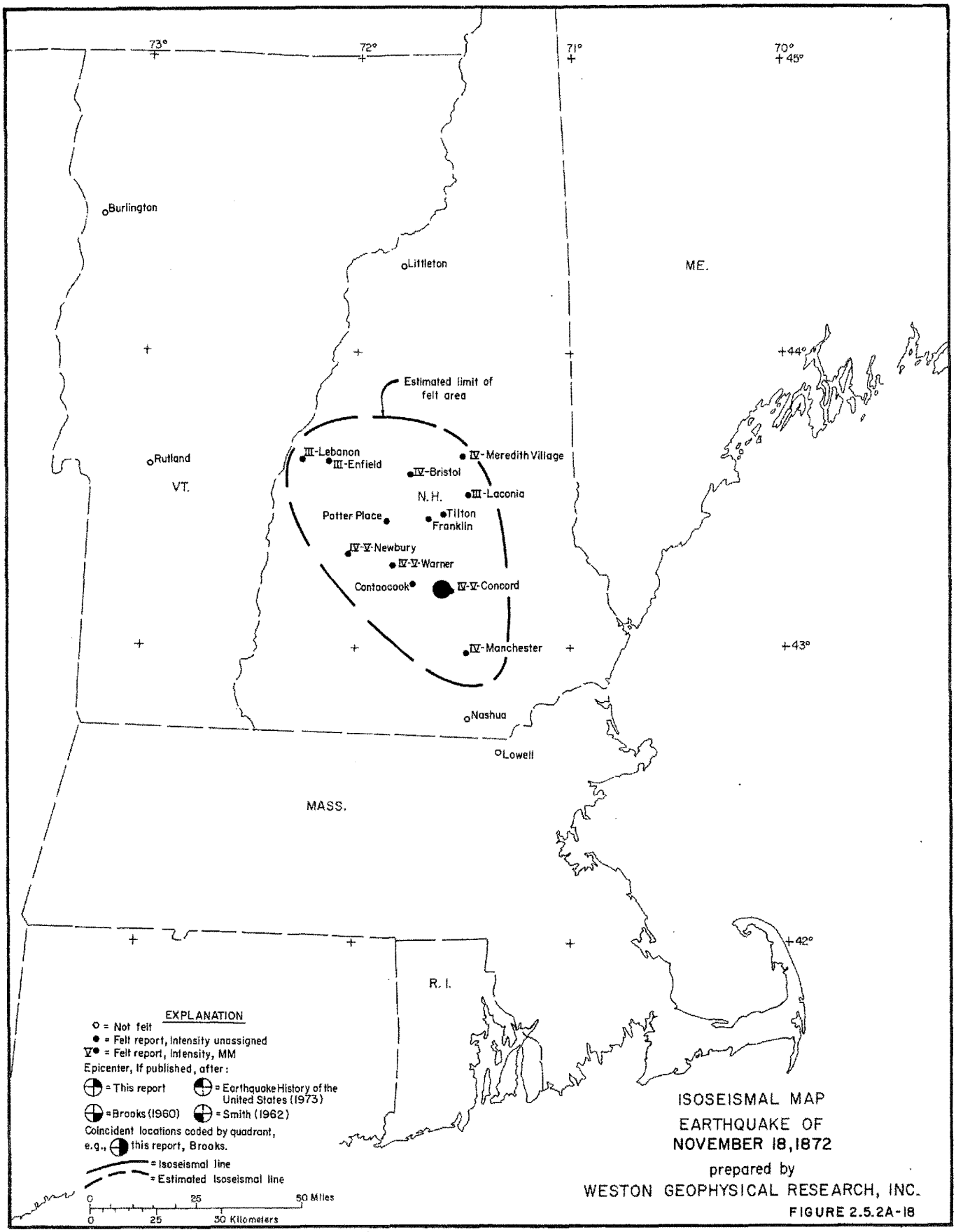
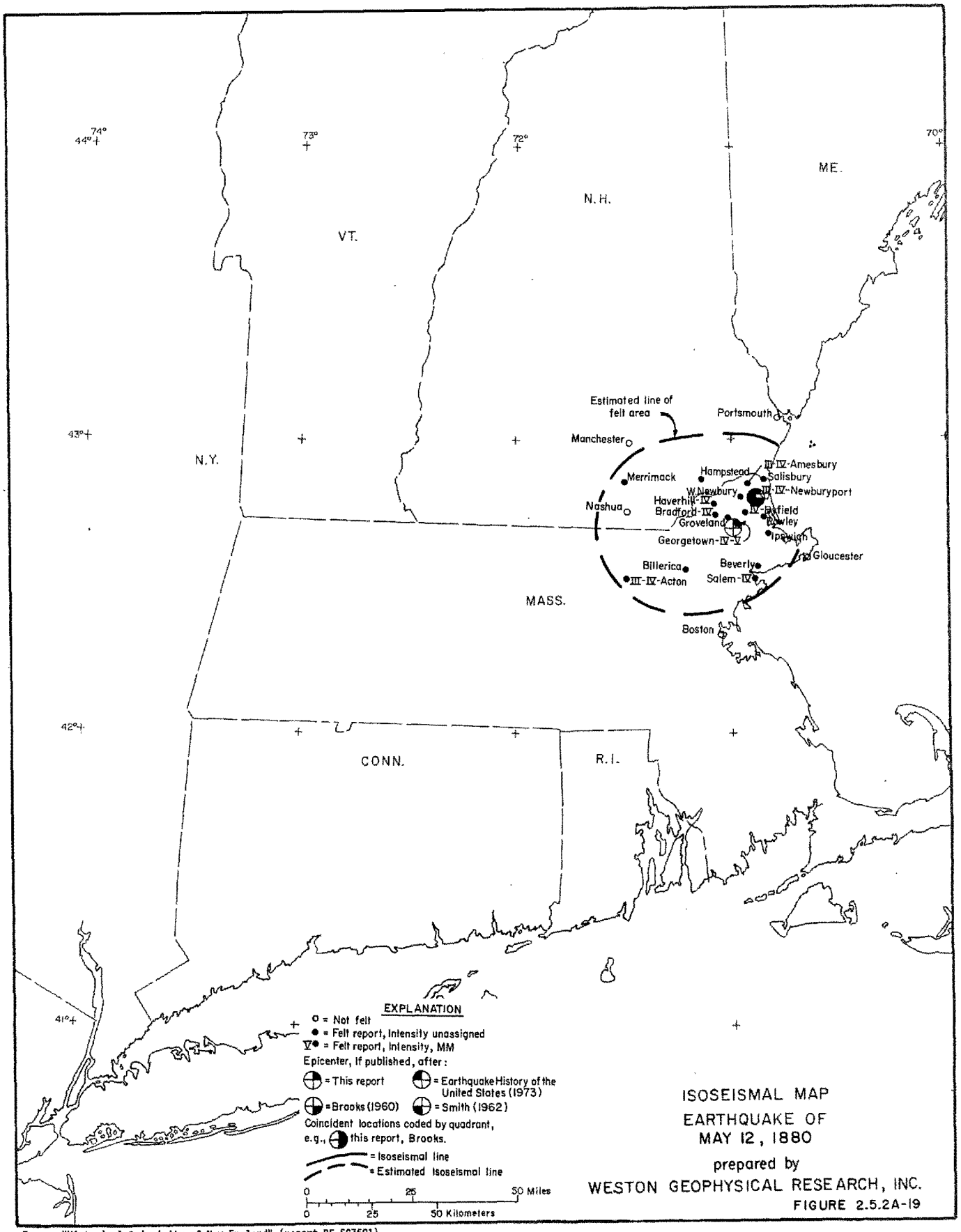


FIGURE 2.5.2A-18

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
MAY 12, 1880
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-19

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

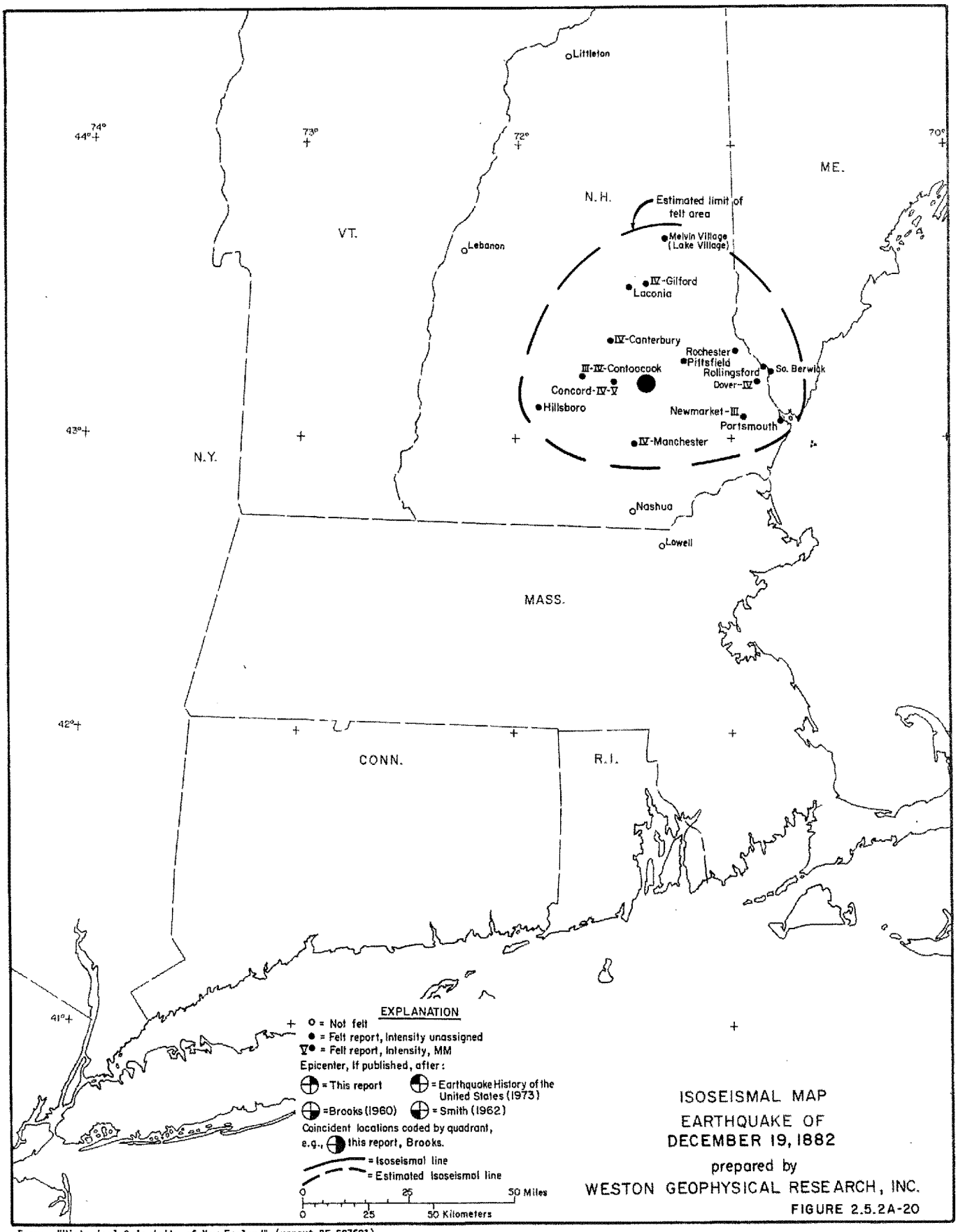
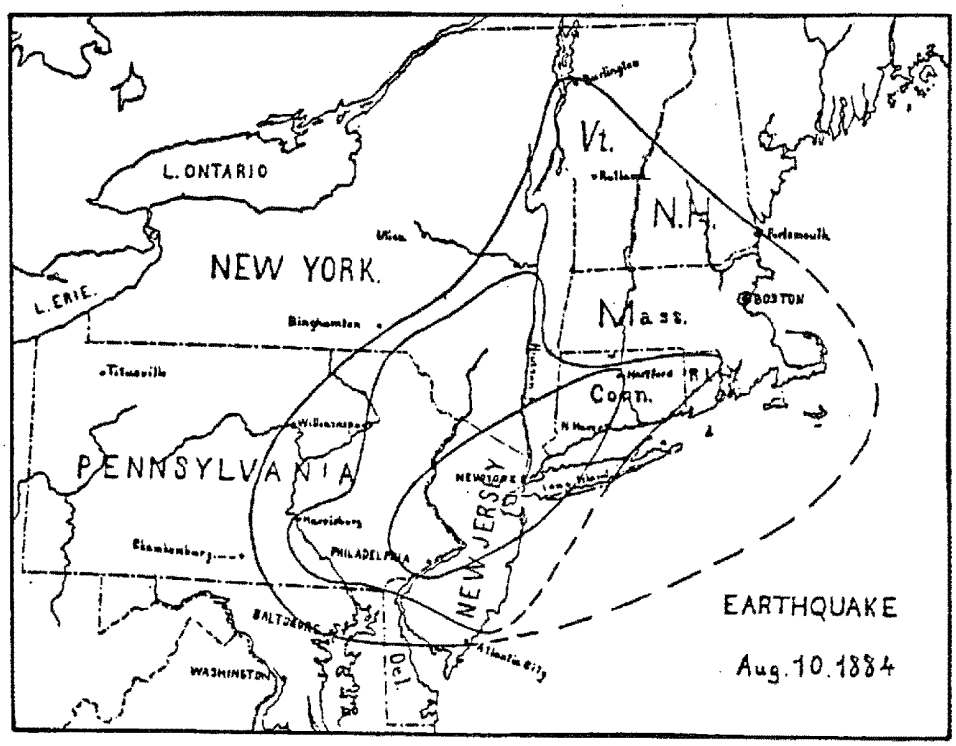


FIGURE 2.5.2A-20

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



Rockwood, C. G., Jr., "Notices of Recent American Earthquakes", Amer. Jour. Sci., V. 29, pp. 425-437.

Figure 2.5.2A-21

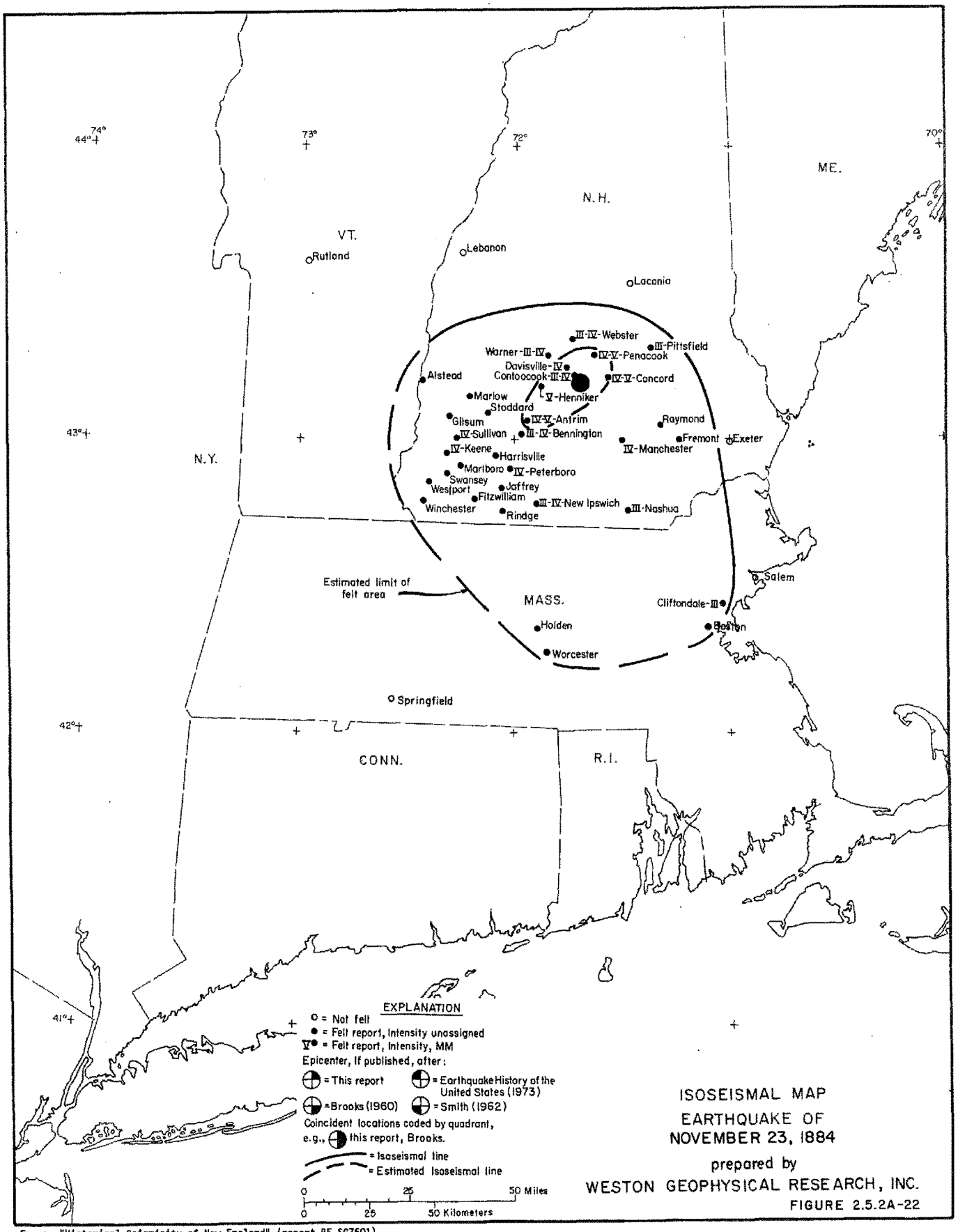
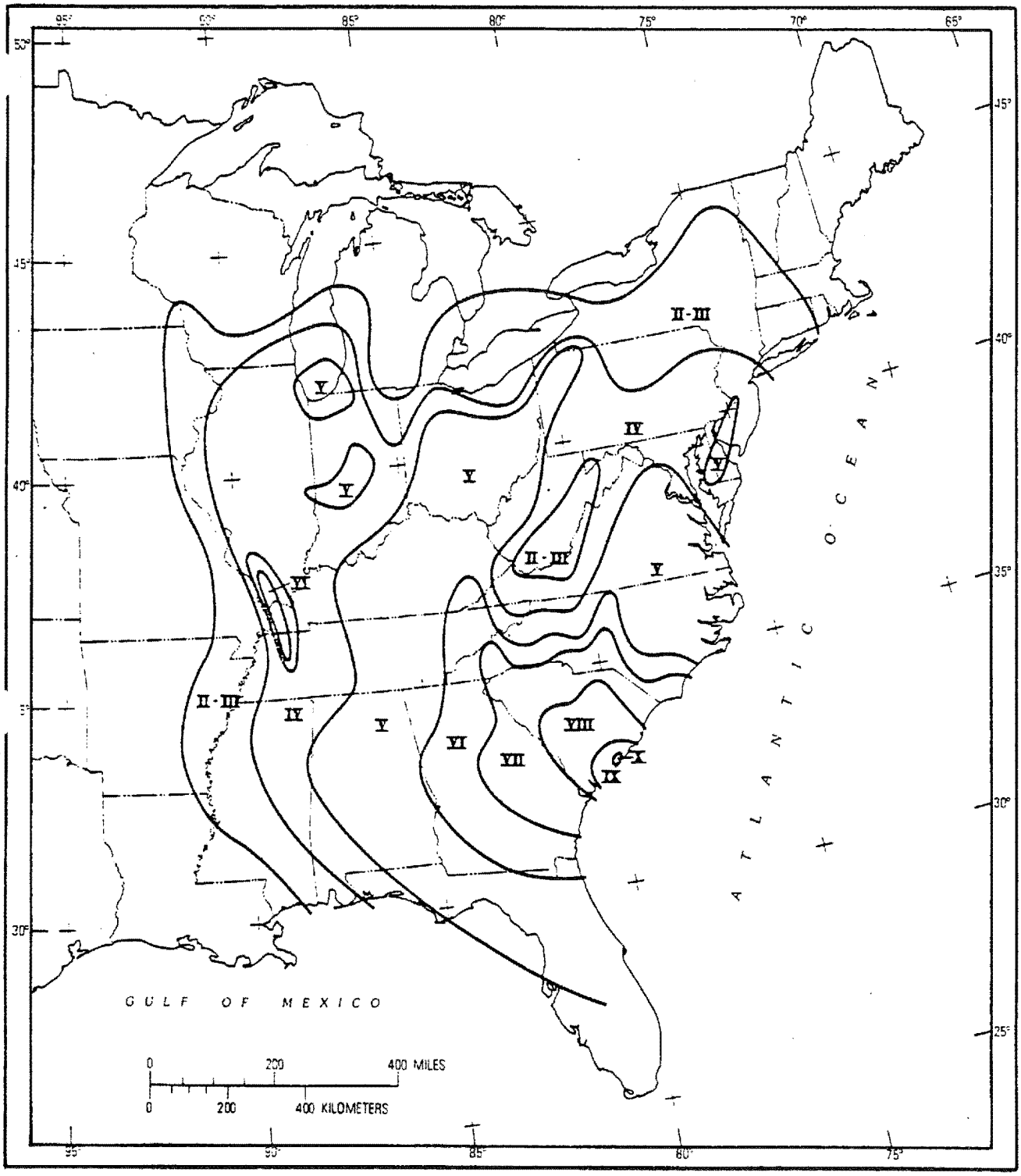


FIGURE 2.5.2A-22

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



.—Isoseismal map of the Eastern United States contoured to show the broad regional patterns of the reported intensities for the 1886 Charleston earthquake. Contoured intensity levels are shown in Roman numerals.

"Studies Related to the Charleston, South Carolina, Earthquake of 1886-A Preliminary Report". Geological Survey Professional Paper 1028, U.S.G.S., Washington, D.C., 1977.

Figure 2.5.2A-23

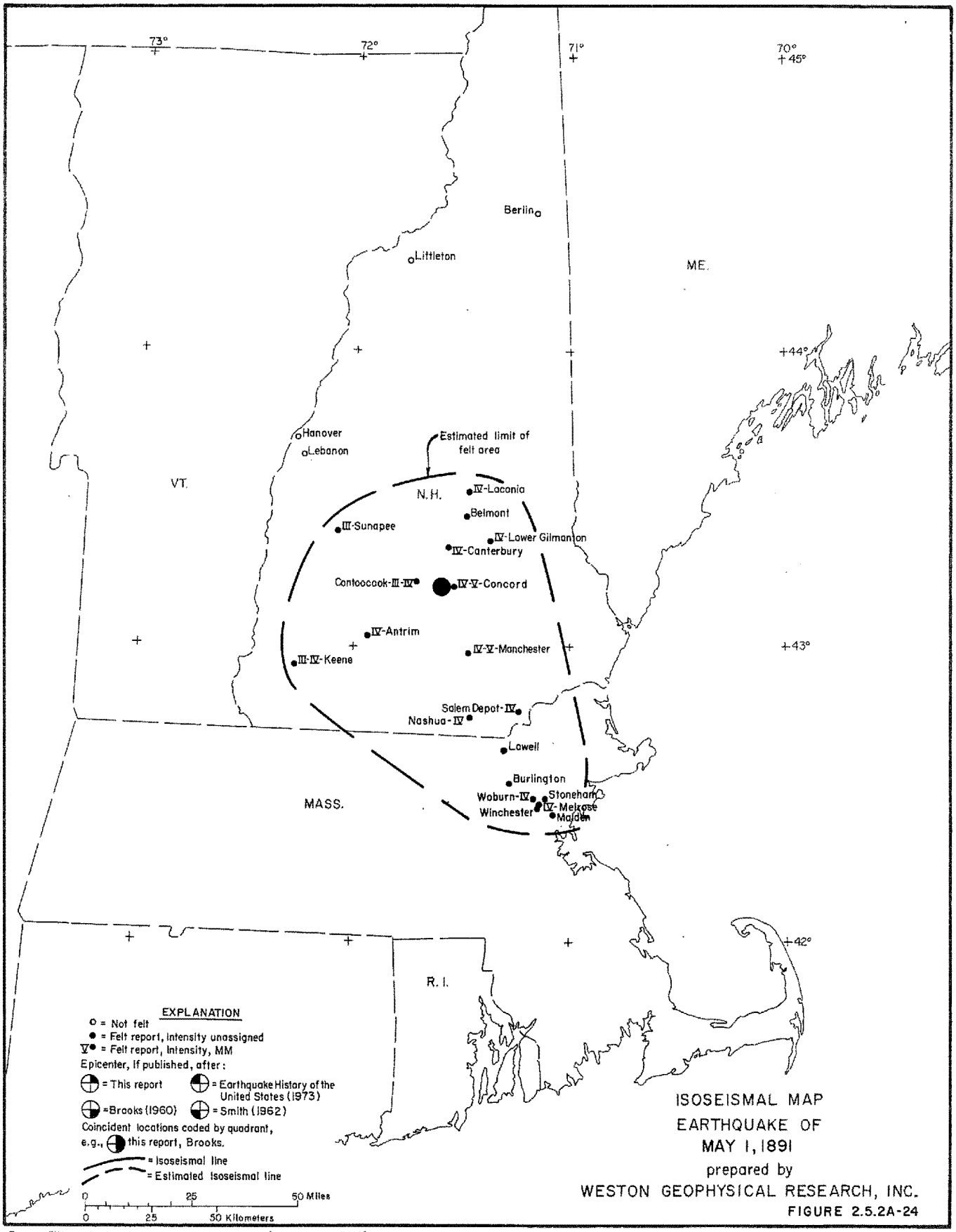
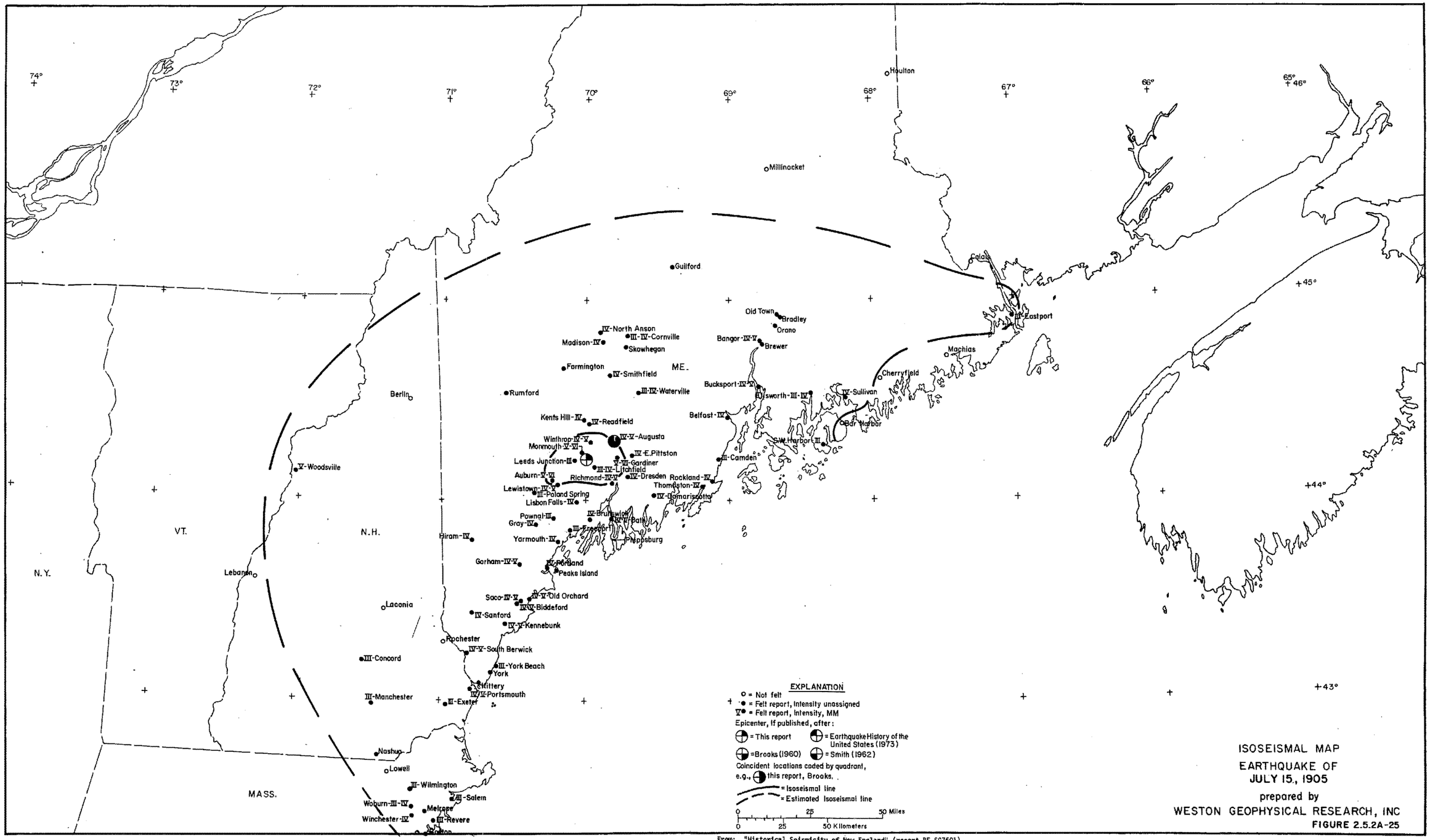


FIGURE 2.5.2A-24

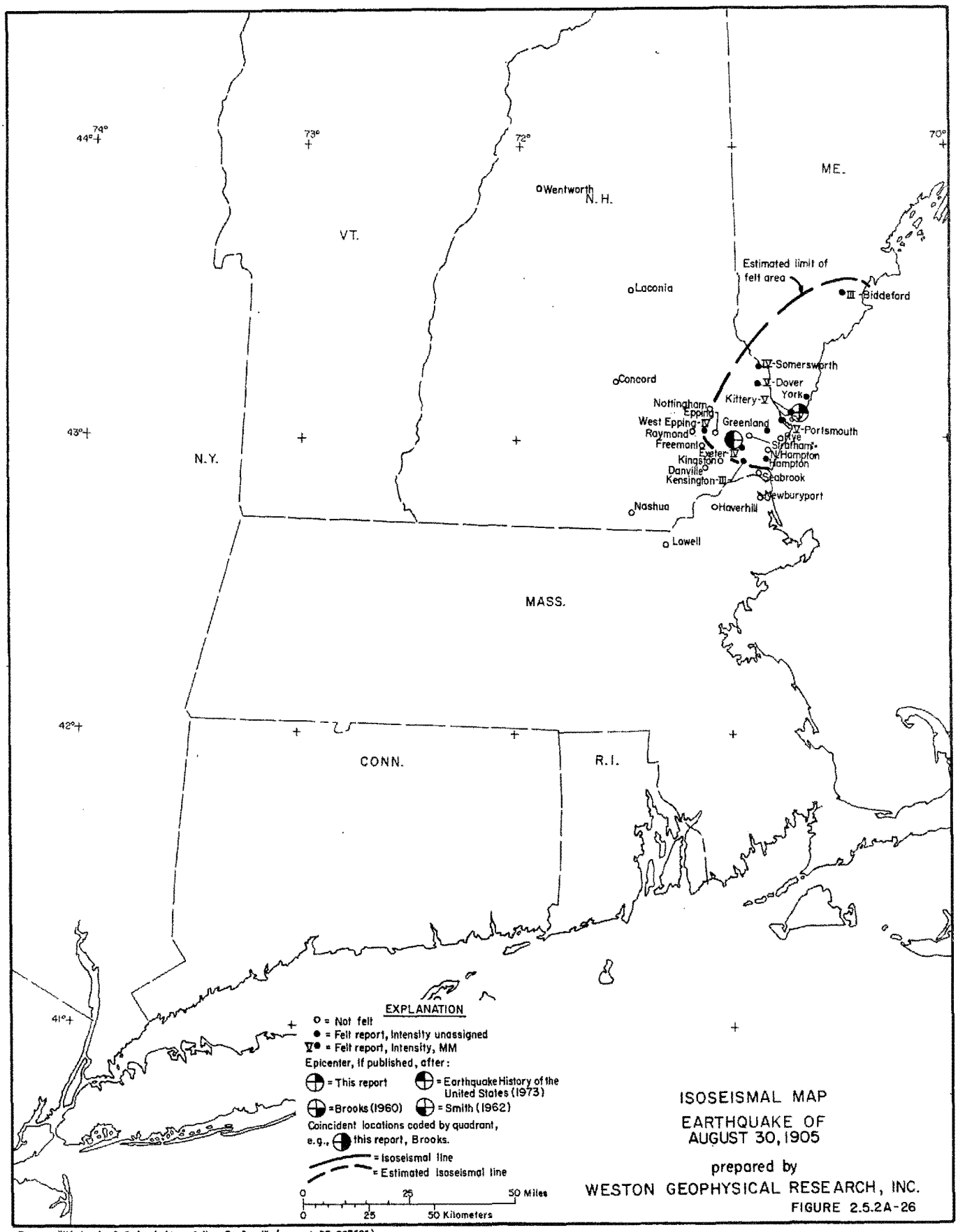
From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
JULY 15, 1905
prepared by
WESTON GEOPHYSICAL RESEARCH, INC

FIGURE 2.5.2A-25

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
AUGUST 30, 1905

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-26

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

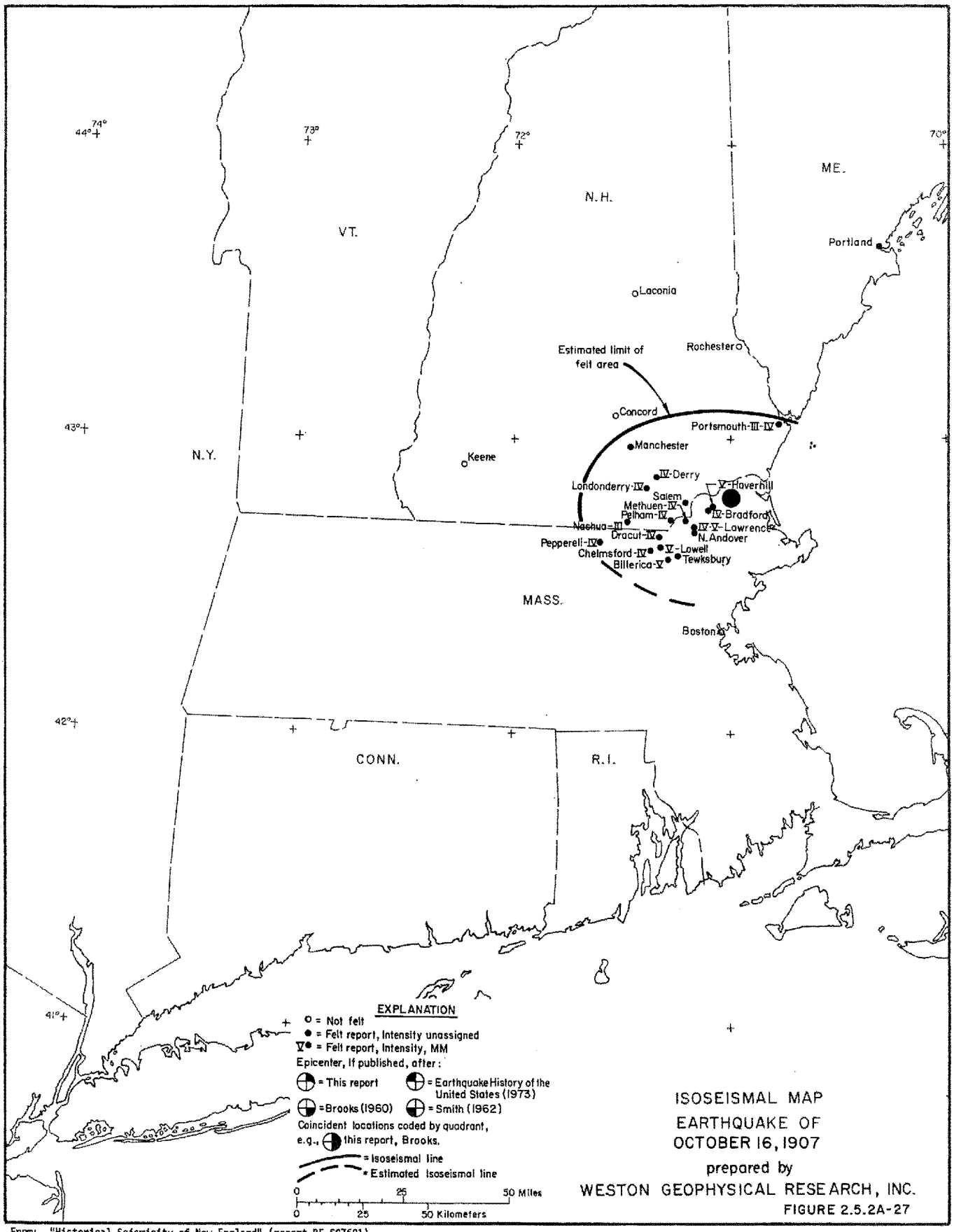
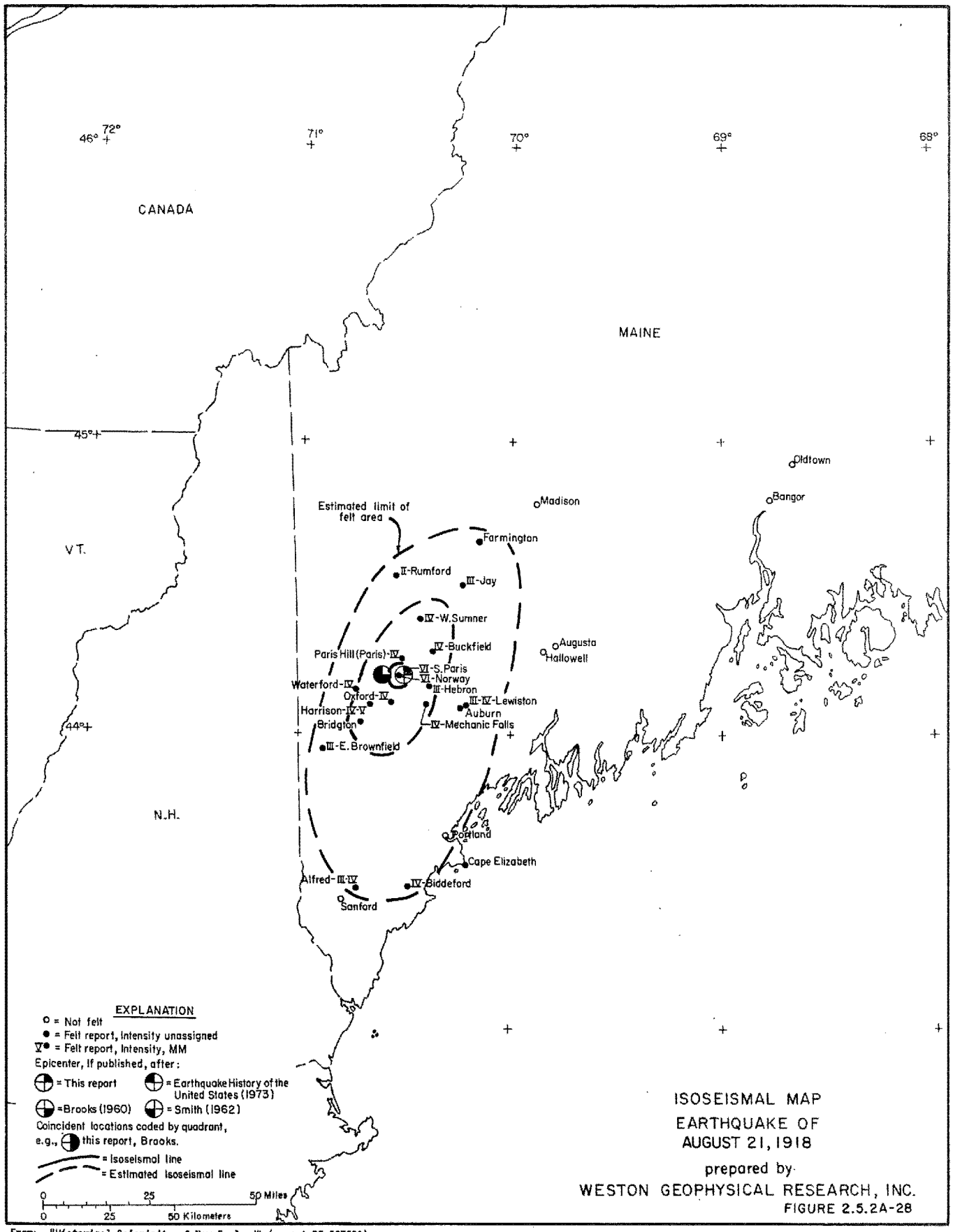


FIGURE 2.5.2A-27

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
AUGUST 21, 1918

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-28

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

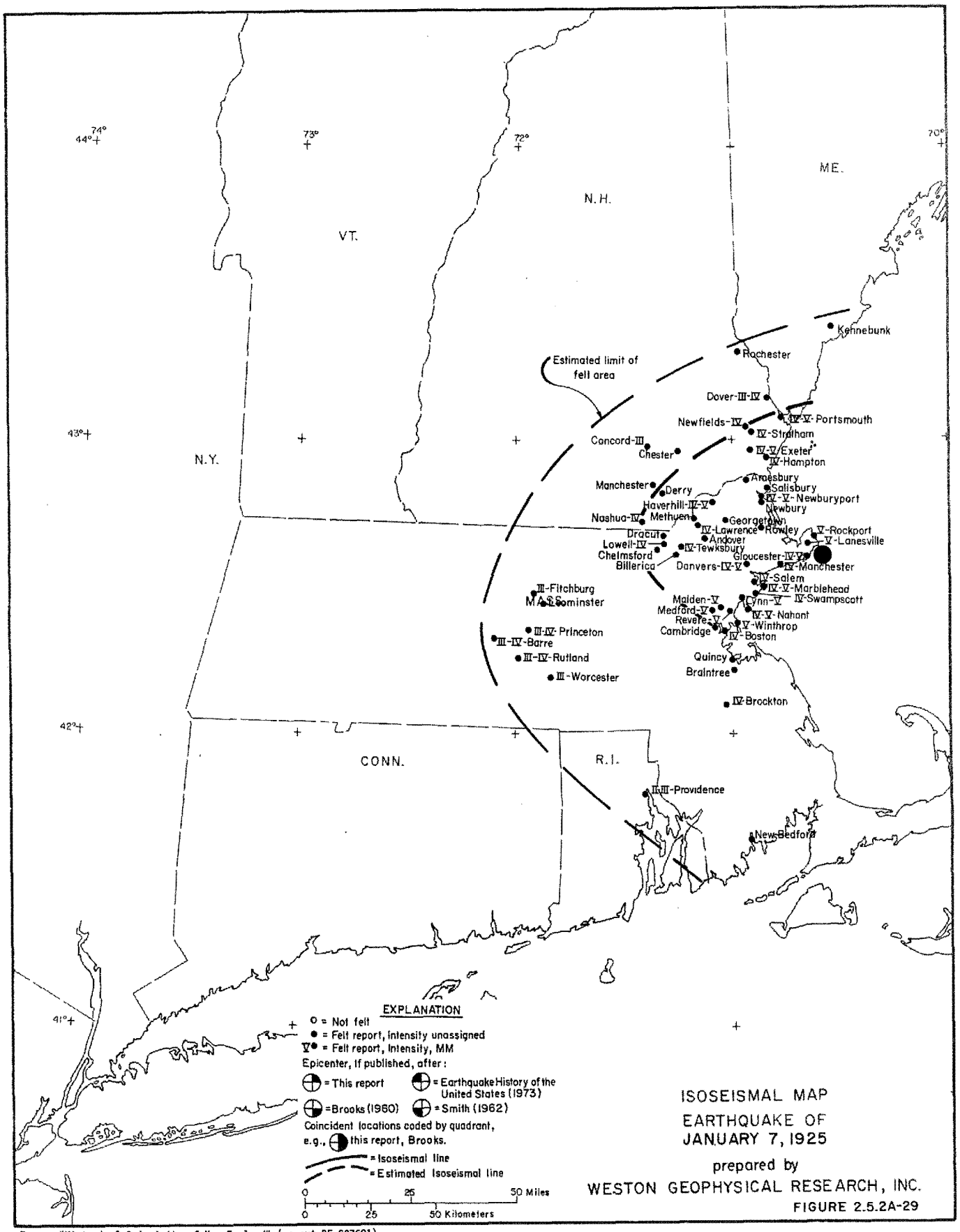
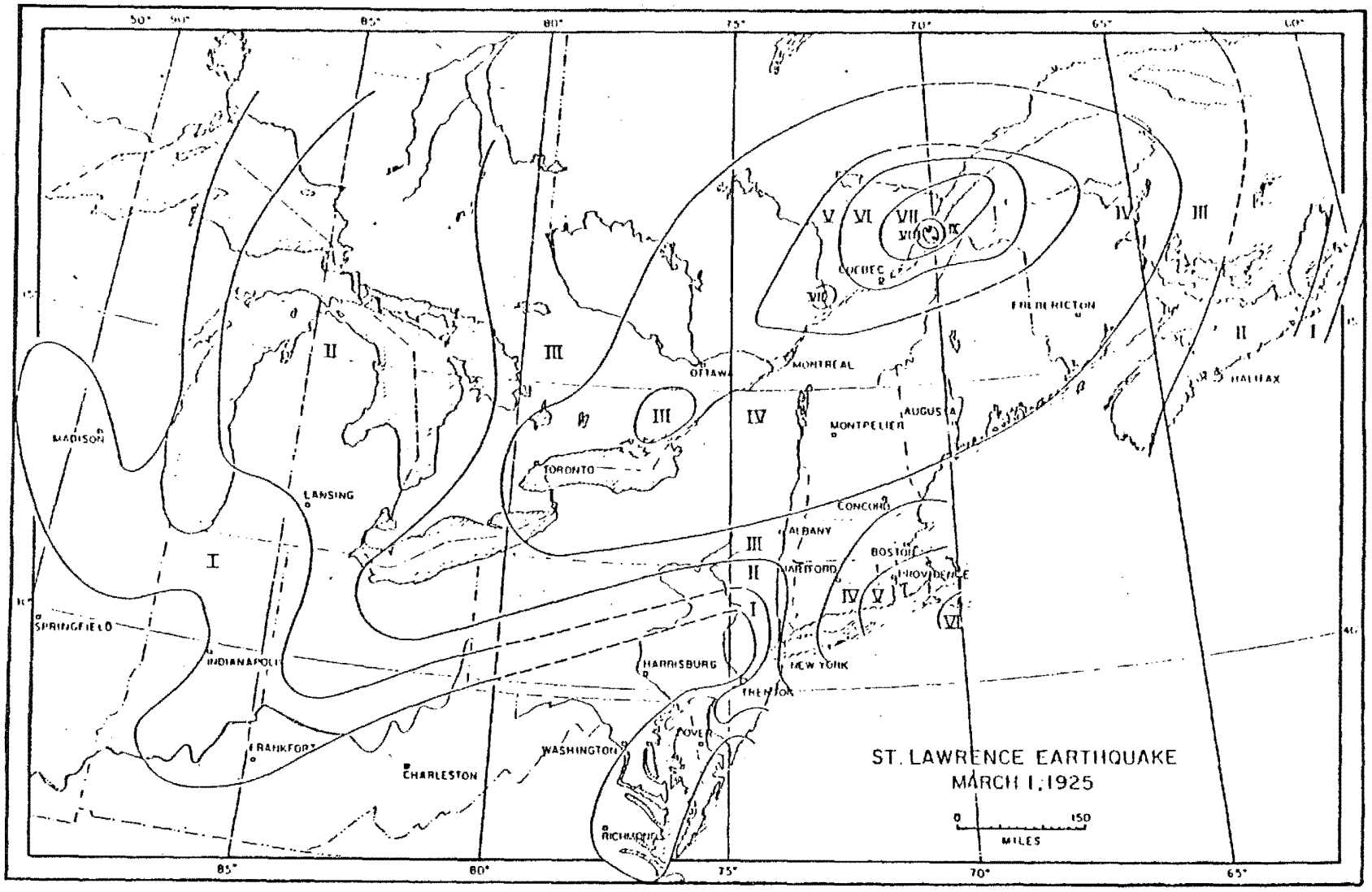


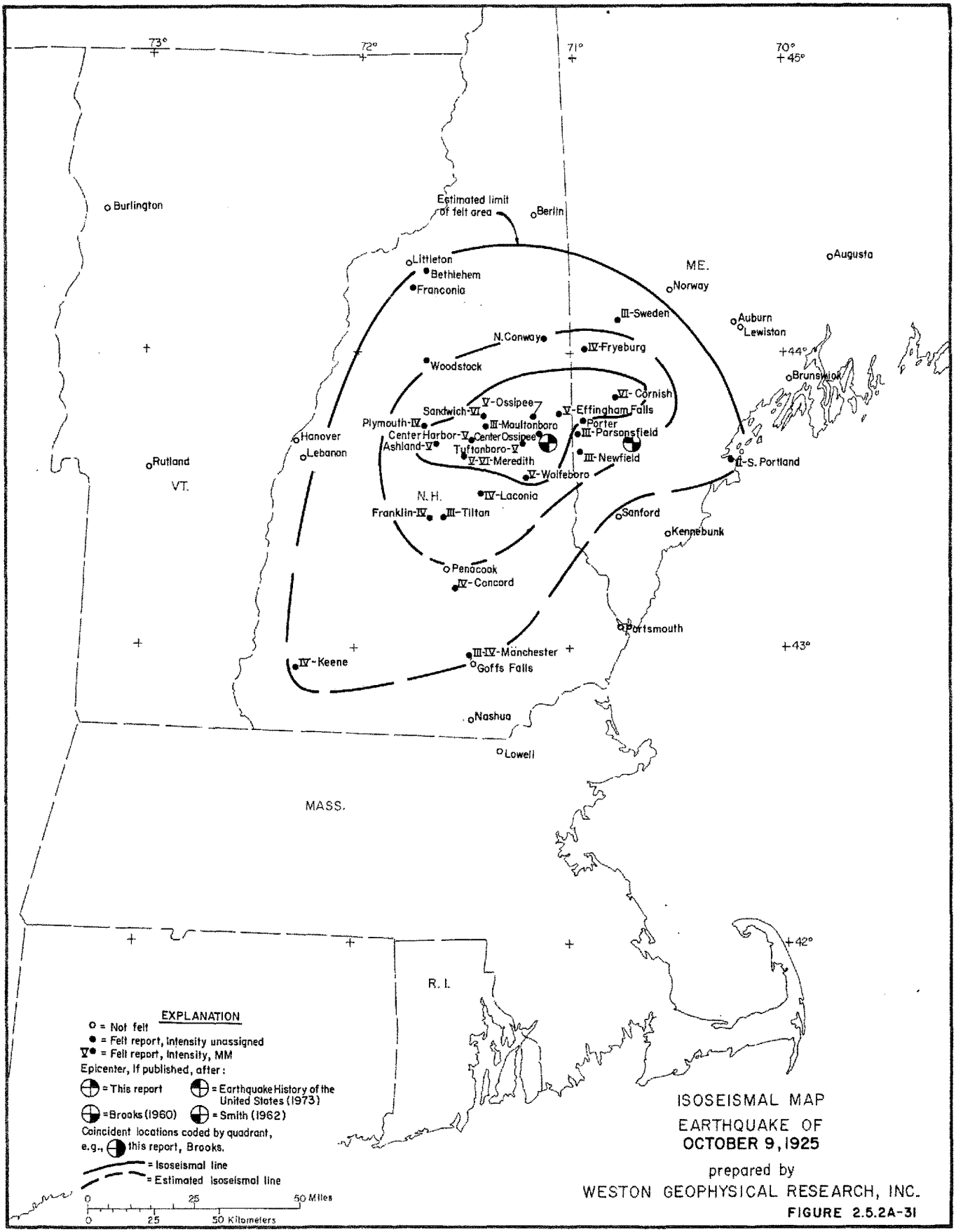
FIGURE 2.5.2A-29

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



Smith, W. E. T., Earthquakes of Eastern Canada And Adjacent Areas, 1928-1959, Publications of the Dominion Observatory, Department of Mines and Technical Surveys, Ottawa, Canada, 1966, p. 119, Vol. 32, No. 3.

Figure 2.5.2A-30



ISOSEISMAL MAP
EARTHQUAKE OF
OCTOBER 9, 1925

prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

FIGURE 2.5.2A-31

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471

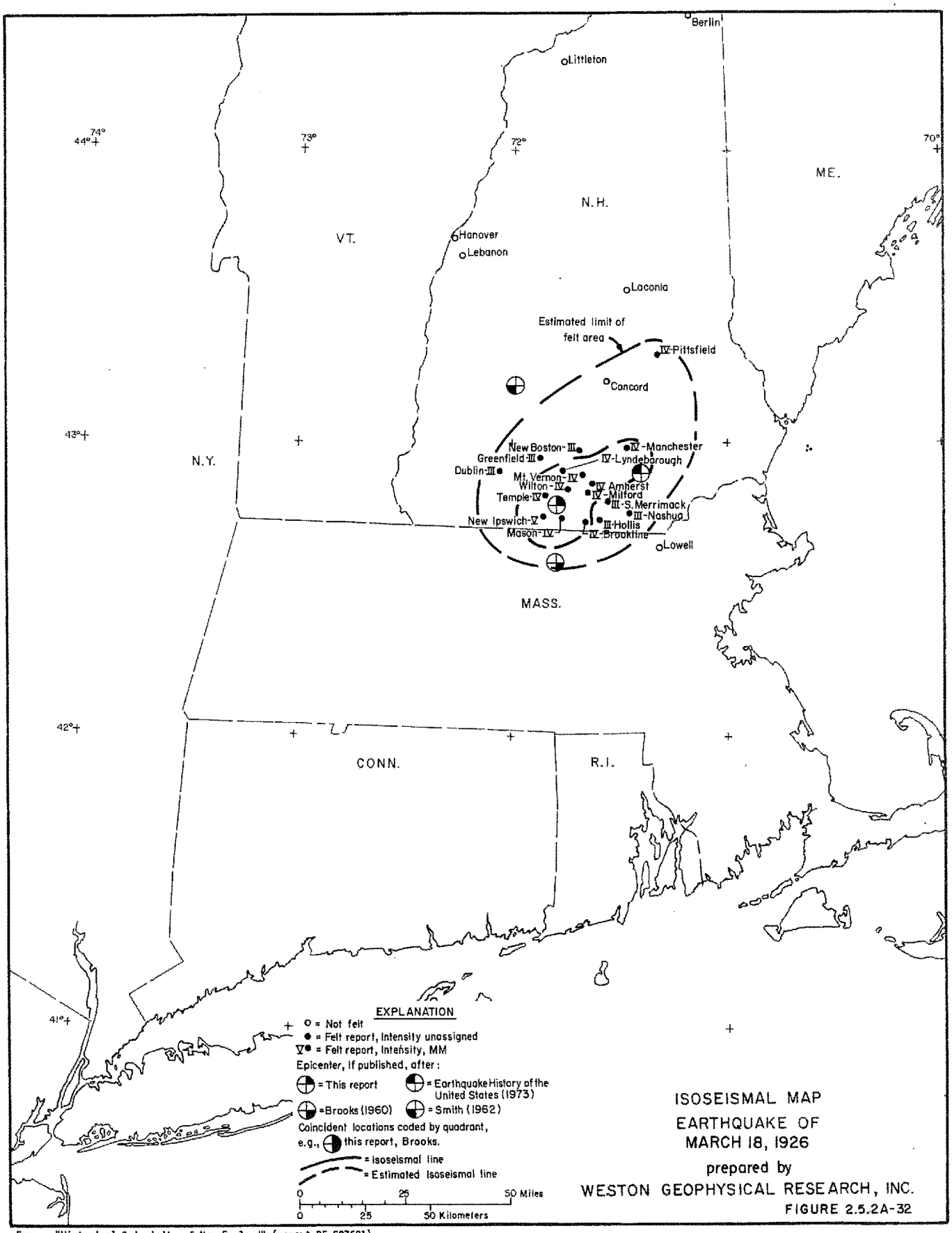
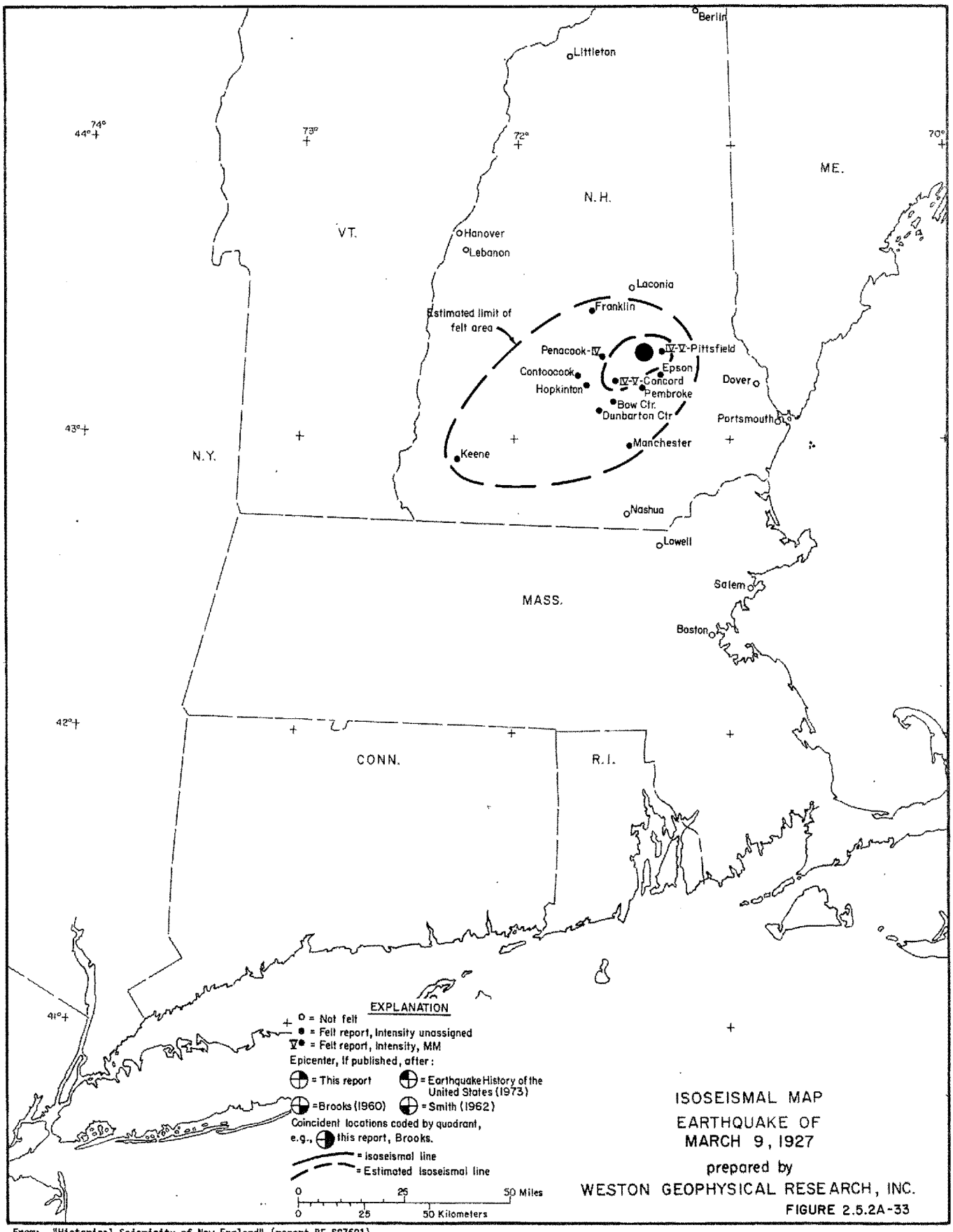


FIGURE 2.5.2A-32

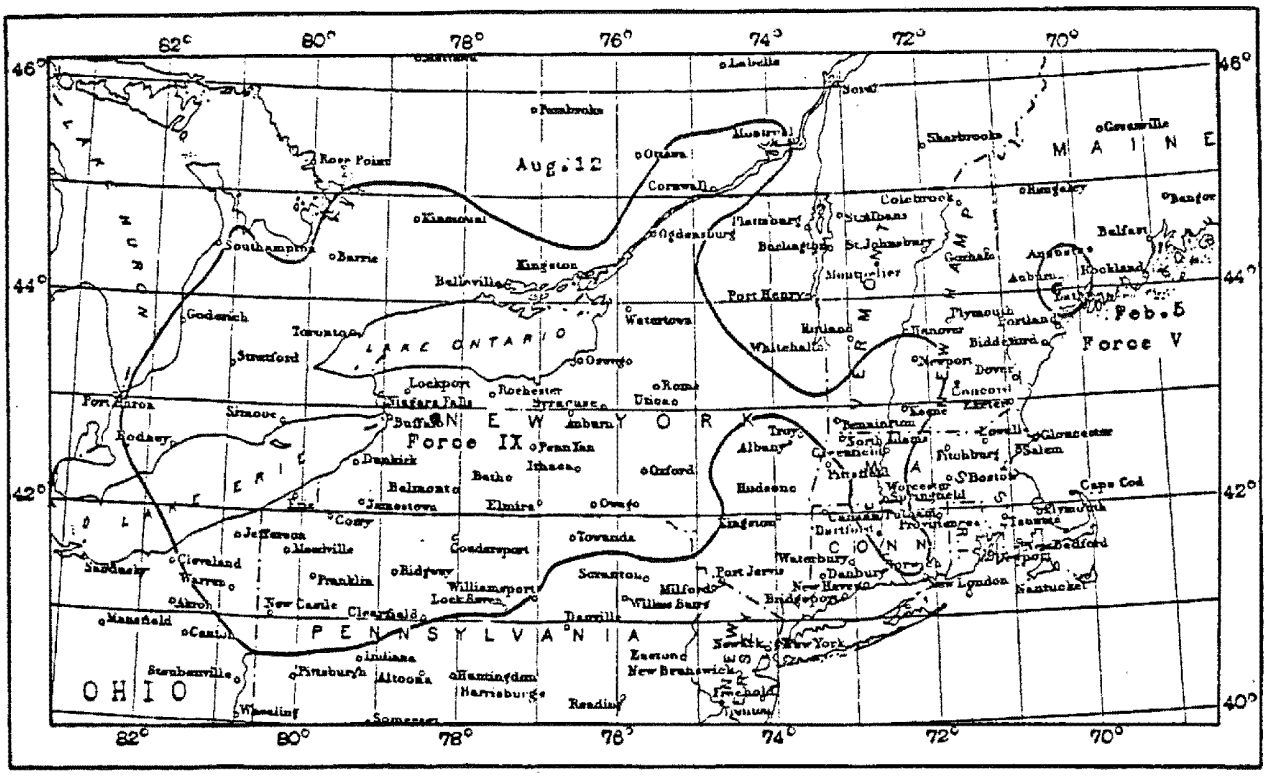
From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



ISOSEISMAL MAP
EARTHQUAKE OF
MARCH 9, 1927
prepared by
WESTON GEOPHYSICAL RESEARCH, INC.

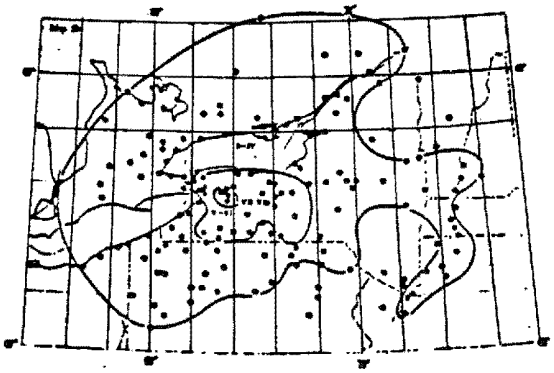
FIGURE 2.5.2A-33

From: "Historical Seismicity of New England" (report BE-SG7601) prepared for Boston Edison Company, Pilgrim Unit 2, Docket No. 50-471



Areas affected by shocks of February 5 and August 12

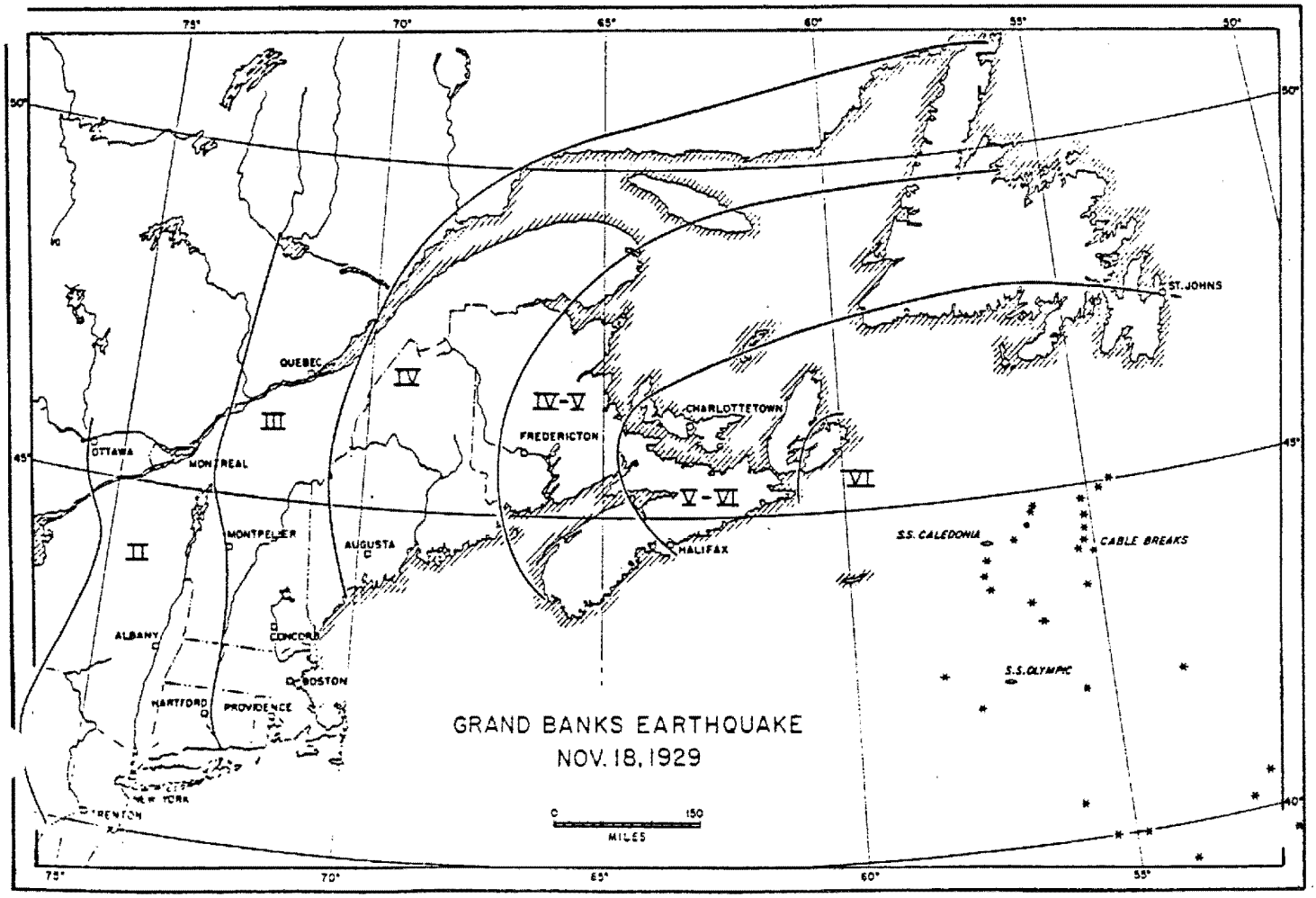
Heck, N. H. and R. R. Bodle, 1931, United States Earthquakes, 1929, United States Department of Commerce, Coast and Geodetic Survey, Washington, D.C., p. 7.



The Attica, New York, Earthquake of August 12, 1929. A modification of Heck and Bodle (1931, fig. 3): 125,000 sq. mi.

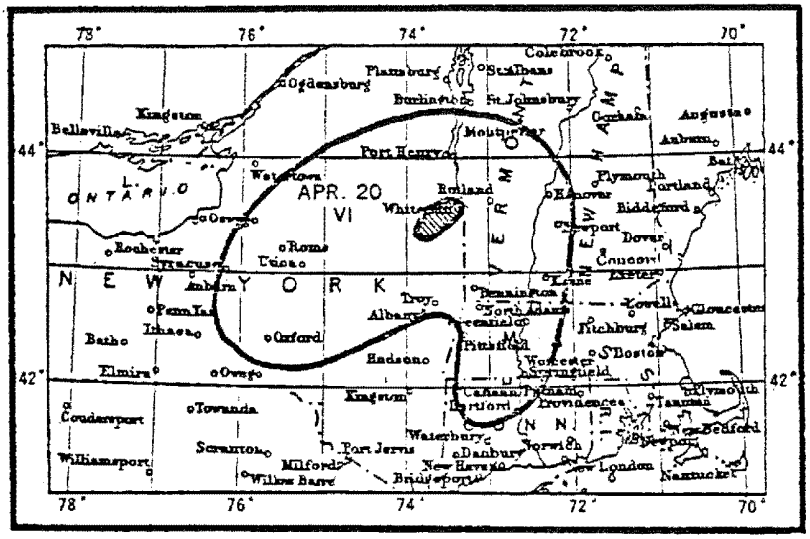
Docekal, J., 1971, Earthquakes of the Stable Interior with Emphasis on the Midcontinent, Department of Geology, University of Nebraska, Lincoln, Nebraska, p. 134.

Figure 2.5.2A-34



Smith, W.E.T., Earthquakes of Eastern Canada and Adjacent Areas, 1928-1959, Publications of the Dominion Observatory, V. 32, No. 3, Ottawa, Canada, 1966.

Figure 2.5.2A-35

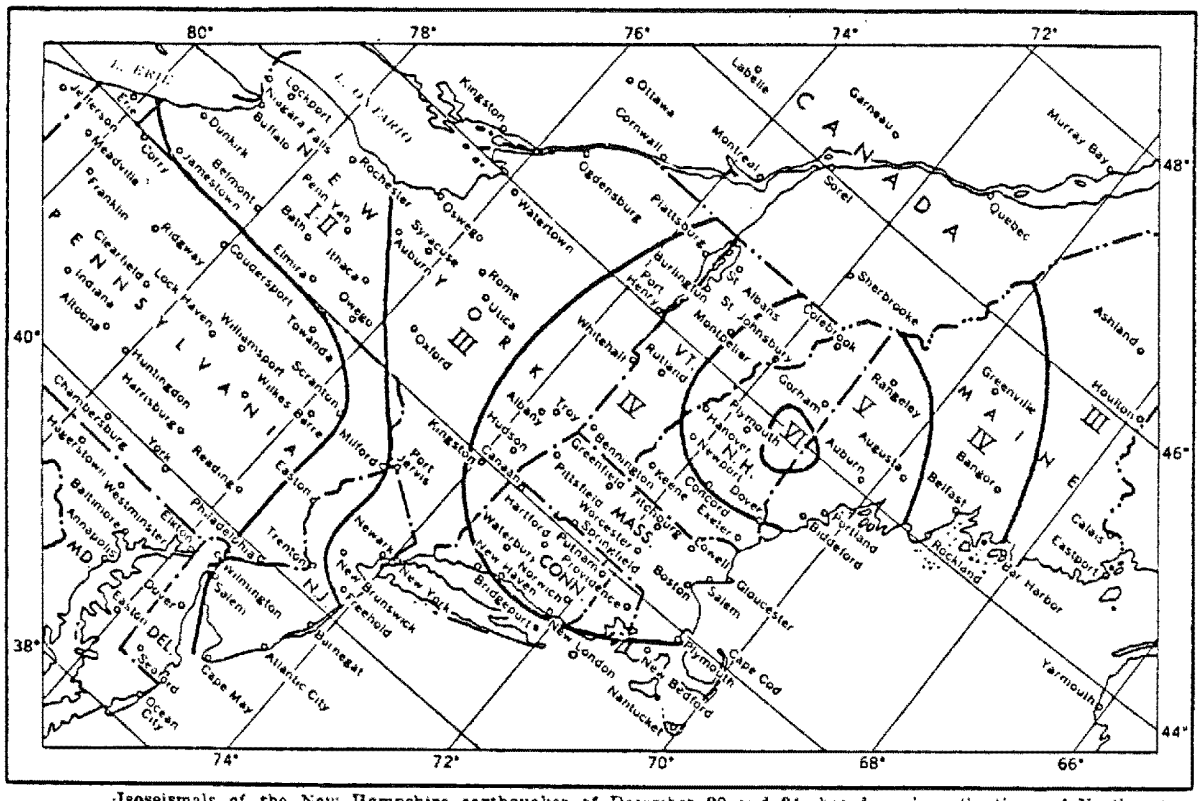


Area affected by Lake George shock of April 20

Neumann, Frank, United States Earthquakes, 1931, U.S. Dept. of Commerce, Coast and Geodetic Survey, Washington, D.C., 1932

April 20, 1931

Figure 2.5.2A-36



Isoseismals of the New Hampshire earthquakes of December 20 and 24, based on investigations of Northeastern Seismological Association.

Neumann, Frank, United States Earthquakes, 1940, U.S. Dept. of Commerce, Coast and Geodetic Survey, Washington, D.C., 1942.

Dec. 20, 24, 1940

Figure 2.5.2A-37

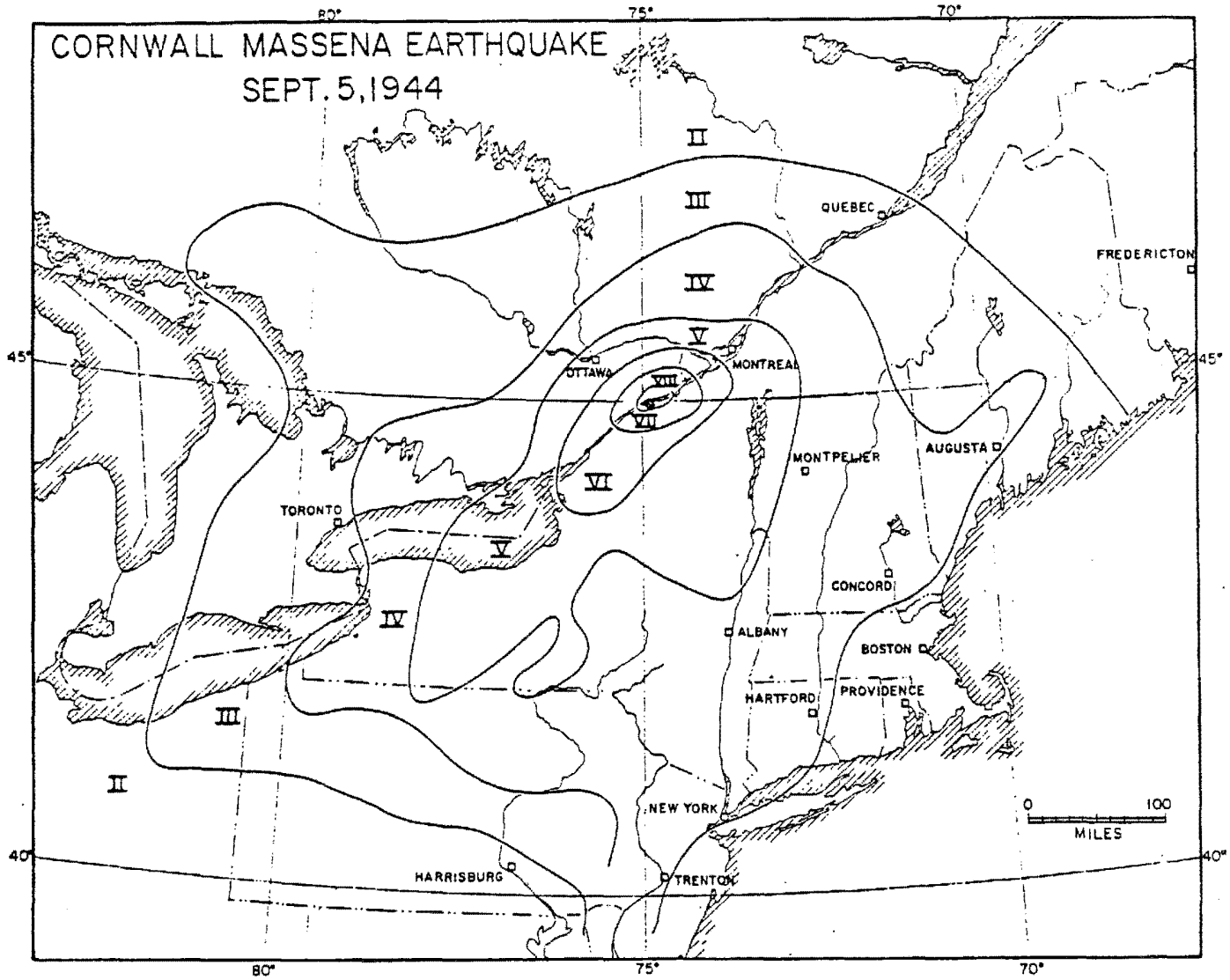
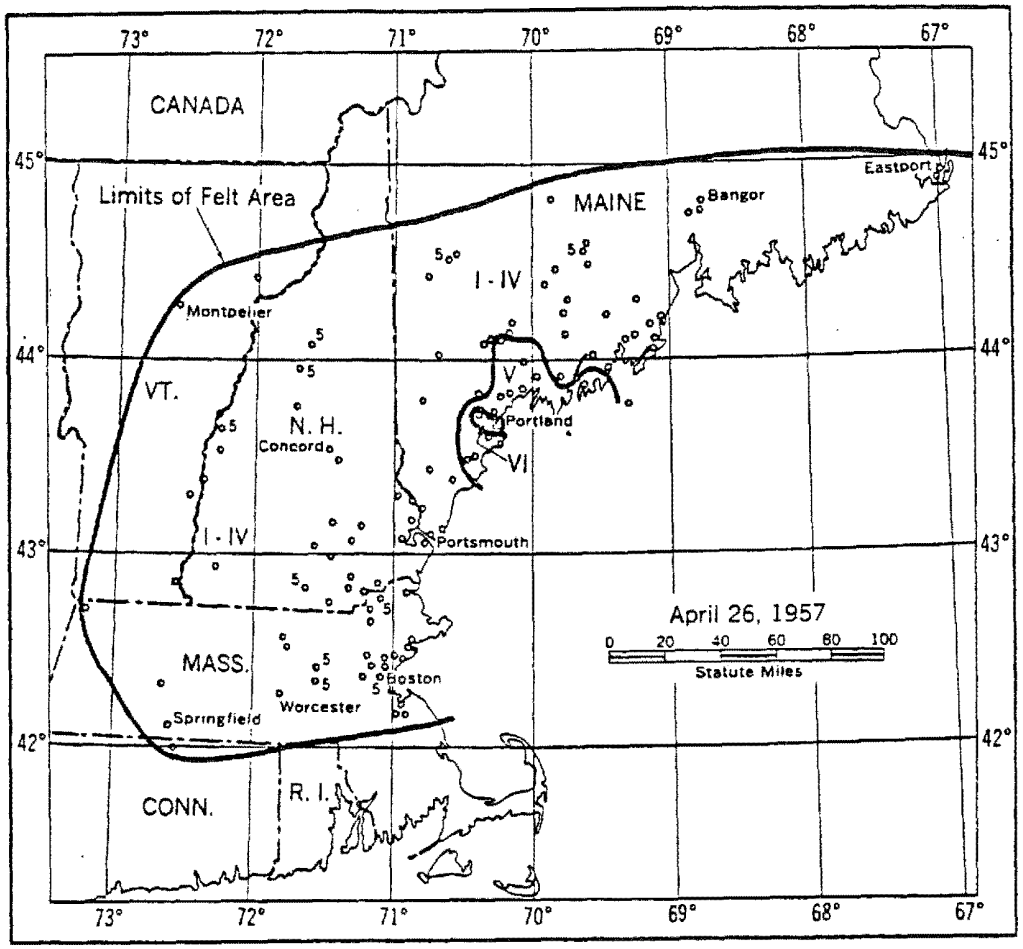


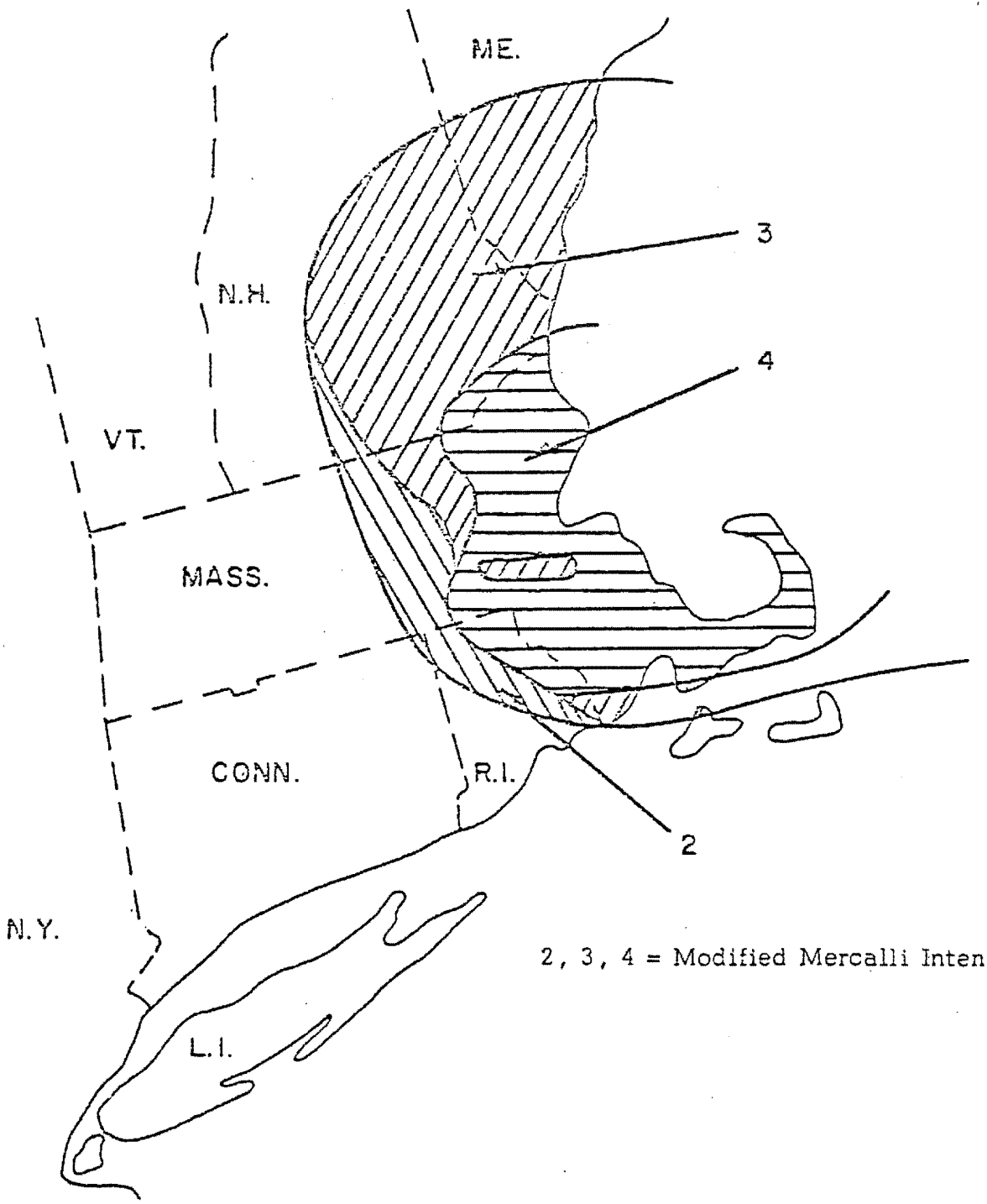
FIGURE 6. Adapted from Milne (M14).

Smith, W.E.T., 1966, Earthquakes of Eastern Canada and Adjacent Areas, 1928-1959, Publications of the Dominion Observatory, Ottawa, Canada, Vol. 32, No. 3.



Brazee, R. J. and W. K. Cloud, United States Earthquakes, 1957, U.S. Dept. of Commerce, Coast and Geodetic Survey, Washington, D.C., 1959.

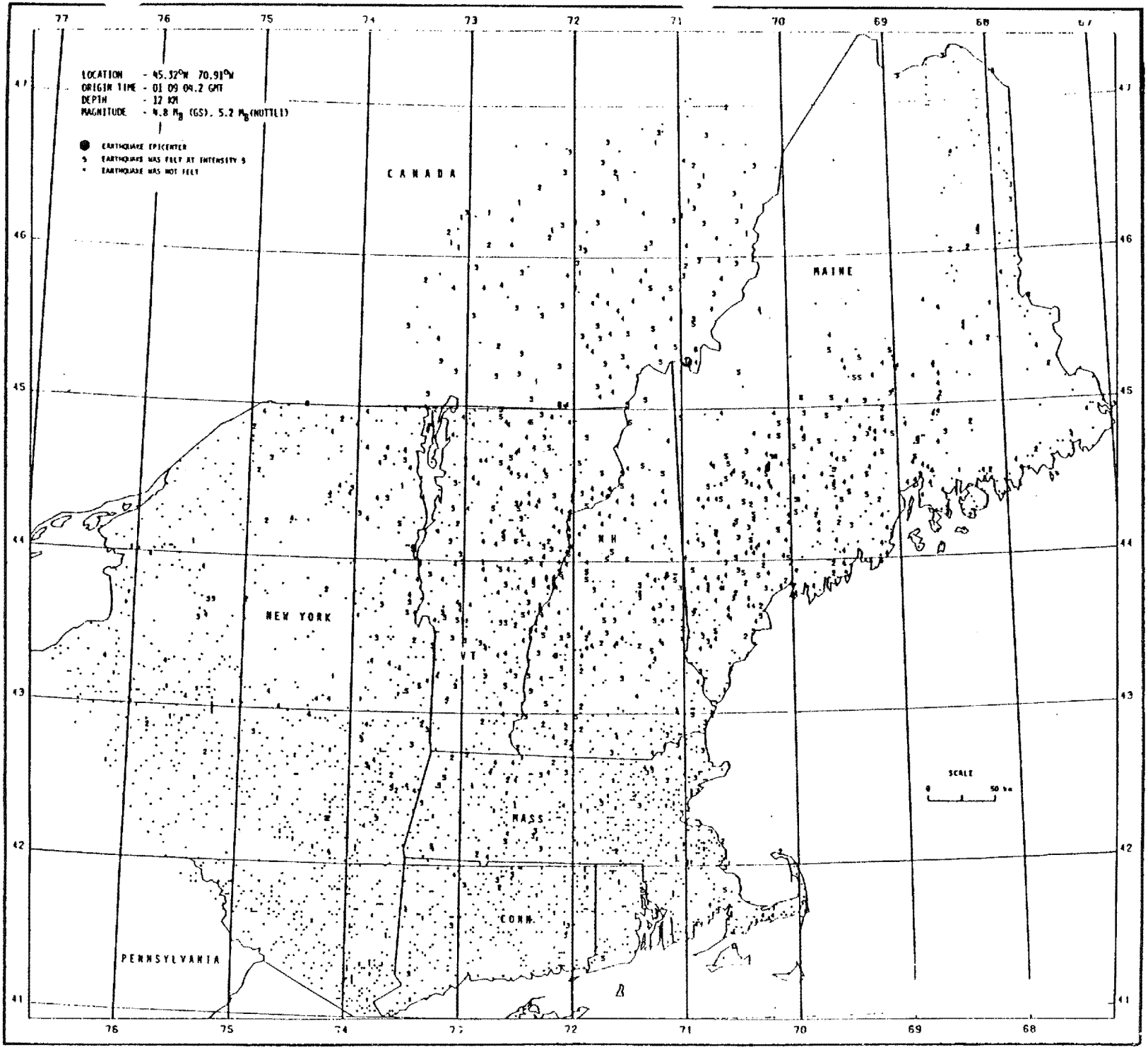
Figure 2.5.2A-39



2, 3, 4 = Modified Mercalli Intensities

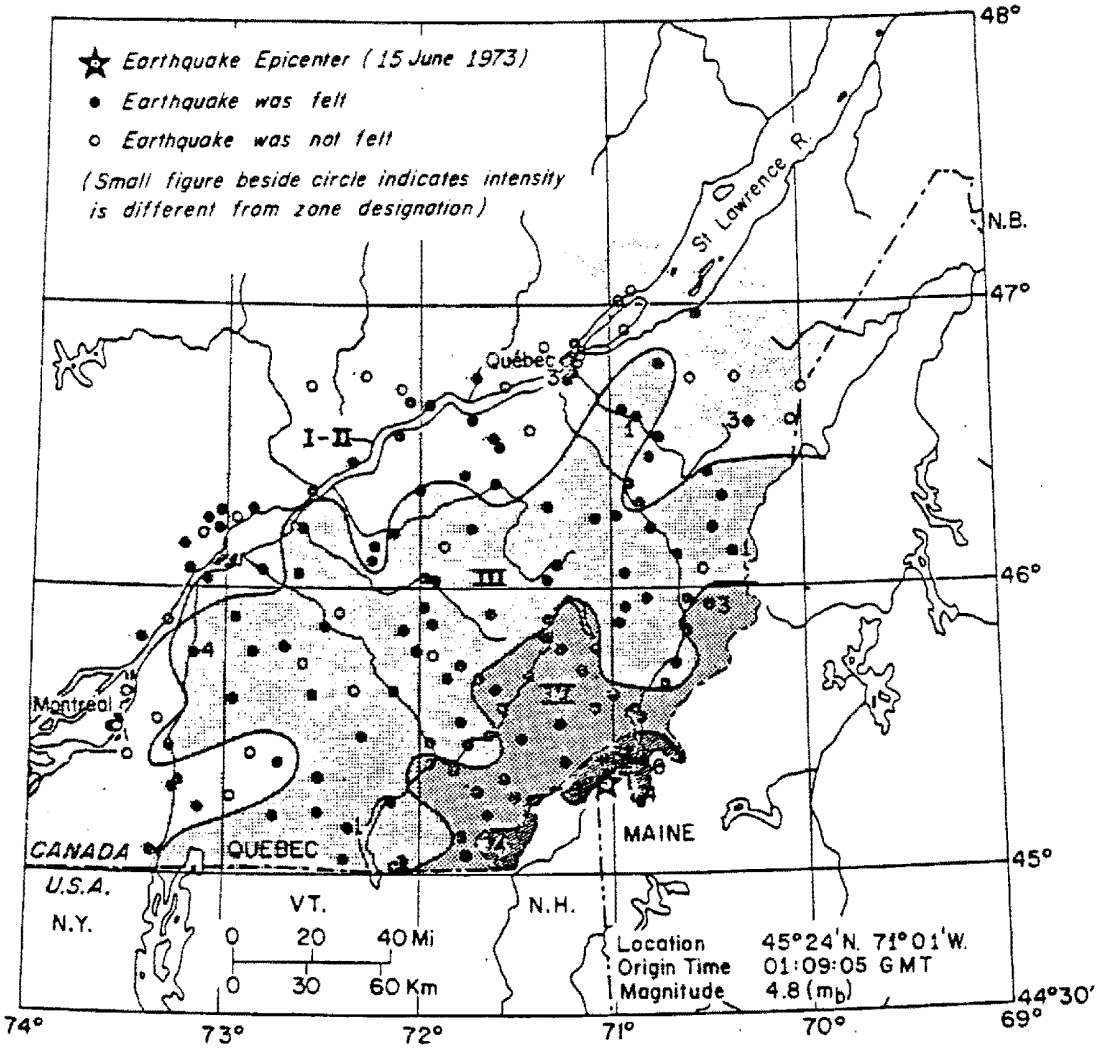
*after Breitling, W., "Crustal Structure and Attenuation Derived from the Boston Earthquake of October 16, 1963," Unpublished Master's Thesis, Boston College, Chestnut Hill, Massachusetts, 1965, page 2.

Figure 2.5.2A-40



Wetmiller, R. J., "The Quebec-Maine Border Earthquake, 15 June, 1973", Canadian Jour. of Earth Sci., V. 12, No. 11, 1975.

Figure 2.5.2A-41a



Wetmiller, R. J., "The Quebec-Maine Border Earthquake, 15 June, 1973", Canadian Jour. of Earth Sci., V. 12, No. 11, 1975.

Figure 2.5.2A-41b

APPENDIX 2.5.2A

PART II

LIST OF TABLES

TABLE NO.	DESCRIPTION
1	Aftershocks of the Earthquake of November 9, 1727 From the Minister's Record (1727-1748) of the Rev. Matthias Plant
2	Record of Aftershocks of the 1727 Earthquake at Newbury and Marblehead, Massachusetts
3	Aftershocks of the 1755 Earthquake
4	Summary of Observations on Aftershocks

INTRODUCTION

This section presents a brief discussion of those historical events that are of special interest to the site, either because of their proximity or their site intensity. Most of the events included in this discussion have a predicted site intensity equal to or greater than IV(MM).

The historical documentation on felt reports near the site, or at nearby localities is also presented whenever available. Information on felt reports near the epicenters has been included only for those few events that are related to the maximum earthquake potential. A more complete documentation for most of the selected events can be found in Historical Seismicity of New England, prepared in 1976 for the Pilgrim Unit II Docket by Weston Geophysical.

EARTHQUAKE OF 1534 (DATE UNCERTAIN)

EPICENTRAL INTENSITY: IX-X(MM)

LOCATION: 47.6N, 70.1W

EVALUATION:

This event is included in the present catalog for sake of completeness. Smith (1962) is the first cataloger of this event. It is omitted in the later edition of the Earthquake History of the United States (Coffman and von Hake, 1973). The time, location, and intensity are quite vague, and the supporting evidence quoted by Smith comes from Thwaites, editor of the Jesuit Relations. Reference is made to the fact that *"the Savages have preserved the tradition of a great earthquake which had happened in former times, but that they did not know either the time or the cause of the disturbance."* Thwaites also quotes from a Topographical Dictionary under the heading "Les Eboulements," where reference is made to the local tradition of an earthquake which happened near this locality between the two voyages of Jacques Cartier (1534-1535).

Clearly, assigning an Intensity IX-X to characterize such a wording is not a rigorous application of the Mercalli scale, but a subjective attempt to imply the occurrence of a severe shock. Once accepted that the event occurred near Les Eboulements, Quebec and had such a large intensity, it is logical to assume that it could have been felt at the site at the Intensity V level.

EARTHQUAKE OF JUNE 11, 1638
(JUNE 1, 1638, JULIAN CALENDAR)

CA: 20:00 (GMT)

EPICENTRAL INTENSITY: IX(MM)

LOCATION: 47.65N, 70.17W

EVALUATION:

The location of this event has been subjected to multiple revisions by various catalogers. Unfortunately, the sparsity of information is the main reason for this variety of interpretations. Because the historical documentation has remained minimal, the presently assumed location must still be considered uncertain. For sake of clarification, it is helpful to recall that Heck and Eppley (1958) in their Earthquake History of the United States listed the event *"In New England,"* with no intensity assigned. Mather and Godfrey (1927) had estimated the potential location *"off Cape Ann"* and the intensity as VIII(RF). Smith (1962), giving high importance to a felt report from Three Rivers (Quebec), decided to give the *"St. Lawrence Valley"* as the probable source region, and used the Three Rivers' coordinates. He also upgraded the Intensity VIII (Rossi-Forel) to IX(MM) without stating his reasons. In 1965, Eppley, in his revised catalog, changed his own 1958 position and accepted Smith's suggested location and intensity. In the meantime, Smith (1966) considered that he should not have diverged from Mather and Godfrey, and in a note placed at the end of the introduction to the second part of his catalog, reversed his position and placed the event back *"off Cape Ann,"* leaving untouched his own upgraded intensity. When Coffman and von Hake (1973) published their revised Earthquake History of the United States, they apparently did not notice Smith's (1966) revision and left the event near Three Rivers, Quebec. Stevens (1974) in a brief note in the Bulletin of the Geological Society of America signaled, in an answer to Sbar and Sykes (1973), that Smith had removed the event from the Three Rivers' location.

In 1976 further research by Weston Geophysical indicated that some similarity between the 1925 isoseismals and the 1638 and 1663 felt report distributions existed, suggesting that all three events could have the same regional location. Smith (1962) had also pointed out that a *"fairly severe shock in the St. Lawrence Valley could have produced the observed results"* in New England. In 1976, the Earth Physics Branch accepted the suggestion that the La Malbaie area was a likely location for the event, although other regions should not be excluded. Basham et al. (1979) consider the event too uncertain to use it in their risk assessment, keeping 1663 as a starting time. They concede that an event (magnitude 6) could be accommodated in the La Malbaie region on the basis of the recurrence curve.

The eyewitness reports from the coastal region of Massachusetts, for the earthquake of June 1, 1638, are not inconsistent with those from the earthquake of March 1, 1925 (GMT). Data from Boston, Plymouth, and Newbury, Massachusetts, Providence, Rhode Island, and the region about Three Rivers, Quebec compare well with the isoseismals of the 1925

event. The absence of reports of damage to dwellings or chimneys in early documents precludes consideration of the Cape Ann region as an epicentral location for the event. Samuel Williams (1785) of Harvard, in one of the earliest published systematic catalogs of New England earthquakes, considers that the 1638 earthquake, like that of the 1663 earthquake, was centered in Canada. An earthquake of epicentral Intensity IX(MM), centered in the La Malbaie region of Quebec, can account for the intensity observations of the historical record for the June 1, 1638 earthquake; it is accepted here as the more probable.

PERTINENT ACCOUNTS:

Anonymous, Town Records Entry, Newbury, Massachusetts

"Being this day assembled to treat or consult about the well ordering of the affairs of the towne about one of the clock in the afternoone, the sunn shining faire, it pleased God suddenly to raise a vehement earthquake coming with a shrill clap of thunder issuing as is supposed out of the east, which shook the earth and the foundations of the house in a very violent manner to our great amazement and wonder, wherefore taking notice of so great and strange a hand of God's providence, we were desirous of leaving it on record to the view of after ages to the intent that all might take notice of Almighty God and fear his name.'" (Cited in Currier 1902, p. 250.)

Bradford, Plymouth Plantation, Massachusetts

"This year, about the first or second of June, was a great and fearful earthquake. It was in this place heard before it was felt. It came with a rumbling noise or low murmur, like unto remote thunder. It came from the northward and passed southward; as the noise approached nearer, the earth began to shake and cause like things as stood upon shelves, to clatter and fall down. Yea, persons were afraid of the houses themselves. It so fell out that at the same time divers of the chief of this town were met together at one house, conferring with some of their friends that were upon their removal from the place, as if the Lord would hereby show the signs of His displeasure, in their shaking a-pieces and removals one from another. However, it was very terrible for the time, and as the men were set talking in the house, some women and others were without the doors, and the earth shook with that violence as they could not stand without catching hold of the posts and pales that stood next them. But the violence lasted not long. And about half an hour, or less came another noise and shaking, but neither so loud nor strong as the former, but quickly passed over and so it ceased. It was not only on the seacoast, but the Indians felt it within land, and some ships that were upon the coast were shaken by it. So powerful is the mighty hand of the Lord, as to make both the earth and sea to shake, and the mountains to tremble before Him, when He pleases. And who can stay His hand?" (Cited in Morrison, 1952, pp. 302-303.)

Hull, Diary Entry, Written While At Boston, Massachusetts

"The 1st of the 4th month, about noon, was a very great and general earthquake. The vessels upon the river, and the goods that were in the said ships, moved much. Many upon the land could scarcely stand upright."

Johnson, 1654

"This yeare, the first day of the Fourth-Month, about two of the clock in the after-noone, the Lord caused a great and terrible Earthquake, which was general throughout all the English Plantations; the motion of the Earth was such, that it caused diverse men (that had never knowne an Earthquake before) being at worke in the Fields, to cast down their workins-tooles, and run with gastly terrified lookes, to the next company they could meet withall; it came from the Westerme and uninhabited parts of this Wildermesse, and went the direct course this brood of Travellers came."

Josselyn

"June the second, a great and terrible earthquake throughout the country.

"...at 4 of the clock we descryed two sail bound for New-foundland, and so far the Streights, they told us of a general Earth-quake in New-England...and now we are two leagues off Cape Ann."

Note: These are notes made upon a voyage from England in 1638. There is no mention of an earthquake felt while at sea.

Le Jeune, Rev. Paul, 1638, Written at Three Rivers, Quebec

"On St. Barnabas' day, we had an earthquake in some places; and it was so perceptible that the savages were greatly surprised to see their bark plates collide with each other, and the water spill out of their kettles. This drew from them a loud cry of astonishment."

Note: This account was written at Three Rivers, Quebec on August 25, 1638. St. Barnabas day is June 11. Catholic countries were already on the Gregorian calendar. Corresponding dates in New England would be 10 days earlier or June 1, Old Style.

Williams, Roger, 1638, Written At Providence, Rhode Island

"2 things at present for information.

"First, in the affaires of the Most High; his late dreadfull voice and hand: that audible and sensible voice, the Earthquake.

"All these parts felt it, (whether beyond the Nanhiggonsick I yet learne not), for my selfe I scarce perceaued ought but a kind of thunder & a gentle mooving & the natiues apprehensions, & but one sudden short motion.

"The younger natives are ignorant of the like; but the elder informe me that this is the 5th within these 4 score yeare in the land: the first about 3 score & 10 yeare since: the second some 3 score & 4 yeare since: the third some 54 yeare since, the 4th some 46 since..."

Winthrop, John, 1638, Journal Entry Written At Boston, Massachusetts

"Between 3 and 4 in the afternoon...there was a great earthquake. It came with a noise like a continued thunder or a rattling of coaches in London, but was presently gone. It was at Connecticut, at Naragansett, at Pascataquack, and all the parts about. It shook the ships, which rode in the harbor, and all the islands, etc. The noise and the shakings continued about four minutes. The earth was unquiet twenty-days after by times."

Hutchinson (1765), Later History published 127 years after the 1638 event

"The year 1638 was memorable for a very great earth-quake through New-England. The shake, by the printed accounts of it, and from manuscript letters, appears to have been equal to that of 1727, the pewter in many places being thrown off the shelves, and the tops of chimneys in some places shook down, but the noise, though great, not so surprising as that of the last mentioned. The course of it was west to east."

Note: The account of the later history by Hutchinson contrasts with the eyewitness descriptions provided insofar as it reports chimneys damaged. No eyewitness document reports any damage to dwellings or chimneys.

EARTHQUAKE OF FEBRUARY 5, 1663
(JANUARY 27, 1663, JULIAN CALENDAR)

CA. 17:30 (GMT)

EPICENTRAL INTENSITY: X(MM)

LOCATION: 47.6N, 70.1W

EVALUATION

The above coordinates place the epicenter near La Malbaie, Quebec. They correspond to the March 1, 1925 event. It should be pointed out that such a location has been continuously proposed by E. A. Hodgson (1928), (1950), and Smith (1962). On the other hand, American catalogs show a change of view in this matter. Heck and Eppley (1958) carry the coordinates of Three Rivers, Quebec; Eppley (1965) and later, Coffman and von Hake (1973), probably following Smith, adopted the La Malbaie location. The confusion is understandable in view of importance given to the description of landslides near Three Rivers, dramatically formulated in some of the principal sources, these of Father Lalemant and Mother Marie de l'Incarnation cited by Smith (1962).

The Intensity X(MM), the highest assigned to the La Malbaie event, is again an attempt to reflect the relative seriousness of the shock more than a strict application of the Mercalli scale. E. A. Hodgson (1950) ventured to say that this earthquake *"may have been worse than any of the others, or may be that the accounts were exaggerated..."*.

PERTINENT ACCOUNTS:

Hull, John, Diary Entry, Boston, Massachusetts

"26th of 11th. In the evening, about six o'clock, was an earthquake, that shook much for near one-quarter of an hour;---there was shaking in several parts of the town, and other towns, two or three times the same week; but the former was general."

Mather, Cotton, Written at Boston, Massachusetts

"Earthquakes: six or seven shocks in January '1663'. (Authors Note: of this Increase Mather, in his Illustrious Providences, says: 'In the year 1662, on the 26, 27, and 28 of January, the Earth was shaken at least six times in the space of three dayes. I remember that upon the first approach of the earthquake, the things on the Shelves in the House began to move. Many People ran out of their Houses with fear and amazement; but no House fell, nor was any damage sustained.')"

Sewall, Samuel, Recollection in letter dated November 14, 1727

"I remember the Earthquake of 1662/3 and my being shaken by it, as I sat in my father's house at Newbury in the jâm of the chimny."

EARTHQUAKE OF NOVEMBER 9, 1727
(OCTOBER 29, 1727, JULIAN CALENDAR)

CA: 22:40 (L)

EPICENTRAL INTENSITY: VII(MM)

LOCATION: 42.8N, 70.6W

EVALUATION:

This is the second largest historical event after that of November 18, 1755 that has occurred off the coast of northeastern Massachusetts. Its approximate location is based on felt report distribution (Figure 2.5.2A-1). The epicentral distance to the site is about 14 miles; the event has been considered related to the Cape Ann pluton and the structure of the northeastern Massachusetts Thrust Fault Complex. It was felt widely over an area of 296,000 square kilometers, from the Kennebunk River, Maine to the Delaware River, south of Philadelphia. Maximum damage was observed near the mouth of the Merrimack River (Intensity VI-VII). Cracked chimneys were reported from as far north as Portsmouth, New Hampshire, and as far south as Boston. Historians seem unanimous in that the earthquake was strongest in Newbury, Massachusetts. The complete listing of all reported accounts have been presented in the Boston Edison Company, Pilgrim Unit II Docket No. 50-471, BE-SG 7601. Only the most pertinent accounts are included here.

This shock had a long sequence of aftershocks which historical records have preserved. A discussion of this sequence follows the accounts.

PERTINENT ACCOUNTS:

Allen, J., Boston, Massachusetts (Undated period entry as remark in church record)

"It began as I conceive in the South-East, about half an Hour after Ten in the Lord's Day Evening after the 29th of October, 1727. All of a sudden our Houses shook as if they were falling to pieces, and this was attended with a great Noise, which lasted about one Minute, and then took its course Northward. In a very short time it return's upon us, tho' with far less Strength, and the Shocks were repeated seven Times in my hearing that Night; but there were many more at Salem, Ipswich, etc. Distant Rumbles were heard by us many times until the next Friday-Evening. Since that we don't know that we have heard it; but it has been heard at Newbury every Day since, and for more than three Weeks."

SB-8561 (B)

Blunt, John, New Castle, New Hampshire (Letter dated January 23, 1728)

"...on the night between the 29 & 30 of October about 9 of the clock I retired to bed. (being my usual hour) but being that night otherwise different than commonly I took a book and read of it for about the...of an hour and then composed my bed for sleep but long had I not been asleep before I awoke, Awoke! Did I lay...: I Dreamt, oh Dream! Do I lay, no, no Dream neither, But to then that I lay I believe a mean between both, but never in such a strong...confirmation in all my Life: for as soon as I raised my head from my pillow and my Intellect again began to exert its operative faculty, Perceiving the Bed to Work like a boat & the house trembled as though it would immediately fall to pieces and the Terrible noise which was began compared to the strongest that I remember now...to...Rev. Landon to inqure what the matter was (who himself had just got out of his bed) replied, its a Terrible Earthquake with that I ran & got my clothes, then we ran out at the Door, but by the trembling of the Earth and the Dreadful noise accompanying it seemed as the foundations of the Earth now moved and the Powers of heaven shaken the...land to come from the NW & pass along toward the SE (this from my own observation... (manuscript unclear)*...one of our neighbors they plainly perceived the shaking of the earth about half a minute before they heard the noise...I cannot now give you a particular account to affects it had on the place & people, I cannot give, the chimneys of many houses have broken and the tops broken off to the roof of the houses and som Cellar walls tumbled in. It seems it was a gread Deal more Terrible in the towns on Merrimack, espeically Haverhill, Amesbury, Saybrury and Newbury..."*

Boston Gazette, The, Boston, Massachusetts (Period newspaper account dated November 6, 1727)

"Boston, Nov. 6.

"On the 29th past about 30 Minutes past 10 at Night, which was very Calm & Serene, and the Sky full of Stars, the Town was of a sudden exceedingly surprised with the most violent shock of an Earthquake that ever was known. It began with a loud Noise like Thunder, the very Earth reel'd and trembled to such a prodigious degree, that the Houses rock'd and shook insomuch, that every Body expected they should be Buried in the Ruins. Abundance of the Inhabitants were wakened out of their Sleep with the utmost Astonishment, and others so sensibly affrighted, that they run into the Streets thinking themselves were safe there; but thro' the Infinite Goodness and Mercy of GOD, the Shock continued but about ten Minutes, and tho' some small damage was done in a few Houses, yet by God's great Blessing, we dont hear that any Body received any hurt thereby. There were several times till the next Morning heard some (manuscript unclear)*. Rumblings of it, but since then, the Earth has been quiet, tho' the Minds of the People have still a great and just Terror and Dread upon them.'"*

Clark, Peter, Salem Village, Massachusetts (Period diary entry)

"Being Lord's day, at night, between 10 & 11 o'clock there happened a very great earthquake, accompanied with a terribel noise and shaking, which was greatly suprising to ye whole land, ye rumbling in ye bowels of the earth, with some lesser trepidation of the earth, has been repeated at certain times, for divers weeks after."

Jaques, Stephen, Newbury, Massachusetts (Probable period account, date unknown)

"On the twenty-ninth day of October, between ten and eleven, it being sabath day night, there was a terabel earthquake. The like was never known in this land. It came with a dreadful roreing as if it was thunder, and then a pounce like grate guns two or three times close one after another. It shook down bricks from ye tops of abundance of chimnies, some almost all the heads...All that was about ye houses trembled, beds shook, some cellar walls fell partly down. Benjamins Plumer's stone without his dore fell into his cellar. Stone walls fell in a hundred plasis. Most peopel gat up in a moment. It came very often all ye night after, and it was heard two or three times some days and nights, and on the sabath day night on ye twenty-fourth of December following, between ten and eleven, it was very loud, as any time except ye first, and twice that night after but not so loud. The first night it broke out in more than ten places in ye town in ye clay low land, blowing up ye sand, sum more, sum less. In one place near Spring Island it blew out, as was judged twenty loads, and when it was cast on coals in ye night, it burnt like brimstone."

Jeffrey, James, Salem, Massachusetts (Period "diary" entry in almanac)

"...about half an hour after ten oclock there was the most terrible Earthquake every known in New England -Continued about two minutes of first shock & had several small ones afterwards, & some night ye continued at times all ye weeks afterwards all ye People in Town sat up most part of ye night."

Kelley, Richard, Amesbury, Massachusetts (Period diary entry)

"In ye yeare 1727, October 29, about ten of ye clock, it being Sabath day night, was a Grate earthquake which was extrodenery loud and hard as awaked many out of sleep, the housen did shake & windows ratel and puter and dishes clater on ye shelves & ye tops of many chimneys fell of & maney ware so shatered as that people ware fain to take them down and new build them again."

Plant, Rev. Matthias, Newbury, Massachusetts (Period account, primary source is original Minister's Record Book; later variants noted in references)

"Oct. 29. 1727. being the Lord's-Day, about 40 Minutes past Ten the same Evening, there came a great rumbling Noise; but before the Noise was heard, or Shock perceived, our Bricks upon the Hearth rose up about three quarters of a Foot, and seem'd to fall down and loll the other way, which was in half a Minute attended with the Noise or Burst. The Tops of our Chimneys, Stone-fences, were thrown down; and in some Places (in the lower Grounds, about three Miles from my House; where I dwell) the Earth opened, and threw out some Hundred loads of Earth, of a different Colour from that near the Surface, something darker than your white Marl in England; and in many Places, opened dry Land into good Springs, which remain to this Day; and dried up Springs, which never came again. It continued roaring, bursting, and shocking our Houses all that Night. Though the first was much the loudest and most terrible, yet eight more, that came that Night, were loud, and roared like a Cannon at a Distance...

"Postscript.

"I forgot to tell you, Sir, that (except the first Shock) these frequent Repetitions of the Roaring and Shocks of the Earthquake were upon Merrimack River, and seldom extended above seven or eight Miles Distance from, or 20 or 30 up the said River; those Instances only excepted, which I have mention'd in the Relation; and the first Shock of it was greater with us than anywhere else in New-England; and the Tops of Chimneys, and Stone-fences, were thrown down only in these Parts."

Prince, Thomas, Boston, Massachusetts (Notes appended to a sermon in 1727)

"The Preface.

"Giving a Summary Account of the OCCASION of the following Sermons.

"On the Night after the Lord's Day Octob. 29. about 40 Minutes past X, in a calm & serene Hour, the Town of Boston was on a sudden extreamly surpriz'd with the most violent Shock of an Earthquake that has been known among us. It came on with a loud hollow Noise like the Roaring of a Great fired Chimney, but incomparably more fierce & terrible. In about half a Minute the Earth began to heave and tremble: The Shock increasing, rose to the Hight in about a Minute more, when the Moveables, Doors, Windows, Walls, especially in the upper Chambers, made a very fearful Clattering, and the Houses rock'd & crackl'd, as if they were all dissolving and falling to pieces. The People asleep were awakened with the greatest astonishment: many others affrighted run into the Streets for Safety. But the Shaking quickly abated, and in another half Minute intirely ceased.

"The Noise & Shakes seem'd to come from the Northwestward, and to go off Southeasterly; and so the Houses seemed to reel. Some Damage was done to the more brittle sort of Moveables, and some Bricks on the Tops of some Chimneys fell; but not an House was broken, nor a Creature hurt. At several times till Day-light, were heard some distant Rumblings, and some fainter Shocks were felt: But since, the Earth has been quiet in Town, tho' the minds of many continue very greatly & justly affected."

Sargeant, (Rev.) Christopher, Methuen, Massachusetts (Period entry in notebook)

"Observations on the Year 1727.

"This year October the 29th we had the most terrible Earthquake. It began on Sabbath Day Night between ten & eleven of the clock wh puts people into the utmost consternation & fright many possessed with fear y^{t} It was the Great Day of the Son of man appearing...It began like a most violent clap of thunder. Some say preceeded by a trembling of the Earth. But it was accompanied with most dreadful Shock of the Earth. It Continued a Minute & half at least falling & then returning with violence three times in the s^{d} Term..."

Sewall, Henry, Newbury, Massachusetts (Letter dated November 21, 1727)

"Honored sir:

"Thro' God's goodness to us we are all well, and have been preserved at the time of the late great and terrible earthquake. We were sitting by the fire and about half after ten at night our house shook and trembled as if it would have fallen to pieces. Being affrighted we ran out of doors, when we found the ground did tremble, and we were in great fear of being swallowed up alive; but God preserved us, and did not suffer it to break out, till it got forty or fifty rods from the house, where it brake the ground in the common near a place called Spring island, and there is from sixteen to twenty loads of fine sand throwm out where the ground broke, and several days after the water boiled out like a spring, but is now dry, and the ground closed up again. I have sent some of the sand that you may see it. Our house kept shaking about three minutes."

Waldeigh, George, Dover, New Hampshire

"An earthquake occurred of which it is recorded that - the shock was very loud, and was attended with a terrible noise, something like thunder. The houses trembled as if they were following: divers chimney were cracked and some had their tops broken off."

Note: It is uncertain whether this is a generic description, or whether it described the actual effects at Dover. (Later history published 1913)

Waldron, Richard, Portsmouth, New Hampshire (Letter dated January 12, 1728)

"...the Earthquake still continues in these parts; but it is most frequent and loud near the Merrimack River. On Saturday night last it was heard several times in our neighborhood. And a Man who lives about a mile distant from us, in the skirts of a wood, immediately after the first Rumbling and little Shock, heard a fine musical sound, like the sound of a Trumpet at a distance...the Musick continued till after the Second Rumbling, which succeeded the former in about ten minutes. The man's wife heard what he did..."

Weekly News-Letter, The, Boston, Massachusetts (Period newspaper, November 16, 1727)

"Hampton in New-Hampshire, Novemb. 13th. 1727.

"'The first shock of the Earthquake on the 29th past was here much as it was in Boston, or perhaps a little stronger. Divers People in this & some Neighbouring Parishes observed just as the Earthquake began, A flash of Light at the Windows: A Young Man of this Town being then standing abroad near his Fathers House, at first heard a small Rumbling Noise; immediately upon which he sew a Flash of Light run along ypon the Ground 'till it came to the House, and then began the Shake. It appears that what he said of the flash of Light was not a meer Fancy, by this, That a Dog which was then lying on its Course as the Light came to him gave a sudden yelp and leap, and thereby slow'd that he perceiv'd it.

"'Another thing among us which seems worth or Notice is, A Spring of Water which (as the Owner says) has run freely there Fourscore Years is now, upon the Earthquake very considerably Sunk, so that they were oblig'd to dig it out, and tho' the digging has rais'd the Water something, yet not to its former height. But what is, it may be, yet more remarkable is, That this Spring which was never known to Freeze before, now Freezes like any standing Water.

"'It seems nothing has been perceiv'd at Boston since the first Night, but it has been otherwise here; not a Day since but that the sound has been heard, and oftentimes it has been so as to give some Jarr to our Houses.

"'in the time of the first shock the Brute Creatures (as was observ'd by some who were then abroad) Ran Roaring about the fields in the greatest distress: and the Reasonable Inhabitants of the Earth were no less frighted. So was Isreal when GOD came down upon Sinai, and the whole Mount quaked greatly: Then they spoke well, and made promises of Obedience: And GOD says upon it, Deut. 5:29 Oh that there were such an HEART in them, that they would Fear Me, and keep my Commands always, that it might be well with them, and with their Children for ever.

AFTERSHOCK SEQUENCE OF THE NOVEMBER 9, 1727 EVENT

DISCUSSION:

The earthquake of November 9, 1727, is characterized by a very long sequence of aftershocks, particularly dense during the following three months. None of the aftershocks exceeded Intensity V(MM); most were only locally felt in the Cape Ann, Massachusetts region. Several second order aftershocks followed by swarm-type activity are noted. These are the earthquakes of November 14, 1727, Intensity IV-V(MM) and a series of small shocks during the period November 19 through 22 and January 4, 1728, Intensity IV-V(MM) followed by a series of small shocks on January 18 and 19. A late large aftershock occurred on February 10, 1728, Intensity V(MM).

Numerous aftershocks were noted by Rev. Matthias Plant at Newbury, Massachusetts who maintained a record of earthquakes felt from 1727 through 1748 in his Minister's Record. A detailed aftershock record also exists at Marblehead, Massachusetts. Rev. Ebeneezer Parkman of Westboro, Massachusetts has included in his diary references to some of the aftershocks.

Through research into historical documents, especially diaries and journals, it is possible to reconstruct a very detailed list of the aftershocks. Table 1 gives the date, local time, and estimated intensity of each aftershock; in general, the Plant's chronology has been accepted as the preferable one.

In Table 2, a comparative listing of the Newbury and Marblehead accounts is presented for the first week after the main shock.

Three aftershocks with an intensity greater than IV(MM) are presented below:

EARTHQUAKE OF NOVEMBER 14, 1727
CA. 17:00 (L)
Epicentral Intensity: IV-V(MM)
Location: 42.8N, 70.6W

The epicentral location is assumed similar to that of the main shock, approximately 14 miles east-southeast of the Seabrook site. No damage is reported from any locality, including Newbury where Rev. Matthias recorded "...very loud claps." It was felt in Essex and Middlesex counties in Massachusetts, as well as Boston and Westborough to the west-southwest.

PERTINENT ACCOUNTS:

Note: Dated accounts are the Julian Calendar, an addition of 11 days is required for conversion to the Gregorian Calendar.

Dexter, (Rev.) Samuel, Dedham, Massachusetts (Period diary entry)

"very sensible...as I sat in my study, to y^{t} Degree y^{t} it jarr'd the windows. People were put in a very great surprise by it, both in Boston & in ye Country."

Douglass, William (letter dated November 20, 1727)

"Essex and Middlesex counties:

"(at 4^{h} p.m.) 'a small shock was felt all over the countys of Essex and Middlesex.'"

New England Weekly Journal, Boston, Massachusetts, November 13, 1727 (letter dated November 8, 1727 written from Marblehead with dated entries)

"Marblehead, Mass.:...and a very considerable one that made our windows jar at 4^{h}."

Parkman, Ebeneezer (Rev.), Westborough, Massachusetts (Period diary entry)

"My wife and the young People of the house asserted that between 4 and 5 p.m. they heard the Like again...And this was confirmed by many other persons."

Plant, (Rev.) Matthias, Newbury, Massachusetts (Period entry, published in 1742-1743)

"Evening; very loud claps"

Sargeant, (Rev.) Christopher, Methuen, Massachusetts (Period diary entry)

"a very considerable return of it."

EARTHQUAKE OF JANUARY 4, 1728
CA. 23:00 (L)
Epicentral Intensity: IV-V(MM)
Location: 42.8N, 70.6W

No damage was reported from any locality. It was felt from Casco Bay, Maine, south to the Charles River region in Massachusetts. It was not reported as felt in Boston, Massachusetts.

PERTINENT ACCOUNTS:

Note: Dated accounts are in the Julian Calendar, an addition of 11 days is required for conversion to the Gregorian Calendar.

Gookin, (Rev.) Nathaniel, Hampton, New Hampshire (Appendix to sermon published 1727)

"there were two Shocks; the first of which was very loud, and jarred the Houses. This Shock, I am informed, extended from Charles River to Casco-Bay."

Plant, (Rev.) Matthias, Newbury, Massachusetts (Period account in minister's record)

"it was very Loud, as any time except ye first, and twice that night after but not so loud."

Note: Casco-Bay is the old name of the settlement corresponding to Falmouth, Maine.

EARTHQUAKE OF FEBRUARY 10, 1728
CA. 15:30 (L)
Epicentral Intensity: V(MM)
Location: 42.8N, 70.6W

The earthquake of February 10, 1728 is considered to be an aftershock of the earthquake of November 9, 1727. The epicentral intensity, based on reports from Newbury and Ipswich, Massachusetts, is V(MM). The felt area is estimated at 8,500 square kilometers. No damage is reported for this event.

PERTINENT ACCOUNTS:

Note: Dated accounts are in the Julian Calendar, an addition of 11 days is required for conversion to the Gregorian Calendar.

Boston Gazette, Boston, Massachusetts, February 12, 1728
(Letter from Marblehead dated January 31, 1728)

"Marblehead, Massachusetts: 'a terrible shock of an Earthquake, which began with a rumbling noise like the rolling of a log over an hollow floor & increased until it seemed like the discharging of several cannon at a distance; at which time the earth trembled so as to jar the pewter on the shelves in many houses; the whole shock lasted about 50 seconds. It's thought that had this Shock been in the Night in still weather it would have appeared the greatest since the Great Shock on the 29th of October. This is the 3d shock we have had within these Six Day last past; and about the 30th since the 30th of October last.'"

Boston Gazette, Boston, Massachusetts, February 5, 1728
(Period newspaper account)

"we had here the severest Shock that has ever been heard since this 30 of Oct. last. It making the very houses shake and the people to run out into the Streets in the utmost consternation.

"And the same was felt about the same time in divers other Places. And more particularly at Ipswich, where it had done considerable damage in some houses."

Boston Weekly News Letter, Boston, Massachusetts, February 1, 1728
(Period newspaper account)

"we had here in Boston the greatest Shock that has been observ'd since the Night after Octob. 29. It made the Houses Shake and the Moveable jarred. It was perceived mostly by those indoors; and many ran out into the streets in great Consternation. The same was felt in the same manner in diverse other Places."

Bucknam, Nathan, Medway, Massachusetts (Period diary entry)

"there was an Earthquake y 2 of y Clock y^{t} jarred y house"

New England Weekly Journal, Boston, Massachusetts, February 5, 1728
(Period newspaper account)

"there was felt in this Town a considerable Shock of an Earthquake, and we learn that the same was heard and felt about the same time in divers other Towns even as far as Piscataqua."

New England Weekly Journal, Boston, Massachusetts, February 12, 1728
(Period newspaper account)

"about a quarter before 2 of the Clock p.m. one of the most observable since the first Earthquake, but not equal to that, the roaring or rumbling heard very generally in the Towns round about, and in many places a Shaking or Trembling of the Earth and Houses, the Glass ratling, and the Pewter on some Shelves, ceasing in about a Minute."

Parkman, Ebenezer, Westborough, Massachusetts (Period diary entry)

"It was heard and felt by most persons. The Sound was great, and, with many a shake was distinctly perceiv'd...almost all people heard it and many felt it shake the houses."

Plant, (Rev.) Matthias, Newbury, Massachusetts (Period acount in minister's record)

"there was a very loud clap equall to any but ye first for Terror, shaking ye houses so as that many people were afraid of their falling down Pewter: was shaked of dressers considerable distance."

Plant, (Rev.) Matthias, (Philosophical Transactions published 1742-43)

"there was a very great Roaring, equal to any but the first, for Terror: It shook our Houses so, that many People were afraid of their falling down; Pewter etc. was shook off our Dressers; the People that were in the Church for Evening Service, ran out; the lead Windows rattled to such a Degree, as that I thought they would all be broke."

Sargeant, (Rev.), Christopher, Methuen, Massachusetts (Period diary entry)

"returned w considerable force"

EARTHQUAKE OF SEPTEMBER 16, 1732
(SEPTEMBER 5, 1732, JULIAN CALENDAR)

CA. 16:00 (GMT)

EPICENTRAL INTENSITY: VIII(MM)(R)

LOCATION: 45.5N, 73.6W

EVALUATION:

Because this earthquake is one of the largest in the Western Quebec Seismic Zone and its location and epicentral intensity have often been questioned in recent years, both in Canada and United States, it was the object of an intensive study during the preparation of New York State Electric & Gas Corporation's (NYSE&G) I and II, PSAR (1978). The main reason for these uncertainties lies in the sparsity of the basic documentation available to the earlier catalog authors; in addition, some of the original information remains confusing because the contemporaneous style is often metaphoric.

A brief review of the historical cataloging of this event is necessary to understand the justification of the revised intensity. Mather and Godfrey (1927) were the first to estimate the intensity of the event. They associated an Intensity IX (Rossi-Forel) with an epicenter somewhere *"in Quebec"*; they also estimated an Intensity III(RF) for the Boston area. They gave only two references: Brigham (1871) and Lewis and Newhall (1865). The second catalog to appear was that of Heck and Eppley (1958), which placed the epicenter northwest of Montreal (46N, 74W), with an Intensity VIII(MM). Brigham was the only reference given. Brigham had leaned heavily on Rev. Matthias Plant's diary for his summary (See below). Brooks (1959), in his catalog, retained the same parameters as Heck and Eppley. Smith (1962) moved the epicenter to Montreal (45.5N, 73.6W), and raised the intensity to IX(MM), with no further explanation than *"chimneys fell and walls were cracked. Three hundred houses were damaged. One girl was killed."* In support, he quoted from a letter by Mother Duplessis, religious superior of the hospital in Quebec to a female friend in France. He also gave a dozen references which will be discussed below. Eppley (1965) and Coffman and von Hake (1973) repeated the new location and intensity, and simply gave Brigham and Smith as their only references.

Smith's choice needs to be critically evaluated, in view of the fact that limited evidence is presented in support of the upgraded intensity that makes this event the largest one within the Western Quebec Seismic Zone. Besides referring to all antecedent catalogs, Smith listed several other sources, but these sources referred to the 1732 earthquake only in a superficial way, except for two of them, Laflamme and E. Hodgson, which quoted part of the same letter of Mother Duplessis. It becomes apparent after reading the references used by the various catalog authors,

that they had no first-hand reports from Montreal itself, and that the letter from Mother Duplessis, written in Quebec, was the key description of the main earthquake, its effects and aftershocks.

From 1976 to 1978, investigations were carried out by Weston Geophysical, both in Montreal, Quebec, and at the Canadian Archives in Ottawa, to uncover additional information which could directly or indirectly help in ascertaining both the epicentral location and intensity of the event. Also included was a search for felt reports at more remote locations.

The major findings consist of a brief history of the religious community which was in charge of the Hotel-Dieu Hospital in Montreal, written in Montreal, by Sister Cuillerier, for the years 1725-1747, and of some correspondence related to compensatory funds for the repairs of local damages. It is considered that from their nature, i.e., historical notes and business letters, these primary sources are more objective and direct than second-hand reports, even if the contemporaneous style remains ornate at times.

The earthquake description found in Cuillerier's pages leaves no doubt that the main shock was severe, and that a long sequence of aftershocks occurred. Chimney damage was considerable; walls were cracked; wells were disturbed; fear made people run outside; and the frequent aftershocks compelled some to stay out. Damage to the hospital walls were relatively bad, but this structural damage is explicitly attributed to two previous fires that had weakened the masonry. In a letter of Mr. Chaussegros de Lery to the Marine Council, it is stated that the damage to the stone walls around the city was minor: *"few stones were displaced"*; similarly for the damage to parapets. It is also explicit, from Sister Cuillerier's and Mother Duplessis' texts, that fear was kindled by the clergy, as if the earthquake occurrences were related to some divine punishment for sinful activity. There is no doubt that the style of both writers is colored by this view; thus, many of the metaphors used should not be accepted literally.

One important point to be made is that all felt reports and damages observed in Montreal can be objectively included in an Intensity VIII(MM). The poor quality of masonry, the construction practices in the early 1700's, and the soil conditions of Lower Montreal (glacial deposits resulting from the Champlain submergence, Clark, 1972) constitute many factors that can explain the extensive chimney damages, without requiring a large magnitude event.

It should be noted that such an Intensity VIII(MM) appears to accommodate conservatively all other felt reports obtained at remote locations, in particular, those in New England and at Quebec City. In Figure 2.5.2A-2, isoseismals calculated with the intensity-distance relationship of Gupta and Nuttli (1976) have been superimposed on the felt report map.

From other studies where more abundant data points exist, such relationship has been observed to be conservative. Intensities reported in eastern Massachusetts, New Hampshire and Connecticut are in good agreement with the predicted values. Similarly, the single report from Quebec City, by the Intendant, Mr. Hocquart, that the earthquake *"amounted to not much"*, constitutes at the most an Intensity IV, and possibly III-IV; this level is quite acceptable with respect to the predicted V level, but would be anomalously low in comparison with a predicted VI-VII level that would result for Quebec if an Intensity IX is postulated for Montreal. Other reports in Philadelphia, New Castle, Annapolis, are in good agreement with the predicted isoseismals associated with an Intensity VIII(MM) for I_o. The fact that more distant localities, such as Louisburg, N.S. and Southern James Bay did not report any tremor, also suggests that I_o=VIII(MM) is a more likely characterization of the event.

In view of the fact that reports on earthquake effects in Montreal and felt reports from other distant locations support an epicentral intensity VIII(MM), it is concluded that the Intensity IX(MM) proposed by Smith (1962) should be revised. An Intensity VIII(MM) appears to be a more objective characterization.

Concerning the location of the epicenter, it is proposed that the Smith's coordinates be retained as the most probable, and given an uncertainty of 30 miles. The main reason for this position is the fact that the distribution of settlements near Montreal, particularly along the St. Lawrence, was such that an epicenter substantially outside Montreal would have been recognized as such. A 1739 census, as given by Sulte (1882), certainly indicates a good coverage around Montreal, with the exception of the northwest. Yet, the hypothesis of an epicenter in this direction, e.g. near Mont-Tremblant, is rejected, as it would imply a larger epicentral intensity in order to explain a site intensity VIII in Montreal, but would become irreconcilable with the Quebec and James Bay observations. The continuous spread of settlements from Montreal to Quebec illustrated by Sulte militates against E. Hodgson's *"suggested possibility that the event could have been further down the river"*.

It is thus concluded that the 1732 event should be considered as having occurred most probably in Montreal, with an epicentral intensity VIII(MM). It is further suggested that a magnitude $m_{bLg}=6.0\pm\frac{1}{4}$ would be a better characterization of the event, taking into account the entire set of felt reports and the possibility of local amplification at the Montreal site.

PERTINENT ACCOUNTS:

American Weekly Mercury, The, Philadelphia, Pennsylvania, September 7 to September 14, 1732

"New-Castle, Sept. 6. Yesterday about Noon we had a pretty Considerable shock of an Earthquake in and about this Town, most people in Town being sensibly affected with it, and several that were employed in making and stacking of Hay in our Meadows were greatly surprised. It lasted about a Minute, and everybody that felt it found at the same time a disorder in their Stomach, Head and Sight."

Extrait des ANNALES DE L'HOTEL-DIEU DE SAINT-JOSEPH DE MONTREAL, "Fin des Annales de Soeur Morin, Relation de Soeur Cuillerier: 1725-1747," Archives des Religieuses Hospitalières de Saint-Joseph, 251, Avenue des Pins ouest, Montréal.

"Nous avons entré dans nos dortoirs en 1728 et 29 une party de la dote de Ma soeur Gassien a étée consomée à cet ouvrage 1730 se sont passée tranquillement et sans auquun évenement particulier Mais en trinte-deux nous avons eue une picotte sy universelle qu'il a passée dans nos salles plus de 500 Malades qui nous ont donné une fatigue incroyable. Cette picotte fut précédée d'un tremblement de terre si terible que l'on doute qu'il y en eu de plus violent dans les endroits même qui ont ettée renversé et qui ont abimée. Ce fut le 16 septembre à onzes heur trois card que la première secousse se fit entandre et santir elle abaty dabor 567 cheminée fandy presque tous les Mures des Maisons la nôtre fut très en daumagée aussi bien que nos métérie des quelles tous les puis furent comblée de ce premier mouvement qui dura bien un car d'heure sans sarétez Nous courument toutes dans le jardin pour naitre pas ecrasez sous notre bâtiment étant plus en danger de tomber qu'un autre nos murailles ayant souffert deux incendy rien de plus terrible Mes chères soeurs que de voir les cloché et les Maisons fléchire come des rausau et branler ausy fort que sy ils avoit étez de Carte après cette première secousse il en vint plus de 50 dans vint-catre heures Ce qui obligea tout le monde de Couchez dans les campagne et dans les jardins dans la crainte dêtre abimée par quel quune Mais les prieres publique fléchirent la miséricorde du seigneur qui cest contanté de tenir tout son peuple en alarmes pendans plus de neuf mois les brouissement sestant toujours fait entandre pandans ce longes-pace de temps les dames firent voeux de laisser les panier et les vanité Mais il y en eu quelqunue qui suivan le légerreté naturelle aux sexe nentandans plus que de petits tremblement se crurent en suretéz et reprirent leurs adjustment dieu sanvangea et en fit entandre un semblable au prémier. la nuit du 25 doctobre au 26 ce qui fit redoubler les voeux et les priere."

Anonymous, manuscript in possession of Bibliothèque de Montréal, Montreal, Canada.

"Tremblement de terre.

"1732. Secousses: Montreal 300 maisons endommagées, une fille tuée, plusieurs personnes blessées,...on couche dans les jardins."

Letter of M. Hocquart, Intendant, to the Governor-General, including the Letter from Sister Levasseur to the Secretary of State, Correspondance Générale in possession of the Public Archives of Canada, Ottawa, Canada.

"Mrs de Beauharnois

Monseigneur

"...avec les autres demandes les religieuses hospitalieres de Montreal nous ont adressé un placet que nous avons l'honneur de vous envoyer, par lequel elles vous supplient Monseigneur, d'avoir égard à la situations où elles se trouvent et au dommage que le tremblement de terre leur a causé nous ne scavons pas précisément en quoy ce dommage consiste: mais nous sommes informés que leur maison en vue de celles qui ont le plus souffert de cet accident, les soins et les attentions que ces religieuses ont pour les malades, méritent que vous ayés des bontés pour elles.

"Nous sommes avec un très profond respect
Monseigneur
Vos très humbles et très obéissants serviteurs.
Hocquart
A Quebec le 27 octobre 1732."

"A Monseigneur de Maurepas ministre et secretaire d'Etat.

Monseigneur

"La bonté avec la quelle Votre Grandeur toujours attentive aux besoins de cette colonie y donne sans cesse des marques de l'honneur de sa protection me faite esperer que mes tres humbles representations pourront interesser cette bonté secourable en faveur d'une communauté nécessiteuse sur laquelle Votre Grandeur a déjà plusieurs fois repandue ses bienfaits, c'est dans cette confiance Monseigneur qu'après avoir adressé mes voeux au ciel pour la conservation de Votre Grandeur je prends la liberté de lui remonter avec un profond respect que le rétablissement de notre monastère nous ayant endetté de plus de vingt mil livres malgré les graces que nous avons receus da Sa Majesté, nous sommes encore aujourd'huy par notre situation l'objet auquel elles peuvent être plus justement appliqués puisque le Seigneur vient de nous donner un nouvel accident en ruinant presque entièrement notre monastère par un tremblement de terre effreyant qui a fait d'autant plus d'impression à nos murailles quelles ont déjà soufferts deux incendies, nous avons meme tout lieu d'apprehender Monseigneur que les grandes gelées de l'hiver ne le fassent tomber absolument, etant toutes fondues a jour la charpente sortie d'un demi-pied, toutes nos cheminées renversées, ce qui nous fait craindre d'etre ecrasez sous notre bâtiment, qu'il plaise à Votre Grandeur Monseigneur d'avoir pitié de cette communauté desolée, et d'écouter la très humble prière que je prends la liberté d'adresser à Votre Grandeur au nom des religieuses hospitalières de Montreal de ville Marie de leur accorder une gratification suffisante pour mettre leur monastere en surêté, et aider à payer leur deptes afin qu'elles continuent leurs soins aux soldats, sauvages et habitans malades. J'ay l'honneur d'être avec un profond respect

Monseigneur
De Votre Grandeur la très humble et très obéissante servante.
Soeur le Vasseur supérieure des religieuses hospitalières de St. Joseph."

Boston Gazette, The, Boston, Massachusetts, September 4, 1732

"On Tuesday last about Noon we were very much surprised here by the Shock of an Earthquake, it was attended with hardly any Noise, the Shake continued near half a Minute, and some Houses were perceived to tremble very much, so that several things were shaken down from their Places."

Boston Weekly News-Letter, The, Boston, Massachusetts, September 14, 1732

"By a letter from Marthas Vineyard, dated the 11th Instant, we have Advice, that they had the Shock of an Earthquake in that Place the Tuesday before, a little after Noon, as was evident to many on the Island, which was near the Time when it was perceiv'd here. They could not learn that the Shake was attended with any Rumbling as is usual. So that hereby we are assured the said Shake was very extensive."

Boston Weekly News-Letter, The, Boston, Massachusetts, November 30, 1732

"On Saturday last Mr. Lydius came hither by land from Albany, and informs us, that before he left that place, he received a Letter from a Relation of his at Montreal in Canada, who gave him an account that on the 5th of September last about noon an amazing Shock of an Earthquake was felt there, (the same day and hour it was last perceived here) which was so violent that about 165 Houses suffer'd more or less damage thereby, and the Walls fortifying the Place in part thrown down. Three Persons were killed, and Six wounded; that the Shake was repeated nine or ten Nights following (and only in the Nights) in all which time the People were afraid to lodge in their Houses. Mr. Lydius had the above Account confirm'd to him by an English Gentleman arrived at Albany from Montreal."

Brigham, William T., Memoirs of the Boston Society of Natural History (1871); I. Volcanic Manifestations in New England Being an enumeration of the principal earthquakes from 1638 to 1869

"September 15, 1732. A violent earthquake was felt in Canada, which did considerable damage at Montreal, as stated in the preceding list. It came at eleven o'clock A.M., and was attended with a rumbling noise. A clock was stopped at Annapolis, Maryland, although the shock was slightly felt at Boston. In June, of the next year, on the fourteenth, according to some authorities, it is said a shock was felt at Annapolis, but there is no certainty that it took place."

Buckman, Nathan, "Diaries: 1722-1767"; written at Medway, Massachusetts, in possession of the American Antiquarian Society, Worcester, Massachusetts

"An Earthquake perceived by some."

Couanier de Launay, M.E.-L., Histoire des Religieuses Hospitalières De Saint-Joseph (France Et Canada), Paris, 1887, p. 119.

"Trois ans après (1732), un affreux tremblement de terre qui se fit sentir surtout à Montréal, endommagea gravement les bâtiments. Les réparations ne purent être terminées que l'année d'après, au moyen de la dot d'une des soeurs."

Faillon, Etienne M., Vie de Mlle Mance Et Histoire De l'Hotel-Dieu de Villemarie, Dans l'Île de Montreal, en Canada, Tome II, 1854.

"Au milieu des embarras qu'elles éprouvaient dans l'état de dénûment où elles se voyaient réduites, elles eurent encore à essuyer, l'année 1732, les effets d'un violent tremblement de terre, qui mit leur vie en péril et endommagea leur nouveau bâtiment. La première secousse, qui eut lieu le 16 du mois de septembre, à onze heures trois quarts, se fit sentir plus ou moins dans toute la colonie, mais nulle part elle ne fut si violente que dans l'ile de Montréal. Cette secousse abattit tout d'abord plus de trois cents cheminées, écrivaient les hospitalières de Villemarie à leurs soeurs de France, et fendit presque tous les murs des maisons; la nôtre fut très-endommagée, aussi bien que nos métairies, dont tous les puits furent comblés par ce premier tremblement, qui dura bien un quart d'heure sans s'arrêter. Nous courûmes toutes dans le jardin pour n'être pas écrasées sous notre bâtiment, qui était plus en danger de tomber qu'aucun autre, nos murailles ayant souffert deux incendies. Rien de plus terrible, mes chères soeurs, que de voir les clochers et les maisons fléchir comme des roseaux, et branler aussi fort que s'ils eussent été de cartes. Après cette première secousse, il en vint plus de trente en vingtquatre heures, ce qui obligea tout le monde de coucher dans la campagne et dans les jardins, crainte d'être écrasé par les maisons. Les dames firent alors voeu de renoncer à l'usage de porter des paniers sous leurs robes et à d'autres semblables vanités; mais il y en eut quelques-unes qui, n'entendant plus que de petits tremblements, se crurent en sûreté, et, suivant leur légèreté naturelle, reprirent leurs adjustements. DIEU, pour les rappeler à leur devoir, fit entendre un nouveau tremblement semblable au premier, la nuit du 25 au 26; ce qui fit redoubler les voeux et les dévotions. Enfin, les prières publiques ont touché la miséricorde du SEIGNEUR, qui s'est contenté de tenir tout son peuple en alarmes pendant plus de neuf mois, les bruissements s'étant toujours fait entendre pendant ce long espace de temps. M. Chaussegros de Léry, ingénieur, écrivait que si la première secousse eût duré quelques minutes de plus, une grande partie des maisons de Villemarie auraient été renversées. Il ajoutait qu'elle s'était fait sentir à Québec, mais très-légèrement.

"Après ce désastre, la mère Levasseur, supérieure des filles de Saint-Joseph, s'empressa d'écrire de nouveau à M. de Maurepas, afin d'obtenir de lui quelques secours, tant pour payer leurs dettes, qui s'élevaient alors à 20,000 livres, que pour réparer les dégâts faits à leur bâtiment."

Note: Inserted here is a quotation of Sister Levasseur's letter. See Letter of M. Hocquart in this appendix.

"M. de Beauharnois et M. Hocquart accompagnèrent la supplique des religieuses au ministre d'une lettre de recommandation, en date du 27 octobre 1732. Ils faisaient remarquer qu'ils ne savaient pas en quoi consistant le dommage que le tremblement de terre leur avait causé, mais que leur maison était une de celles qui avaient le plus souffert de cet accident. Enfin, ils terminaient en assurant le ministre que les soins et les attentions de ces religieuses pour les malades méritaient qu'il vint à leur aide dans cette occasion. Le 6 mai 1733, le ministre invita le gouverneur et l'intendant à faire l'estimation de ce dommage, que M. de Léry porta à la somme de 640 livres. Nous vous supplions, Monseigneur, écrivaient au ministre le gouverneur et l'intendant, de vouloir bien accorder cette somme à cette communauté; elle mérite vos bontés pour les soins assidus que les religieuses apportent au soulagement des pauvres malades, et qu'elles ont redoublés à l'occasion de la petite vérole, ayant continuellement eu, pendant quatre mois, près de cent soldats à soigner. Cette maladie épidémique fut si ufut si universelle à Montréal, que les hospitalières recurent dans leurs salles plus de cinq cents malades; ce qui leur occasionna beaucoup de dépenses et un surcroit de fatigues excessives. Ce fut l'année même où arriva cette contagion, en 1733, qu'elles parvinrent enfin à achever leur bâtiment, en employant pour cet usage la dot d'une de leurs soeurs. Mais comme la croix devait être le plus ferme appui de cette maison, à peine les bâtiments étaient achevés, et avant même qu'on eût recu la somme de 640 livres accordée pour réparer les dégâts faits par le tremblement de terre, tous ces bâtiments furent de nouveau réduits en cendres, comme nous le raconterons au chapitre suivant."

Hobart, Nehemiah, "Journal of Nehemiah Hobart, written at Hingham, Massachusetts: 1721-1746", in possession of the Massachusetts Historical Society, Boston, Massachusetts

"A shock of an earthquake att (sic) Boston, Ma: Vinyard about noon, yet no rumbling heard."

Hocquart, M., "Lettre d'Hocquart au Ministère," Manuscript in possession of the Public Archives, Ottawa, Canada.

"M. Hocquart 30 Octobre 1732

"Monseigneur

"...J'ay recu aujourdhuy une lettre de Montréal par laquelle on me marque que la nuit du 24 au 25, il s'est fait sentir un tremblement de terre à peu près semblable à celuy du 16 7bre moins violent, mais plus long accompagné d'un bruissement dans la montagne qui a duré longtemps.

L'on ne m'écrit pas d'autres circonstances, ni que ce tremblement ayt causé de nouveaux dommages.

"Je suis avec un très profond respect
"Monseigneur
"Votre très humble et très obéissant serviteur.
"Hocquart
"à Québec le 30 octobre 1732."

Hodgson, E. A., 1950. The Saint Lawrence earthquake, March 1, 1925: Dom. Obs. Pub., Ottawa, v. 7, No. 10, Appendix B, p. 430, "Earthquake September 5, 1732."

"In the second of the four lists published by Sir. Wm. Dawson, he states: "1732, September 5, Canada, New England, and as far as Maryland, buildings injured..."

Note: After referring to abstracts of Mgr. Laflamme, Sister Duplessis, and other correspondence, Hodgson concludes:

"It is desirable that further references to this earthquake be sought, in order that it may be established whether an earthquake of such intensity centred near Montreal or, if not, the position of its epicentre.

"The fact that the first tremors lasted 'only two or three minutes,' would indicate that Montreal was not the centre of this earthquake. It is just possible that later references. may establish an epicentre much farther down the Saint Lawrence."

Holyoke Diaries, The, annotated by George Francis Dow, the Essex Institute, Salem, Massachusetts, 1911, p. 4

Note: At Marblehead.

"Large shock of an earthquake."

Hunt, Ebeneezer, "Journal", Judd Manuscripts in possession of the Forbes Library, Northampton, Massachusetts, Vol. I, p. 23

"...about 12 o'clock in the day which shook the houses considerably. Some thought it was as powerful as that of Oct. 29, 1727."

LaFlamme, Mgr. J.-C. K., "Les tremblements de terre de la région de Québec," Memoires de la Societé Royale du Canada, 1907, Sec. 4, p. 160-161

"1732.--Le séisme de 1732 n'ayant affecté que la région de Montréal (M) ne rentre pas rigoureusement dans le cadre de ce travail. Nous en dirons quelques mots cependant pour faire voir que, si les séismes montréalais ont, en général, moins d'intensité que ceux de la région inférieure de la province, ils peuvent cependant atteindre un certain degré de violence.

"La Mère Duplessis de Ste Hélène, supérieure de l'Hôtel-Dieu de Québec, après avoir parlé, dans une lettre du 20 octobre 1732, de l'incendie de Montréal qui avait détruit 190 'corps de logis,' ajoute: 'Depuis un mois c'est un tremblement de terre qui y jette une consternation qu'on ne peut exprimer. De la première secousse qui ne dura que deux ou trois minutes, plus de trois cents maisons ont étè endomagées, quantité de cheminées tombées des murailles fendues, des personnes blessées, une fille tuée, des grêles de pierres qui se répandaient partout et qui semblaient être jetées par des mains invisibles, enfin un effroi si universel que les maisons sont désertes, on couche dans les jardins, les bêtes même privées de raison jetaient des cris capables de redoubler la frayeur des hommes. On fait des confessions générales de tous les côtés; les dames ont quitté leurs paniers, les prêtres leur ont fait signer une promesse. Plusieurs ont fui et sont venus à Québec peur d'être enseveli sous les ruines de cette pauvre ville. Le fâcheux est que tout cela n'est pas fini. Il n'est point de jour qu'il ne se fasse sentir; il y a des puits qui ont étè extrêmement taris, des chemins bouleversés.'

"D'autre part, l'ingénieur de Léry écrit au ministre pour lui annoncer qu'il y a eu un tremblement de terre à Montréal. Le 3 octobre 1732, l'intendant Hocquart apprend au Ministre la nouvelle de ce tremblement de terre, et, le 12 avril 1735, le Président du Conseil de Marine écrit à l'intendant Hocquart qu'il ne peut accorder aux Récollets la somme qu'ils demandent pour les pertes subies par eux dans le tremblement de terre.[1]"

[1]*Renseignements fournis par M. J.-E. Roy*

Lewis, Richard, Philosophical Transactions, Number 429, 1733

A letter from Mr. Richard Lewis, at Annapolis in Maryland, to Mr. Collinson, F.R.S. containing the Account of a remarkable Geneneration of Insects: of an Earthquake; and of an Explosion in the Air.

"On Tuesday the 5th of September last, about Eleven in the Morning, an Earthquake was felt in diverse Places in Maryland; the most particular Account I have heard of it was from Mr. Chew. It shook his House for some time, and stopp'd the Pendulum of his Clock; during its Continuance, a rumbling Noise was heard in the Air, and many People who did not feel the Shaking, as well as those who did, complained of a Dizziness in their Heads, and Sickness at their Stomachs: At the same time, I have been credibly informed, it was felt in Pennsylvania, and New-England; but I have not heard whether it extended to North or South Carolina."

Des Miettes d'histoire par S.S.-Eulalie de Barcelone, 1925, Archives de la Congregation de Notre-Dame, Montréal, Quebec, 200.100, 1, p. 32.

"1732-Inondation, petite vérole. Plus de trente secousses de tremblement de terre en vingt-quatre heures, et abattent plus de trois cents cheminées. Ces secousses se renouvellent plus ou moins fréquentes pendant neuf mois."

Lewis, Alonzo and James R. Newhall, History of Lynn, Essex County Massachusetts: including Lynnfield, Saugus, Swampscot, and Nahant, Boston, 1865

"1732. On the 5th of September, there was an earthquake without noise."

New-England Weekly Journal, The, Boston, Massachusetts, September 11, 1732

"Boston"

"On Tuesday last a few Minutes after Twelve at Noon was felt here a surprizing Shock of an Earthquake, attended with little or no Noise, the Shake continued near half a Minute, and some Houses were perceived to shake very much, so that several small things were shook down from their Places. The same was very sensibly felt in most of the Neighbouring Towns, and to the Eastward as far as Piscataqua."

New-England Weekly Journal, The, Boston, Massachusetts, September 25, 1732

"Boston.

"We are inform'd, that the Earthquake felt here on Tuesday, the 5th Instant, was perceived near the same time at Philadelphia; and from Springfield we hear it was very surprizing there, shook down several things from off the Shelves at the House of Capt. William Pynchon; and a Man in a Orchard there perceiv'd that several Apples were shook off the Trees thereby."

Nova francia, Vol. III, No. 2, 24 décembre 1927, "Lettre de Mère Marie-Andrée Duplessis de Sainte-Hélène, supérieure des Hospitalières de l'Hôtel-Dieu de Québec," avec des notes de A.-Léo Leymarie.

"Madame et tres chere amie,...

"Il est temps de vous parler des fleaux dont Dieu afflige le canada, il y a quelques années que je vo mandé un incendie presque general qui avoit consumé plus de 190 corps de logis à Montreal ce printemps, la même ville a été inondée et fort incommodée de leau qui a monté si haut que les caves étoient pleines tout y flottoit, les planchers se soulevoient, les rues étoient impraticables et plusieurs marchands ont beaucoup perdu, depuis un mois c'est un tremblemt de terre qui y jette une consternation qu'on ne peut exprimer des la p^ere^ secousse qui ne dura que 2 a 3 minutes plus de 300 maisons ont été endomagées, quantité de cheminées tombées, des murailles fenduës, des personnes blessées, une fille tuée, des grêles de pierres qui se repandoient partout et qui sembloient être jettées par des mains invisibles, enfin un effroy si universel que les maisons sont désertes on couche dans les jardins, les bêtes mêmes privées de raison jettoient des cris capables de redoubler la frayeur des hommes, on fait des confessions genérales

de tous cotés, les Dames ont quitté leurs paniers, les prêtres leur ont fait signer une promesse, plusieurs ont fuï et sont venues a Quebec peur d'etre ensevelies sous les ruïnes de cette pauvre ville, le facheux est que cela n'est pas fini, il n'est point de jour qu'il ne se fasse sentir, il y a des puys qui ont entierement tari, des chemins bouleversés...."

Parkman, Ebenezer, September, 1732, The Diary of Ebenezer Parkman, First Part 1719-1755, ed. Francis G. Walett, American Antiquarian Society, 1974

"September 5. N.B. An Earthquake just about (or a little after) Noon."

Note: Rev. Parkman lived in Westboro, Massachusetts.

Pennsylvania Gazette, The, Philadelphia, Pennsylvania, September 12 to September 18, 1732

"Philadelphia, Sept. 18

"On Tuesday the 5th Instant, a small Shock of an Earthquake was felt in this City, about Noon. It was also felt at New-Castle."

Plant, (Rev.) Matthias, Philosophical Transactions of Royal Society, London (1742-43), No. 462, Vol. XLII, p. 33.

"September 5, 1732. About noon we had a severe shock, which was perceived at Boston and Piscataqua, but attended with little or no noise. The same earthquake was heard at Montreal, in Canada, at the same time and about the same hour of the day, and did damage to one hundred and eighty-five houses, killed seven persons, and hurt five others; and it was heard there several times afterwards, only in the night, as the newspapers give us this account."

Roy, Pierre George, Inventaire des Papiers de Lery Conservés aux Archives de la Province de Quebec, Volume I, Quebec, 1939, Letter of M. Chaussegros de Lery to the President of the Marine Council.

" 20 octobre 1732"

"Monseigneur.

"Neuf jours apres mon départ de Montreal qui étoit le 16, du mois passé il y a eu un tremblement de terre assez violent qui a fait tomber une bonne partie des cheminées, en a fait fendre dautres et plusieurs mur des maisons se sont ouverts les personnes qui en viennent mont asseuré que sil avoit continué encore deux minutes une grande partie des maisons auroient été renversée jay apris depuis que la terre avoit tremblé pendant plusieurs jours mais les secouses nont pas eté si violentes le premier tremblement s'est fait sentir presque dans toute la colonie je lay senty a Quebec mais cetoit peu de chose.

"Les Entrepreneurs qui sont descendus mon dit avoir visité les murs de L'anceinte ils disent qu'a la porte de St. Laurent il y a en quelques pierres de dérangées qu'ils ont accomodé et mont demandé 10 livres pour cela dans la maconnerie il y a eu quelques desus de parapets de dérangés et quelques pierres du desus des Embrazures de tombées ils offrent de retablir le tout pour 50 livres dans le bastion du nord il setoit fait une fente ils m'ont asseuré que dans les dernieres secouses elle s'etoit fermée ils mon dit aussi que les allignements des murs et les taluds n'avoient pas changés, Mr. le Général et Mr. L'Itendant on receut plusieurs lettres de Montreal je suis persuadé Monseigneur qu'ils vous informeront mieux que moy du degat qu'a causé ce tremblement en ayant receu le détail....

"Je suis avec un profound respect,
Monseigneur,
Votre tres humble et tres obéissant serviteur.

CHAUSSEGROS DE LERY

"A Quebec le 20 octobre 1732.

"Soeur Sainte-Henriette, Cahier 6e." Archives de la Congrégation de Notre-Dame, Montréal, Quebec, p. 420.

"Petite vérole. Tremblements de 1732-1733.

"A la même époque, il y eut des tremblements de terre qui se firent sentir particulièrement à Montréal. La première secousse, qui eut lieu le I6 septembre 1732, abattit plus de trois cents cheminées; il y en eut plus de trente en vingtquatre heures et elles se renouveleront à divers intervalles pendant plus de neuf mois."

Weekly Rehearsal, The, Boston, Massachusetts, September 11, 1732

"Boston, Sept. 11. About 12 o'Clock on Tuesday last, we felt a considerable Shock of an Earthquake, which lasted the space of half a Minute; and several Persons affirm that they observed the Houses at some Distance to move; but we cannot learn that this shaking was attended with any such Noise as usual. We hear the Shock was felt in several of the adjacent Towns, particularly at Salem, where the shaking was very violent and lasted near a Minute. From Portsmouth, a Gentleman writes, 'That the Shock was very little inferiour (sic) *to the great Earthquake in 1729* (sic)*, and lasted near a Minute, but was not accompanied with the usual Rumbling.' It was felt in all the Places from whence we have yet heard, at the same Instant we observed it here."*

Williams, Samuel, "Observations and Conjectures on the Earthquakes of New England," Memoirs of the American Academy of Arts and Sciences, Boston, 1785

"Observations and Conjectures on the Earthquakes of New England.

"In 1732, there was an earthquake, which, though small, was of considerable extent. It came on September 5, o.s. at about 11^h A.M. being attended with a rumbling noise; and was of such violence as to occasion a considerable jarring of the houses. The duration of it, was not more than ten or fifteen seconds. This earthquake was much more evident at Montreal in Canada, than it was in any part of New-England; being attended with considerable damage there. As this was the chief feat of it, it seems to have come from thence, in a north-westerly course, to New-England. Its extent, from south-west to north-east, was equal to that of most of the earthquakes that have been in the country; being felt from Maryland to the northeasterly parts of New-England: and from north-west to south-east, it reached from Montreal, and probably from many miles beyond it, to the seacoast."

EARTHQUAKE OF JUNE 14, 1744
(JUNE 3, 1744, JULIAN CALENDAR)

CA. 10:15 (L)

EPICENTRAL INTENSITY: VI(MM)

LOCATION: 42.5N, 70.9W

EVALUATION:

This earthquake is estimated to be centered in the Southern Cape Ann region, near Salem, Massachusetts (Figure 2.5.2A-3). Reports of an Intensity VI(MM) level are found for Newburyport, Salem, Lynn, Melrose, and Boston. The epicentral location cannot easily be determined, as attested by early catalogs which referred only to "eastern Massachusetts." Smith's location, further to the east, (42.6N, 60.0W) is an attempt to take into account the undetermined location "off Cape Ann" given by Mather and Godfrey (1927), and to accommodate the observed coastal distributions of felt reports. The higher intensity to be associated with an epicenter at sea was logical, but remains an extrapolation.

The current location near Salem is preferably chosen in view of the distribution of similar Intensity VI(MM) levels, from Newburyport to Dorchester, and the fact that the report of the main aftershocks and some secondary ones appear to be primarily associated with the Salem vicinity.

In some of the reports, a reference is made to the similarity of this shock with that of 1727. At first, one might consider the possibility of a similar epicenter and intensity. On closer examination, one finds that such a position is not accurate; in Dorchester, it is explicitly reported that the 1744 earthquake was not as strong as that of 1727. The felt reports for the 1727 earthquake were predominantly stronger north of Cape Ann, in contrast with the 1744 earthquake.

There is no doubt that a large uncertainty ±15 miles can be associated with the event.

PERTINENT ACCOUNTS:

Boston Weekly News-Letter, The, Boston, Massachusetts, June 5, 1744
(Period newspaper account)

"Last Lord's Day between 10 and 11 o'Clock in the Forenoon we were surprized with a violent Shock of an Earthquake attended with a loud rumbling Noise whereby People were put into a very great Consternation, and many who were attending the Divine Worship ran out into the streets fearing the Houses would fall upon them: A great many Bricks were shook off from several Chimneys in this and other Towns, and much of the Stone Fences in several Places in the Country was tumbled down by it. It was perceived to continue longer and be more severe in some Places than at

others; and 'tis tho't by some to be felt near equal to that which we had in the Year 1727. How extensive it was we cannot yet learn, but by Information at present we are assured that it reach'd above 100 Miles. Another shock was felt at Salem, and others reach'd above 100 Miles. Another shock was felt at Salem, and others adjacent: Towns, about five o'Clock in the Afternoon of the same Day, which was considerable and again surprised the People very much. Three or Four smaller Shocks were perceived in the Night and Morning Succeeding.

"We hear from Hopkinton, that the Monday before the Earthquake, the Mud arose from the Bottom of two large fishing Ponds in that Town so as thicken the Water and prevent their fishing in them. It continued so for two or three Days and then setled and grew clear again. T'is remarkable that the same happened to these Ponds a few Days before the great Earthquake in the Year 1727."

Fuess, Salem, Massachusetts (Later history, published 1835)

"The Earthquake of 1744 - In 1744 there was another terrific earthquake, which was thought by some to have been nearly equal in severity to that of 1727. In May there had been two slight shocks, occurring in both instances in the morning. At a quarter past ten on Sunday morning, June 3, just after church services had begun, the severest shock came. It reached only about a hundred miles and was ushered by a loud rumbling, which threw the people into consternation as they remembered the experience of seventeen years before.

"People ran out of their houses, fearing they would fall upon them; and the rector and many of the congregation ran out of the Episcopal Church at Newbury (in that part now Newburyport). In the Hamlet parish in Ipswich (now the town of Hamilton), the shock came when the pastor, Rev. Mr. Wigglesworth, was preaching. The congregation was greatly alarmed; but he endeavored to calm them, remarking that 'there can be no better place for us to die in than the house of God.'

"Bricks were shaken from chimneys and stone walls were thrown down. At about five o'clock in the afternoon another and lesser shock was felt at Salem and adjacent towns, and people screamed and ran out of doors. Three or more lesser shocks were perceived that night and the next morning."

Boston Gazette or Weekly Journal, The, Boston, Massachusetts, June 12, 1744
(Period newspaper account)

"Portsmouth, N.H., June 9

"Last Lord's Day, a little after 10 o'clock. the People thro' out this Province and the County of York, were very sensible of a severe shock of an Earthquake, attended with a loud rumbling Noise, which greatly surpris'd them; but we can't learn of any damage being done: Those that were upon the Water near the Coast and Rivers, were as sensible of the convulsion as those on the Land."

Wadleigh, George, Dover, New Hampshire (Later History, published 1913)

"A great Earth Quake Sabbath Day June 3, 1744."

Sawyer, (Rev.) Roland D., Kensington, New Hampshire (Later History, published 1974)

"The only earthquake ever felt in Kensington of sufficient severity to be recorded were those of October 29, 1727 and June 3, 1744."

Parson, Langdon, Rye, New Hampshire (Later History, published 1905)

Note: June 3, 1744 - smart shock of earthquake.

EARTHQUAKE OF NOVEMBER 18, 1755

CA. 04:12 (L)

EPICENTRAL INTENSITY: VIII(MM)

LOCATION: 42.7N, 70.3W

EVALUATION:

This is the largest historical event within the site region. It is also the most significant one because of its close epicentral distance to the site (30 miles). The approximate location can only be estimated on the basis of the felt report distribution from which isoseismals are attempted (Figure 2.5.2A-4). An uncertainty of ±15 miles seems to be a reasonable compromise.

The event has been thoroughly discussed in the Pilgrim Unit II Docket Boston Edison Company, 1976. Its tectonic origin and location have been related to the Cape Ann pluton and the Northeastern Massachusetts thrust fault complex. All documentary evidence of felt reports have been published in the Historical Seismicity of New England (BE-SG 7601, Boston Edison Company, 1976), prepared by Weston Geophysical.

The event was felt over a wide area of approximately one million square kilometers, extending from Halifax, Nova Scotia to Annapolis, Maryland. The damage was limited to coastal New England locations, from Portland, Maine to New Haven, Connecticut. The worst chimney and fence damages, definitely of an Intensity VII(MM) level were observed in the Cape Ann region and in Boston proper. Because much of the damage in Boston was confined to landfilled areas near the shores, it is considered to be partly attributed to soil amplification. For this reason, the Intensity VII(MM) reports of the Cape Ann region, even though less dramatic in style and fewer in number, are considered to be more indicative of the epicentral location.

PERTINENT ACCOUNTS:

Adams, N., Portsmouth, New Hampshire (citation in later History 1825)

"The most severe and tremendous earthquake, which was ever felt in this country, took place on the night of the 18th of November, after midnight. The weather was remarkably serene, the sky clear the moon shone bright, and a solemn stillness prevailed all nature, at the time it commenced."

Boston Weekly News Letter, November 20, 1755 (Effects in Boston)

"the tops of many Chimnies, and some of them quite down to the Roofs, were thron down, and several of the Roofs upon which they fell were beat in: Many Chimnies also, for 6, 7, and 8 Feet below the Top, were loosened and turned several Inches on the main Body; and others, with the Brick Walls of some Houses were disjointed, burst out and shatter'd: the wooden Post that supported the Spindle and Vane of Faneuil Hall Market was by the Shake broke off, and they fell to the Ground on the North Side....And in the inside of many Houses, the Pewter, Earthen, Glass, China, and other Ware, were thrown off the Shelves, and other Places whereon they stood, and many Things were broke to Pieces."

Dow, J., Hampton, New Hampshire (Citation in Later History, 1893)

"The shaking of the earth was so great that several chimineys in this town were thrown down.

"The earthquake occurring at an hour when the mass of the people were asleep, many of them being suddenly awakened were very much terrified, not imediately perceiving the cause of the commotion. The older people, however, had not forgotten the earthquake of 1727, and now, as on the occasion, they recognized the hand of God in the occurrence."

Quincy, E., Portsmouth, New Hampshire (Letter dated November 22, 1755)

"...it was very shocking in thes Town and the Towns round about us....My wife awoke in the midst of the shaking...." (Letter 22 Nov. 1755)

Winthrop, John (1757) Description of Effects in Boston

"the principle effect of the earthquake for which I can find sufficient vouchers, for many strange things have been related which upon examination, appear to be without foundation. Besides the throwing down of glass, pewter and other movables, in the houses, many chimneys were levelled with the roofs of the houses, and many shattered and thrown down in part. Some were broken off several feet below the top, and, by the suddeness and violence of the jerks, canted horizontally an inch or two over, so to stand very dangerously. Some others were twisted or turned around in part. The roofs of some houses were quite broken in by the fall of chimneys; and the gable ends of some brick buildings thrown down, and many were craked. The vane upon the public market house was thrown down; the wooden spindle which supports it, about five inches in diameter and which had stood the most violent gusts of wind, being snapped off. A new vane upon one of the churches was bent at its spindle, two or three points of the compass; and another at Springfield was bent to a right angle. A distiller's cistern made of plank, almost new, and very strong put together, was burnt to pieces by the agitation of liquor in it; which was thrown out with such force as

to break down one whole side of the shed that defended the cistern from the weather....About 100 chimneys were in a manner levelled with the roofs and about 1,500 shattered or thrown down in part."

Note: Much of the damage in Boston probably occurred in areas where poor foundation materials were present. An account of the earthquake quoted by Brigham (1871) says *"that in some places, especially on the low, loose ground made by encroachments on the harbor, the streets are almost covered with the bricks that have fallen."*

AFTERSHOCKS OF THE EARTHQUAKE OF NOVEMBER 18, 1755

EVALUATION:

Data regarding the aftershocks of the earthquake of November 18, 1755 have been compiled. These data are summarized in Table 3. Aftershocks are reported from the period of November 18, 1755 to March 15, 1756.

A widely felt, though lesser shock of the main tremor at 4:30 a.m., is reported for eastern New England at 5:29 a.m. on November 18, 1755. At 4:00 p.m. on November 18, a tremor is also reported at Kittery, Maine. On November 19 and 20, 1755, three are reported from northeastern Massachusetts at Chelmsford, Ipswich (10:00 p.m.), and York, Maine (time not given), respectively. The largest aftershock, that of November 22, 1755, is widely reported. The aftershock of December 19, 1755, at 10:00 p.m., was reported felt from Marshfield, Massachusetts to Portland, Maine. On March 11, 1756, earthquakes are reported as felt in the towns east of Boston, Massachusetts (between 3:00 and 4:00 p.m.), and on March 15, 1756, along the coast from Salem, Massachusetts to Wells, Maine (time not given). Neither event was reported as felt in Boston.

A number of contemporary observers within the scientific community at Boston, Massachusetts recorded detailed observations on the aftershocks as well as the effects of the main shock. Only three aftershocks were reported in Boston; November 18 (5:29 a.m.), November 22 (8:27 p.m.), and December 19, 1755 (10:00 p.m.). However, reports of numerous shocks from locations north and east of Boston are reported in period citations.

The principal data summarizing observations through 1755 are given in Chauncy (1755), Mayhew (1755), and Winthrop (1757) (Table 4). The aftershocks on March 11 and 15, 1756, were not felt in Boston, according to newspaper reports. Later publications by Winthrop (1757) and Williams (1785) do not indicate that any aftershocks were reported in Boston after December 19. During the period November 18 (from the 5:29 a.m. event) up to November 22, reports from Portland and York, Maine, Hampton, New Hampshire, and Essex County, Massachusetts indicate that slight shocks were reported almost daily. The reports are not sufficiently descriptive to define the earthquakes; for example, a journal entry by Rev. Thomas Smith for November 22, 1755, written at Portland, Maine, merely notes the events as *"Besides several earthquakes we have had this week..."*

The available reports indicate that a large number of aftershocks were reported from localities east and north of Boston, Massachusetts and support a Cape Ann epicenter region.

EARTHQUAKE OF MARCH 12, 1761

CA. 02:15 (GMT)

EPICENTRAL INTENSITY: V(MM)

LOCATION: CAPE ANN REGION

EVALUATION:

This earthquake is estimated to be centered in the Cape Ann region based on reports from coastal localities (Figure 2.5.2A-6). No damage is attributed to this tremor; however, it was widely felt extending over an estimated 127,000 square kilometer region. It appears to have been most strongly felt near Salem, Massachusetts. This was the basis for some early epicentral estimates; the event is included in Table 2.5.2-2 because of the uncertainty of the location.

PERTINENT ACCOUNTS:

Boston Gazette and Country Journal, The, Boston, Massachusetts, March 16, 1761 (Period Newspaper Account)

"Portsmouth (New Hampshire) March 13

"Yesterday Morning, between the hours of two and three o'Clock, a smart Shock of an Earthquake was felt in this and the neighboring Towns, attended with a loud rumbling Noise, which was soon followed by another, but hapily did no Damage.

Lane, Samuel, Stratham, New Hampshire (Diary entry)

"Earthquakes in the years following...Mar 12, 1761."

EARTHQUAKE OF NOVEMBER 9, 1810

CA. 21:15 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 43.0N, 70.8W

EVALUATION:

The earthquake of November 9, 1810 is centered in the vicinity of Portsmouth, New Hampshire, Figure 2.5.2A-8. This location is consistent with the epicentral location of the original PSAR. It was felt over an area of 21,500 square kilometers. The maximum effects were reported from Portsmouth, New Hampshire; the principal damage was broken glass. At Hampton, New Hampshire, no damage was reported, but *"it was severe enough to stop clocks."* (Newburyport Herald, November 13, 1810).

PERTINENT ACCOUNTS:

Columbian Centinel, Boston, Massachusetts, November 14, 1810

"Earthquake. A severe agitation of the earth was felt in Portsmouth, N.H. Friday evening last, about three minutes past 9 o'clock. - Its progress appeared to be from N.W. to S.E. and was accompanied by a heavy explosion. - Its duration from one to two minutes -Some window glass was broken by the shock, which a vessel coming into the harbor felt as severely as if she had run aground. The Kennebunk paper mentions it as having been violently felt there; that it lasted about 20 seconds, was attended with a loud rumbling, and that the houses and contents were very much agitated. The Portland Gazette states its being but slightly felt there, about half past 9 o'clock, and that from a calm the wind for a few moments blew very fresh before the shock. It was sensibly felt at Salem, Newburyport, York, Exeter, Dover, Haverhill, and many of the interior towns, and at Charlestown, in this vicinity, but we have not heard of its being experienced in this town."

New Hampshire Gazette, The, Portsmouth, New Hampshire, November 13, 1810

"On Friday evening last, at a few minutes past 9 o'clock, a shock of an earthquake was felt in this town, the most severe it is said since 1755. It was felt also at Portland and at Newburyport. Its apparent course from west to east."

Newburyport Herald, Newburyport, Massachusetts, November 16, 1810

"Dover, New Hampshire - Inhabitants of this town were considerably alarmed by a severe shock of an earthquake--lasted one minute more severe than any of last fifty years.

Newburyport Herald, Newburyport, Massachusetts, November 13, 1810

"Earthquake - On Friday evening last a severe shock of an earthquake was felt in this town, which lasted about 20 seconds. It appeared to pass from the southward to the northward,--the noise like a carriage moderately passing a bridge, till there succeeded a kind of roaming (sic) like distant thunder. A vessel was at that time coming up the river, which felt the shock, so as to induce the people to think she struck a rock.

"At Haverhill it was sensibly felt, and at Hampton it was so severe as to stop clocks.

"In Portsmouth, (says the Oracle) it was felt a minute past nine, its duration nearly two minutes; being more severe than has been felt there for many years. Some window glass was broken by the shock."

EARTHQUAKE OF OCTOBER 5, 1817

CA: 11:45 (L)

EPICENTRAL INTENSITY: V-VI(MM)

LOCATION: 42.5N, 71.2W

EVALUATION:

The earthquake of October 5, 1817, is listed in numerous earthquake compilations as an event of epicentral Intensity VII-VIII(MM), based upon the observation of Brigham (1871) (as reported by Felt, 1899) that *"walls were thrown down at Woburn."*

Contemporary accounts, mainly from newspapers, indicate that the intensity did not exceed V-VI. The *"walls"* referred to by Brigham are probably wall fences characteristic of rural New England pasture land rather than house walls (Berkshire Star, October 16, 1817). These walls are constructed by removing glacial boulders from pasture land and piling them loosely on top of each other to make a *"stone fence."* Intensity IV-V(MM) effects are characterized almost exclusively by indirect descriptions such as *"severe"* and isolated cases of excitement. There are no reports of any damage identified to buildings or their contents.

The density of felt reports is insufficient to adequately define the epicenter of the earthquake. The region between Tyngsboro and Woburn defines the meizoseismal area. The convention of listing the epicenter as published in existing lists, then Woburn, is retained. The maximum epicentral intensity does not exceed V-VI(MM). The perceptible area is about 55,000 square kilometers (Figure 2.5.2A-11).

PERTINENT ACCOUNTS:

Berkshire Star, Stockbridge, Massachusetts, October 16, 1817

*"The Earthquake mentioned in our last, was more severely felt in some towns, to the north and east, than in this place -We have accounts of it from towns in New York, Vermont, New Hampshire, and from many towns in this State, as far east as Newburyport - In many places it caused great alarm. - At Cambridgeport *the meeting house was so severely shaken as to cause the whole congregation to desert it instantaneously - and in some places the wall fences were thrown down.*

Boston Commercial Gazette, Boston, Massachusetts, October 6, 1817

"Yesterday about 20 minutes before 11 o'clock, a smart shock of an Earthquake was felt in this town. The vibration continued about one second in this place. In Broad-street, we are told, the shock was so severe as to occasion several of the inhabitants residing therein to leave their houses.

"We have since learnt, that the shock was severely felt in the neighboring towns, particularly at Cambridgeport, where the meetinghouse was shook in so tremulous a manner, as to cause an immediate desertion of the whole congregation; - at Woburn, many of the walls were thrown down, and some houses represented as rocking like a cradle."

Essex Register, Salem, Massachusetts, October 7, 1817

"Last Sunday, at 47 minutes past eleven, A.M. we had a shock of an Earthquake. It came from the Northwest, and continued about 10 seconds. The noise was considerable, and the shock great enough to bring a whole congregation from their seats.

"A small distance was observed between the first report and the shock, the undulation was quick, but without the least injury."

Portsmouth Oracle, The, Portsmouth, New Hampshire, October 11, 1817

"An Earthquake was felt in this town on Sunday night last at 5 minutes before 12 o'clock and was said by some persons to be repeated by a violent one a few moments afterwards. The shock was considered as sensible as any observed for many years.

"Exeter Oct 7 One of the severest shocks of an earthquake ever known in this town was experienced on the last Sabbath about a quarter before twelve o'clock, A.M. It was attended by a sound similar to the rapid passage of a heavy wagon, and continued about thirty seconds. Buildings were sensibly shaken and this effort continued some seconds after the cessation of the noise.

Salem Gazette, Salem, Massachusetts, October 7, 1817

"On Sunday last, at 47 minutes before 12 o'clock, apparent time, a shock of an earthquake, of 1 or 2 seconds continuance, was experienced in this town and vicinity; the jar and trembling, though so considerable as in many instances to cause persons involuntarily to flee from their seats, were by others not perceived at all."

EARTHQUAKE OF JULY 23, 1823

CA: 06:55 (L)

EPICENTRAL INTENSITY: IV-V(MM)

LOCATION: 42.9N, 70.6W

EVALUATION:

The earthquake of July 23, 1823 was originally identified as a local felt report from Sanford, Maine, by Mather and Godfrey (1927). However, the event was unreported in the Sanford area newspapers. Dispatches in area newspapers indicated that the event was in fact, widely felt. Reports from Bath, Maine, and Nantucket, Massachusetts, were not confirmed in the local newspapers. It was felt from at least Kingston, Massachusetts, to Portland, Maine. Except for a report from Bellows Falls, Vermont, there are no local felt reports from localities outside of the line shown on the isoseismal map as the estimated limit of felt area (Figure 2.5.2A-12). The epicenter is estimated as southeast of Portsmouth, New Hampshire. The epicentral intensity is estimated at IV-V(MM), based on attenuation. The perceptible area is 29,000 square kilometers.

PERTINENT ACCOUNTS:

Columbian Centinel, Boston, Massachusetts, July 26, 1823

"Earthquake. - A shock of earthquake was very sensibly felt in this city about 7 o'clock on Wednesday morning, for four or five seconds. It was also experienced in Dorchester, Milton, Salem, Gloucester, Reading, Lexington and other places heard from. - A gentlemen in Kingston, after noticing the shock, remarks that it was more violent than the four felt on the 12th inst. Remote papers mention other slight shocks felt on the 12th. It may be remarked that similar shocks have been observed for many years after a fall of heavy rain has succeeded dry spells."

Portsmouth Journal of Literature and Politics, Portsmouth, New Hampshire, July 26, 1823

"The Earthquake of Wednesday morning was felt in this town with unusual violence, and its extent must have been great. It was felt, as we are informed in Bath, Portland, Kennebunk, Dover, Exeter, Newburyport, Salem, Boston, Reading, Gloucester, Lexington, Kingston M, etc. It is said that some stone walls were thrown down in the neighborhood of this town. Piscataqua Bridge was violently shaken. It appeared in some houses like the report of a distant heavy cannon. The Salem Register says the Earthquake was at 5 minutes after 7- in this town it was at 5 minutes before 7."

Newburyport Herald, Newburyport, Massachusetts, July 25, 1823

"A smart shock of an Earthquake was felt in this town Wednesday morning at four minutes before 7 o'clock. Its duration was 8 or 10 seconds."

New Hampshire Gazette, Portsmouth, New Hampshire, July 29, 1823

"Earthquake. - A smart shock of an Earthquake was felt in this and the neighboring towns on Wednesday morning last about 7 o'clock. It was also felt in Kennebunk, Newburyport, Salem, Boston, &c."

EARTHQUAKE OF AUGUST 25, 1846

CA: 04:45 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.5N, 70.8W

EVALUATION:

The earthquake of August 25, 1846 is centered off the coast of eastern Massachusetts in the Cape Ann region (Figure 2.5.2A-13). This epicentral estimate is consistent with other previous estimates. The epicentral intensity is considered as V(MM), with V(MM) effects reported from Newburyport, Beverly, and Salem, Massachusetts. Although newspaper dispatches from other localities mention that a chimney was damaged in Jamaica Plain, near Boston, this is not corraborated by any dispatch from a Boston newspaper. The earthquake was felt over an area of 51,800 square kilometers. At Newburyport, Massachusetts *"houses were shaken, windows and doors rattled, bells were rung, and the slumbering were waked up."* (The Herald, Newburyport, Massachusetts, August 26, 1840).

PERTINENT ACCOUNTS:

Herald, The, Newburyport, Massachusetts, August 26, 1846

"'An earthquake of very considerable violence was experienced in this city' (at approximately 4:57 a.m.) 'houses were shaken, windows and doors rattled, bells were rung, and the slumbering were waked up.'"

"Felt at Cambridge, Lynn, Nahant, Salem, Beverly, Westboro, Worcester; sensibly felt at Worcester. At Beverly, - felt in every part of town. At Wilmington, 'in some instances crockery ware was thrown from shelves.' Felt also at Braintree, Dedham, Concord, and Jamaica Plains, Massachusetts."

Lewis, Lord John, Diary of Newbury, August 1846

"--a smart shock of an earthquake was felt in this place on the 25th in the morning at 5 o'clock, it was sufficient to shake the houses, and the beds in which people were. It was felt all round, the northern part of New England, in Maine, New Hampshire and other places. In Salem, Beverly, and other places, it opened doors, shook the crockery from the shelves, etc. it lasted from 10 to 15 seconds."

New Hampshire Patriot, Concord, New Hampshire, August 27, 1846

"The Earthquake in this city was felt 2½ minutes before 5 o'clock on Tuesday morning, Aug. 25, but, timekeepers vary, we had better call it 5 o'clock. It began at that hour at Newburyport, where it lasted 8 minutes. The shock was felt in all the towns of the commonwealth from

which we have heard, and houses were shaken, bells rung, and people roused from their beds in this city. Not being awake at the moment, we cannot, of course, have a very distinct idea of vibrations. - Boston Post, Wednesday."

Salem Advertiser, Salem, Massachusetts, August 26, 1846

"A smart shock of an earthquake was experienced in this city, with effects causing, doors to be thrown open, and even crockery in some instances to be tumbled from the shelves."

Salem Gazette, The, Salem, Massachusetts, August 28, 1846

"An Earthquake.

"Quite a smart shock of an Earthquake was experienced in this city, and its vicinity, at a few minutes past five o'clock, on Tuesday morning. - The accounts are so uniform, and come from so many concurring sources, in our city and out of it, that we are not at liberty to doubt that our city has been visited by this uncommon and extraordinary phenomenon of Nature. It was very sensibly felt throughout our city-and our advices, so far as we received them yesterday, lead to the belief that the concussion was very extensive....

"The Traveller says: - We have heard from Cambridge, Newton, Lynn, Nahant, Salem, Beverly, Westboro, and Worcester, and in these places the houses were shaken, windows and doors rattled, bells were rung, and the slumbering were waked up. The vibrations do not appear to have been preceded or attended by that rumbling sound which usually accompanies earthquakes. The sound, as it appeared to us, was more like that produced by the sudden and violent motions of a person in an adjoining room, or in the chamber overhead. Some say there were two or three successive shocks; but, to us, it rather appeared like one continued jar, or shock, of considerable violence....

"A correspondent of the Journal, at Beverly, writes as follows: -

"Mr. Sleeper: -We had a heavy earthquake, this morning, at Beverly, about 5 o'clock. It was felt in every part of the town. My bed shook, and it sounded as though a dozen railroad trains were passing over the roof of my house.

"Was it an Earthquake? -At five minutes before 5, this morning, a heavy noise and shaking was heard and felt by a number of our citizens. It was of longer duration than could have been produced by a cannon, or an explosion of powdermill. -Springfield Republican, 25th.

"The Earthquake.

"We have placed on our first page an account of the earthquake, as it appeared in some other places. In this city, the clocks struck five immediately after its termination. The duration of the shock is differently estimated, according to the imagination of the observer, from one second to several minutes. The noise was so great, and the motion so decided, that great numbers of persons were awakened from their sleep. It does not appear to have extended west or south of Massachusetts...."

Salem Register, Salem, Massachusetts, August 27, 1846

"By the concussion houses were shaken, windows rattled, doors unlatched, door bells were rung, furniture as well as china and other wares were much disturbed and many slumberers were aroused. At Jamaica Plain a chimney was shaken down."

EARTHQUAKE OF NOVEMBER 27, 1852

CA: 23:45 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 43.0N, 70.9W

EVALUATION:

The earthquake of November 27, 1852 is centered near Exeter, New Hampshire (Figure 2.5.2A-15). It was felt over a 9,900 square kilometer region from the Cape Ann region north to Saco, Maine. The maximum effects, Intensity V(MM), were observed near Exeter, New Hampshire.

PERTINENT ACCOUNTS:

Daily Morning Chronicle, Portsmouth, New Hampshire, November 30, 1852

"The Earthquake, on Saturday night, was likened by some persons in this city, who happened to be up and doing, to the roaring of a chimney on fire-others supposed it to be the heavy rumbling of a loaded wagon over a paved street.

"It was supposed by some gentlemen at Kittery Point to be a steamboat in the harbor letting off steam.

"The Salem Register calls it a 'smart shock,' and says, 'The rumbling noise and the jarring of the windows and doors were very perceptible for the space, some say, of half a minute. Some faithless ones attribute the shock to the explosion of a power-mill somewhere.'

"A lady in Greenland says the earthquake shook her house and those of her neighbors very sensibly.

"The Boston Journal says it was felt at Exeter where it shook the doors and windows violently, and in one instance jarred down some of the plastering of a dwelling house. It does not seem to have been felt at Boston.

"A very heavy explosion startled our citizens at 25 minutes before 12 o'clock, Saturday night. It came from a northerly direction and was probably from the Exeter Power Mills, though no former explosion of these mills ever produced here half so severe a concussion, or anything like the loud report and reverberation. After the shock, a roar like that of a foul chimney burning, was distinctly perceptible, in doors, for two minutes. The night was still and clear with a light air from NW-ground wet and soft.

"If this was not the effect of a great explosion it must have been one of those earthquakes and the most severe of them all, which at irregular intervals from time immemorial have visited the valley of the Merrimack. -Newburyport Herald."

Maine Democrat, Saco, Maine, December 7, 1852

"The Earthquake. -The shock of an earthquake was felt here on Saturday evening last, at thirty-five minutes after eleven o'clock. The shock here was not severe. We were standing near a stove at the time, and did not perceive any jar, but only heard the noise rumbling off in the distance in a westerly direction, and no apparent cause visible. The night was clear, the moon bright, and the air still.

"The force of the earthquake was evidently to the west of Portsmouth. At Exeter, it was felt with much violence. In Newburyport the Herald notes the minute the same as at Portsmouth. There it was thought it lasted nearly two minutes, and was much more severe than at Exeter. In Salem, it was also noticed, but it was less violent. No mention is made of it south of Salem."

EARTHQUAKE OF DECEMBER 11, 1854

CA: 00:30 (L)

EPICENTRAL INTENSITY: IV-V(MM)

LOCATION: 43.0N, 70.8W

EVALUATION:

The earthquake of December 11, 1854 is centered in southeastern New Hampshire (Figure 2.5.2A-16). The maximum observed intensity is at Newburyport, where there were unconfirmed reports of articles shaken from shelves in some cases. The distribution of intensities within the isoseismal region indicate an epicenter within the area about Exeter, New Hampshire. The earthquake was felt over an area of 4,100 square kilometers.

PERTINENT ACCOUNTS:

Exeter News Letter, The, Exeter, New Hampshire, December 11, 1854

"Earthquake -- This Monday morning at seven minutes before one o'clock, a smart shock of an earthquake was experienced in this town. The motion of the earth was quite perceptible, and its acting upon furniture and loose windows and doors, was anything but agreeable to weak nerves. The noise attending, was like that of the swift approach of a heavy carriage on frozen ground, hit when the shock appeared (sic) *to be immediately beneath, it was much heavier."*

Journal, The, Portsmouth, New Hampshire, December 16, 1854

"The Earthquake

"On Saturday (sic) *night last, at half past 12 o'clock, a shock of an earthquake was sensibly felt in this city and vicinity. The watchmen* (sic) *at the Navy Yard thought they saw lightning at the time and regarded the noise as thunder. Some of our city watchmen who were at the time in Market Street, heard the commencement and passing away of the sound. It seemed to them like two distinct explosions. --probably from the sound coming through* (sic) *different avenues between high buildings. It rattled the door shutters near them.*

"The Newburyport Herald says it was sensibly felt there at the same hour. The houses were shaken and the crockery ware in some houses was thrown down from the shelves.

"It was not felt in Salem. The Saco papers make no mention of it. Nor do those of Manchester and Concord."

"Quotes Exeter New Letter

"The direction of the sound in Portsmouth and Epping was apparently from the southeast to the northwest.

"In Greenland and in Epping it was as severely felt. As has usually been the case, rain fell the next day."

EARTHQUAKE OF OCTOBER 17, 1860

CA. 11:15 (GMT)

EPICENTRAL INTENSITY: VIII-IX(MM)

LOCATION: 47.5N, 70.1W

EVALUATION:

The earthquake of October 17, 1860 is centered in the St. Lawrence River Valley, northeast of Quebec city, near La Malbaie, about 510 kilometers from the site. The earthquake was felt over a 1,700,000 square kilometer region. It was felt throughout much of New England. Based upon intensity attenuation characteristics (Table 2.5.2-7), the intensity at the site is estimated at IV-V(MM).

EARTHQUAKE OF OCTOBER 20, 1870

CA: 16:30 (GMT)

EPICENTRAL INTENSITY: IX(MM)

LOCATION: 47.4N, 70.5W

EVALUATION:

The earthquake of October 20, 1870 is centered in the Baie St. Paul region, northeast of Quebec city about 500 kilometers north of the site. It was felt over a 2,500,000 square kilometer region including all of New England. Based on intensity attenuation characteristics (Table 2.5.2-7), the intensity at the site is estimated at V(MM).

PERTINENT ACCOUNTS:

Daily Free Press and Times, The, Burlington, Vermont, October 21, 1870 (Dispatch from Newburyport, Massachusetts)

"At twenty minutes to twelve, a slight jar was felt in this city, which was almost immediately followed by a rumbling, which lasted half a minute, jarring buildings, ringing doorbells, and shaking globes from chandeliers. In many instances the occupants ran into the streets from dwellings. It seemed to pass in a south-westerly direction."

Salem Register, Salem, Massachusetts, October 24, 1870

"At Salem, Massachusetts, 'solid and most substantial buildings felt the shock, heavy tables and dishes were sensibly shaken, horse's bells were rung, clocks were stopped in several instances, and hanging implements vibrated materially.'"

EARTHQUAKE OF MAY 12, 1880

CA: 07:45 (L)

EPICENTRAL INTENSITY: IV-V(MM)

LOCATION: 42.7N, 71.0W

EVALUATION:

The earthquake of May 12, 1880 is centered in northeastern Massachusetts (Figure 2.5.2A-19). The maximum effects are noted at Groveland, Massachusetts. The epicentral intensity is IV-V(MM). The felt area is 4,600 square kilometers.

PERTINENT ACCOUNTS:

Monthly Weather Review, May, 1880

"Newburyport, Mass., 12th, 7:45 a.m., a violent shock, houses shook in many parts of the city, the accompanying noise resembling that of a heavy barrel rolling over a chanber floor. Shocks were felt at the same time in Haverhill, Groveland and surrounding towns. Billerica, Mass., 12th, slight shock at 7:30 a.m."

Newburyport Herald, Newburyport, Massachusetts, May 13, 1880

Note: At 7:45 A.M., May 12, 1880 an earthquake was felt at some places and not at others. People had difficulty recognizing it as an earthquake, it being more noise than motion.

It was felt at Byfield, West Newbury, Haverhill, Groveland; at Amesbury the earthquake was strong enough to rattle crockery in several houses.

New York Times, New York, New York, May 16, 1880

"The Salem (Mass.) Gazette gives some further information concerning the earthquake shock which visited Eastern Massachusetts about 7:45 o'clock on Wednesday morning. It says: 'We hear reports of it in all the towns between Salem and Newburyport. In Salem, the shock was felt in all parts of the city. The accompanying sound was by some thought to be thunder; by others, an explosion as of rockblasting; and more generally as the rumbling of a wagon. In Newburyport, the shock was felt in the shaking of crockery and furniture, and in some houses sounding like persons moving in adjoining rooms. From Merrimac and Amesbury, from Georgetown and Rowley we have similar reports. At Haverhill an explosion was heard, the air vibrated, the earth trembled, people were swayed to and fro, crockery was shaken, and other signs of subterranean disturbance were noticed. At Acton, in Middlesex County, the shaking was lateral, and resembled the sensation caused by a heavily-loaded team passing over a stony street.'"

EARTHQUAKE OF AUGUST 30, 1905

CA: 10:40 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 43.1N, 70.7W

EVALUATION:

The earthquake of August 30, 1905 is centered in the vicinity of Portsmouth, New Hampshire and Kittery, Maine (Figure 2.5.2A-26). It was not reported felt in Massachusetts. The epicentral intensity is V(MM). The felt area is 3,600 square kilometers. Newspaper reports from the Portsmouth Herald (August 31, 1905) that *"it is rumored that chimnies were shaken down in North Hampton and Greenland"* are not confirmed by The Exeter News Letter (August 31, 1905) which indicated that the earthquake was not reported from North Hampton, Greenland, Seabrook as well as other localities.

Even though The Exeter News Letter states explicitly that the event was not reported from Seabrook, it is probably more realistic in view of the relatively short epicentral distance to assume that the event was felt mildly, i.e. with an Intensity III.

PERTINENT ACCOUNTS:

Exeter New Letter, The, Exeter, New Hampshire, September 1, 1905

"West Epping - September 4 -- 'At exactly 5:39 p.m. Cambridge time, on Wednesday of last week a distinct earthquake shock was felt here. Windows and dishes rattle violently, while the report was deep, low pitched, weird and long. It must have lasted fully eight or ten seconds, time enough for me to walk from a rear room in a large house out through the front door and on to the lawn. I was on the lawn before the rumbling ceased. We have had a dozen seismic tremors in southern New Hampshire since forty years; this however if memory serves me, was the most pronounced of any.

"Earthquake not reported from:

"Stratham, Rye, Freemont, Raymond, Nottingham, Kingston, Greenland, North Hampton, Hampton, Seabrook, Danville, Epping."

Haverhill Evening Gazette, Haverhill, Massachusetts, August 31, 1905

"Earth Quivers

"Portsmouth, New Hampshire, August 31 -- A series of earthquakes, the most severe ever experienced in this section, which, at about 5:35 to 5:40 o'clock yesterday afternoon were felt from the vicinity of Exeter to beyond Biddeford, Maine had their center of disturbance in this city, and were so severe that people, fearing the shaking houses and stores would collapse, ran in terror out of doors. The scene in the

shopping district was exciting for a number of minutes. For several seconds a tremor ran through the city, and windows, dishes, pictures, and other articles rattled. The experience of other places on the coast line and for a few miles inward was only in a less degree. The shock seemed to travel from west to east. No damage is reported.

"The shock here came at 5:35 and it was accompanied by a loud report as of thunder, followed by a rumbling. There were three distinct shocks, wach with its own rumble -- 'At Hampton the shock was very plain, but it was greater toward this city, for Greenland was more affected. On the other side of the city by Kittery and down to York it was plainly heard, but at Wentworth at Newcastle the shock was not heard at all.

Portsmouth Herald, The, Portsmouth, New Hampshire, August 31, 1905

"Three (3) Earthquake Shocks

"Citizens of Portsmouth, New Hampshire, Kittery and Biddeford, Maine get a scare.

"A series of earthquake shocks, the most severe ever experienced in this section were felt here late yesterday afternoon. Buildings trembled perceptibly, dishes were shaken from shelves, and in many cases people rushed in terror from their houses into the street.

"There were three distinct shocks. In each instance the tremor was accompanied by a sound which might be caused by a distant explosion. --

"The first shock was felt a little before 5:40 p.m. and the other shocks followed soon after. In the business section of the city, the shoppers and store employees rushed out into the street, believing that the buildings were about to collapse. Each of the three shocks continued for several seconds.

"Kittery, Maine

"Three shocks felt - accompanied by heavy rumbling.

"First shock 5:38 p.m., other two in rapid succession.

"As the doors and windows were rattled by the vibrations of the earth and the lighter bric-a-brac came tumbling down from walls and mantlepieces, people ran out of doors in considerable alarm.

"Biddeford, Maine

"A slight shock felt. Dinstinctly felt in overlying districts. Accompanied by a sound like the rumbling of distant thunder.

"An Earth Tremor

"The earthquake shock was the most startling, being so violent as to shake pictures from the walls of houses in the South End. It is rumored that chimnies were shaken down in North Hampton and Greenland.'

"Sounded like heavy object falling and rolling or like explosion. Eclipse of sun in A.M. before quake, thunder storm and lightning after quake."

EARTHQUAKE OF OCTOBER 16, 1907

CA: 00:10 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.8N, 71.0W

EVALUATION:

The earthquake of October 16, 1907 is centered in northeastern Massachusetts (Figure 2.5.2A-27). The epicentral intensity is V(MM). The felt area is 5,600 square kilometers. Even though no explicit felt report can be found for Seabrook, it is assumed in view of the estimated epicenter in the vicinity of Haverhill, that the earthquake must have been felt at Seabrook (Intensity III-IV).

PERTINENT ACCOUNTS:

Portsmouth Daily Herald, Portsmouth, New Hampshire, October 16, 1907

"Quake shock felt

"Tuesday Evening's Jar Was of Several Seconds' Duration

"Residents of this city claim they felt the earthquake shock shortly after seven o'clock on Tuesday evening, which was reported in dispatches from Derry, this county, and Lowell, Lawrence and Haverhill, Mass.

"The shock lasted for several seconds, seemingly, and the heavy rumbling ended in an apparent explosion.

"At Derry dishes were rattled on shelves and table, but no special damage was reported."

EARTHQUAKE OF JANUARY 7, 1925

CA: 13:07 (GMT)

EPICENTRAL INTENSITY: V(MM)

LOCATION 42.6N, 70.6W

EVALUATION:

The earthquake of January 7, 1925 is located in the vicinity of Cape Ann, Massachusetts. The epicentral location and intensity were determined by Porter (1924). The isoseismal map (Figure 2.5.2A-29) is constructed from data after Porter and additional newspaper investigations. The earthquake was felt over an estimated area of 29,000 square kilometers. The maximum intensity is V(MM) at Cape Ann and vicinity. At Hampton, New Hampshire, a news item in the Manchester Union of January 8, 1925, describes the effects as follows:

> *"Reports from Hampton and Stratham state that the shock was distinctly felt there, causing dishes and other contents of the house to rattle, and many of the houses were shaken."*

PERTINENT ACCOUNTS:

Porter, William W. II (1924)

"Intensity

"The region known to be affected by the earthquake of January 7, 1925, consists of a roughly semicircular area limited on the east by the Atlantic Ocean, and on the south, west, and north by a circular curve passing from a short distance south of Providence, Rhode Island, north-northwest to Worcester, Massachusetts, to Fitchburg, to Manchester and Rochester, New Hampshire, and to the seacoast near Kennebunk, Maine, about thirty-eight miles south of Portland. The position of the inner isoseismic line is very poorly defined, as the entire disturbance was of such small magnitude that an accurate quantitative determination of its effects is impossible. However, reports by C. W. Brown of Brown University, Associated Press dispatches, communications from various newspapers and from individuals, and a personal canvass of the northern area indicate that in general, the shock was of greater intensity within the area enclosed by the inner line: a chimney collapsed in Lynn; dishes and other articles were displaced from shelves; pictures fell from walls; and various reports indicate greater intensity in the inner area. The expression on the map of this difference in intensity is the inner isoseismic line, which merely traverses an indefinable zone of gradation between the two areas.

"Greatest Intensity: Barely V, Rossi-Forel Scale. The region of greatest intensity appears to have been Cape Ann. Plaster fell from the ceiling of Redmen's Hall, Rockport; near Lanesville a clock stopped at ten minutes past eight, and bottles 'danced a regular jig' on the drug store shelves; houses were sharply jarred; and the shock was noted by a large percentage of the population. This is the only area where the shock was reported to have been felt by pedestrians out of doors. W. F. Eldrege of Rockport stated that an undulatory wave seemed to stop him abruptly while walking.

"Almost universally the shock was compared to the vibrations produced by a motor truck being driven over rough pavement. In approaching Cape Ann, the size of the truck alluded to increased, and on the Cape, the consensus of opinion was that the vibrations were much too severe to have been produced by a truck.

"At one point on the Cape coal was being unloaded from a truck at the time of the earthquake, and a verbal report stated that a concussion was produced which felt as though the truck had crashed into the house. In Haverhill a contrasting report stated that the disturbance sounded as though a truck had bumped into the house, but that the jar was insufficient.

"Intermediate Intensity: IV +, Rossi-Forel Scale. Next to Cape Ann, the most severely affected regions were Merrimack Valley in northeastern Massachusetts, and the shore district north of Boston, including Lynn, Malden, Salem, Beverly, Marblehead, Nahant, and Ipswich. The inner isoseismic line incloses this region, the general effects of which have been listed above. One feature, however, recieved undue emphasis in press reports. The crack a mile long in Groveland Street, Haverhill, proved to be a series of short breaks in the asphalt with a total length of about fifty yards. Similar cracks are of common occurrence at this time of year due to frost action, and it is probable that tension existed, and that the actual fracture was induced by the seismic vibrations.

"The direction of movement of the disturbance is in most cases very vaguely defined. The one outstanding indication of direction occurred in Haverhill, where sixteen rolls of congoleum rugs were overturned from the east-southeast. These rolls, measuring nine feet in length, and with a diameter of about a foot, were free to fall in any direction except toward the south. The three men who were present at the time of the earthquake were positive that the direction of fall of all the rolls was from the east-southeast. So far as is known, no fixed objects were displaced in this area. The report of a broken water main in Haverhill due to the earthquake is unfounded.

EARTHQUAKE OF MARCH 1, 1925

CA: 02:19:20 (L)

EPICENTRAL INTENSITY: IX(MM)

LOCATION: 47.6N, 70.1W

EVALUATION:

The earthquake of March 1, 1925 is centered in the La Malbaie region, northeast of Quebec city, 525 kilometers north of the site. It was felt over nearly 5,000,000 square kilometers. The major damage occurred in the St. Lawrence River Valley, particularly on soft alluvial soils. Isoseismals (Figure 2.5.2A-30) indicate that the intensity at the site was about IV(MM).

PERTINENT ACCOUNTS:

The Union, March 2, 1925, Manchester, New Hampshire

"All sections of Hampton Beach were in the path of the earthquake, Saturday evening around 9:20. No damage was reported. At the Coast Guard station on the North beach, the shock was only slightly felt. The captain of the guard said the ocean was undisturbed during the earth's tremor.

"At (sic) *Hampton Beach, people living in a cottage reported that dishes shook in the cupboards and a pan under the sink fell to the floor. They were not aware that it was an earthquake until a little later when informed over the radio."*

EARTHQUAKE OF OCTOBER 9, 1925

CA: 13:55 (L)

EPICENTRAL INTENSITY: VI(MM)

LOCATION: 43.7N, 71.1W

EVALUATION:

The earthquake of October 9, 1925 has its epicenter in central New Hampshire (Figure 2.5.2A-31). The epicenter is poorly defined and the published location of Smith (1962) is retained. The epicentral intensity is VI(MM). The felt area is 17,700 square kilometers. The earthquake was not felt at localities such as Sanford and Kennebunk, Maine, and Portsmouth, New Hampshire, and is inferred from the isoseismal map (Figure 2.5.2A-31) to have not affected the site.

PERTINENT ACCOUNTS:

Concord Daily Monitor, Concord, New Hampshire, October 9, 1925

"An earthquake, slight in intensity, but generally felt throughout the Merrimack Valley, the Winnipesaukee Lake region and in the northeastern part of the state along the Maine border, was felt today in Concord by several persons. No damage beyond the breaking of window glass in Ossipee, the tumbling of chimneys in two or three towns, and the dumping of canned goods from shelves in Ossipee and Effingham Falls stores, was reported.

EARTHQUAKE OF MARCH 18, 1926

CA: 21:09 (L)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.8N, 72.8W

EVALUATION:

The earthquake of March 18, 1926 is centered in southern New Hampshire, near the town of New Ipswich (Figure 2.5.2A-32). The epicentral intensity is V(MM). The felt area is 4,800 square kilometers. Published research by Neumann (1925-1927) indicates that the felt reports were mainly in south-central New Hampshire and adjacent Massachusetts. There is no indication that coastal localities in southern Maine, New Hampshire, or northeastern Massachusetts reported the shock.

PERTINENT ACCOUNTS:

Manchester Union, The, Manchester, New Hampshire, March 19, 1926

"Southern N.H. Shaken By Slight Earthquake

"Slight earthquakes are reported to have occurred in four sections of southern New Hampshire yesterday afternoon.

"Towns and cities affected by the tremblor are Manchester, Nashua, Milford, Amherst, Wilton, Mont Vernon and Greenfield, according to dispatches received last night.

"All the shocks were felt at 3 o'clock, or shortly after. Wilton, Milford, Amherst and Mont Vernon are grouped in a semicircle about 12 miles from Nashua, while Greenfield is 25 miles from the Gate City.

"Reports indicate that the 'quake did not last the same length of time in each of the cities and towns. In Milford it lasted for 15 minutes. (sic) *Manchester 20 seconds and other places felt it for fully half a minute.*

"Manchester and Nashua felt only brief shocks, while Milford and surrounding towns experienced the temblor for at least 15 seconds.

EARTHQUAKE OF DECEMBER 20 AND 24, 1940

CA: 07:27:26 (GMT) (DECEMBER 20)

CA: 13:43:44 (GMT) (DECEMBER 24)

EPICENTRAL INTENSITY: VII(MM)

LOCATION: 43.8N, 71.3W

EVALUATION:

Both earthquakes are centered near Ossipee, New Hampshire. The isoseismal map (Figure 2.5-2A-37) shows that the Intensity VII(MM) effects occurred at Tamsworth and Wonalancet, New Hampshire. Damage of Intensity VI(MM) was noted in numerous localities in central New Hampshire and western Maine. The shocks were felt over an estimated area of more than 786,000 square kilometers including all of New England, New York, and New Jersey.

The intensity at the site, as shown by the isoseismal map, Figure 2.5.2A-37, is IV(MM). In the vicinity of the site, at such places as Portsmouth and Durham, New Hampshire, and Amesbury, Newburyport, Salem, and Gloucester, Massachusetts, the earthquakes were felt by many people, and were well accompanied by the creaking of buildings and the rattling of dishes, windows, and doors.

EARTHQUAKE OF JULY 29, 1954

CA. 19:57:06 (GMT)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.7N, 70.7W

EVALUATION:

The epicenter of the earthquake was located off the coast of northeastern Massachusetts, about 15 miles south-southeast of the site. The epicentral location was determined from seismograms recorded at Weston Observatory, Weston, Massachusetts, and at the Harvard Seismograph Station, Harvard, Massachusetts. The earthquake was felt from Lynn, Massachusetts, on the south to Kittery, Maine, on the north, and up to 20 miles inland over a 4,100 square kilometer area.

The quake was most strongly felt along the Massachusetts coast from Gloucester to Salisbury. In this area there were a few reports of small objects overturned, dishes and glassware knocked over, and clocks stopped (Newburyport Daily News, July 30, 1954; Gloucester Daily Times, July 30, 1954). Outside of this area, the earthquakes's effects consisted mostly of dishes, windows, and doors rattling.

Based upon press descriptions and reports collected by Weston Observatory through a canvass card survey, the intensity of this earthquake in the vicinity of the site was III-IV(MM).

EARTHQUAKE OF APRIL 26, 1957

CA. 11:40:06 (GMT)

EPICENTRAL INTENSITY: VI(MM)

LOCATION: 43.6N, 69.8W

EVALUATION:

The epicenter for this event was located off the coast of Maine, about 71 miles northeast of the site. Slight damage of Intensity V to VI(MM) occurred in the Portland area (Figure 2.5-2A-39). The quake was felt over 82,500 square kilometers including most of Massachusetts, Vermont, New Hampshire, and southern central Maine. The isoseismal map prepared by the United States Coast and Geodetic Survey (see Figure 2-5.2A-39) shows that the intensity at the site was no higher than IV(MM).

EARTHQUAKE OF OCTOBER 16, 1963

15:31:01.8 (GMT)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.5N, 70.8W

EVALUATION:

The epicenter for this earthquake was located in Massachusetts Bay, southeast of Cape Ann about 27 miles southeast of the site.

The earthquake was felt over approximately 17,800 square kilometers of northeastern Rhode Island, eastern Massachusetts, southeastern New Hampshire, and extreme southwestern Maine.

von Hake and Cloud (1965) list this earthquake as Intensity VI(MM). They report damages at Somerville (fallen plaster - Intensity VI(MM)) and at Winthrop (cracked windows - Intensity V(MM)), but these reports "were not substantiated" by Breitling (1965). The one instance of damage in Somerville apparently occurred in a building which was either poorly constructed or had undergone settlement prior to the earthquake. The Coast and Geodetic Survey report states that "cracks in the foundation and pantry became large" which indicates that the cracks were present prior to the earthquake.

Breitling's isoseismal map (Figure 2.5-2A-40) shows a maximum intensity of IV(MM) on land. Analysis of press reports and of a canvass card survey conducted by Weston Observatory show that the maximum effects at many towns in eastern Massachusetts consisted of houses rocked, windows and dishes rattled, and knicknacks thrown from the shelves (Amesbury and Methuen).

Based on Breitling's investigations and reports collected by Weston Observatory through a canvass card survey, the intensity of this earthquake in the vicinity of the site was IV(MM).

EARTHQUAKE OF OCTOBER 30, 1963

17:36:57.9 (GMT)

EPICENTRAL INTENSITY: IV-V(MM)

LOCATION: 42.7N, 70.8W

EVALUATION:

The epicenter for this earthquake was located in northeastern Massachusetts, about 13 miles south of the site. The epicentral location was determined from seismograms recorded at four stations of Weston Observatory's New England Seismic Network (stations are located at Weston, Massachusetts; Berlin, New Hampshire; Milo and Machias, Maine). The earthquake was felt in northeastern Massachusetts from north Boston, and in adjacent portions of southeastern New Hampshire over a 5,900 square kilometer area.

A questionnaire canvass conducted by the Weston Observatory indicated that the intensity of the earthquake was IV(MM). However, the press report for a few instances of craked plaster and other minor damage in the Ipswich-Rowley area (Salem Evening News, October 31, 1963) indicate that the intensity may have been as high as V(MM) near the epicenter. *"The intensity of the tremor was felt particularly in Ipswich and in Rowley. Householders in Rowley reported that dishes rattled and lamp fixtures swayed"* (Salem Evening News, October 31, 1963).

Based on the press descriptions and questionnaire survey conducted by Weston Observatory, the estimated intensity of this earthquake at the site was IV(MM).

EARTHQUAKE OF OCTOBER 21, 1971

00:54:46.2 (GMT)

EPICENTRAL INTENSITY: V(MM)

LOCATION: 42.7N, 71.15W

EVALUATION:

The earthquake of October 21, 1971 was reported by Coffman and von Hake (1971) as felt in several Merrimack Valley communities at Intensity V(MM). It was not reported felt in any coastal New Hampshire area.

PERTINENT ACCOUNTS:

Coffman and von Hake (1973)

"Northeastern Massachusetts. The shock shifted objects and shook buildings at a few towns in northeastern Massachusetts. Int. V at Andover, Billerica, Methuen, Newburyport, and Tewksbury. Int. IV at Georgetown, Gloucester, Groveland, Ipswich, Lawrence, Merrimac, Middleton, North Andover, Reading, and Wakefield, Mass., and Salem, N.H. Int. II at Lowell and Wilmington, Mass."

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TABLE 1

AFTERSHOCKS OF THE EARTHQUAKE OF NOVEMBER 9, 1727
FROM THE MINISTER'S RECORD (1727-1748)
OF THE REV. MATTHIAS PLANT

DATE YR	MO	DA	TIME (LOCAL)	INTENSITY* EVALUATION (MM)
1727	11	09	2300	F
1727	11	09	2335	IV
1727	11	09	2354	F
1727	11	10	0215	F
1727	11	10	0410	F
1727	11	10	0545	IV
1727	11	10	1530	F
1727	11	10	1700	F
1727	11	11		F
1727	11	11	1010	F
1727	11	11	1435	F
1727	11	11	1933	F
1727	11	11	2042	F
1727	11	12		F
1727	11	13		F
1727	11	14	1700	IV-V
1727	11	14	2400	F
1727	11	15	0410	F
1727	11	15		F
1727	11	16	1630	F
1727	11	16	2300	F
1727	11	17	1000	F
1727	11	18	1120	IV
1727	11	19		F
1727	11	23	1630	F
1727	11	24	0400	F
1727	11	26	1430	F
1727	11	30	2200	F
1727	12	01		F
1727	12	01		IV
1727	12	10		F
1727	12	12		F
1727	12	16		IV
1727	12	19	1000	IV
1727	12	28	2230	IV
1727	12	29	0400	F
1728	01	04	2300	IV-V
1728	01	09		F
1728	01	12	1400	F
1728	01	14	2100	F
1728	01	17	1800	F
1728	02	04	2130	IV
1728	02	04	2130	IV
1728	02	04	2130	IV
1728	02	05	1300	F
1728	02	08	0630	IV
1728	02	08	1000	F

DATE YR	MO	DA	TIME (LOCAL)	INTENSITY* EVALUATION (MM)
1728	02	09	0100	F
1728	02	09		F
1728	02	10	1350	V
1728	02	10	1530	F
1728	03	04	0030	F
1728	03	11	1315	F
1728	03	17	2345	F
1728	03	23		F
1728	03	28	0300	F
1728	03	30	1340	F
1728	03	30	2100	F
1728	05	03		F
1728	05	09	1700	F
1728	05	16		IV
1728	05	23	0940	F
1728	05	28	2000	F
1728	06	02		F
1728	06	02	1000	F
1728	06	04	2300	F
1728	06	17	0300	F
1728	06	19	0300	F
1728	06	22	0900	F
1728	07	14	0200	F
1728	07	30	1000	IV
1728	08	02	0315	IV
1728	08	05		F
1728	09	28	0400	F
1728	11	20	0400	F
1729	01	29	2000	F
1729	02	02	2400	F
1729	03	30	1400	IV
1729	08	06		IV
1729	09	19	1530	F
1729	10	08	1630	F
1729	11	09	2240	F
1729	11	25	0800	IV
1729	12	08	2000	IV
1730	02	19	2000	F
1730	02	19	2400	F
1730	03	09	0145	IV
1730	03	30		F
1730	04	23	2000	IV
1730	08	08	0900	F
1730	08	26	0800	F
1730	11	25	0900	F
1730	11	25	0900	F
1730	12	05	2020	F
1730	12	17	2245	F
1730	12	22	1845	F

DATE YR	MO	DA	TIME (LOCAL)	INTENSITY* EVALUATION (MM)
1731	01	12	1900	IV
1731	01	22	2400	IV
1731	03	18	1700	F
1731	06	08	0900	F
1731	07	16		F
1731	09	01	2100	F
1731	10	12	2300	IV
1732	02	18	1900	F
1733	01	10		F
1733	03	12		F
1733	10	30	2400	F
1734	01	27	2200	F
1734	07	10	0315	F
1734	10	20	1020	F
1734	11	27	0600	F
1735	02	13	1745	F
1735	04	01	1030	F
1736	02	13	1745	F
1736	07	24	0915	F
1736	10	12	0130	F
1736	11	23	0200	IV
1736	11	23	0600	F
1737	02	17	1615	F
1737	09	20	1020	IV
1740	12	25	0635	F
1741	01	29	0400	F
1741	02	05	1550	F
1742	04	08	0645	F
1742	09	24	1730	F
1743	08	21	1700	F
1744	05	24		F
1744	05	27	1115	F
1746	08	13		F
1747	01	17	2400	F
1747	12	14	0430	F
1747	12	17	1600	F
1748	03	22	0645	F

*F indicates unassigned intensity, inferred to be ≤III (MM).

TABLE 2

RECORD OF AFTERSHOCKS OF THE 1727 EARTHQUAKE
AT NEWBURY AND MARBLEHEAD, MASSACHUSETTS

DATE (O.S.)	TIME (LOCAL)	EXCERPTS TAKEN FROM ORIGINAL MINISTER'S RECORD BOOKS KEPT BY REV. MATTHIAS PLANT AT NEWBURY, MASSACHUSETTS	RECORD OF AFTERSHOCKS AT MARBLEHEAD, MASSACHUSETTS
October 29	--	"...and Eight more immediately followed louder than the rest that followed and lasted al ye week sometimes breaking with loud clasps 6 times or oftener in a day and as oftern in ye night..."	"...There were about 7 or 8 small rumblings, after this, heard before one of the clock;..."
October 30	2:15 a.m.		"...there were two others, one only heard the other felt."
	4:10 a.m.		"...we heard another."
	5:45 a.m.		"...another,"
	3:30 p.m.		"...we heard it again,..."
	5:00 p.m.		"...the same afternoon;..."
	-- p.m.		"...and I am told by some that were up in the following Night, that they heard the rumbling twice or thrice;..."

TABLE 2 (Cont'd.)

DATE (O.S.)	TIME (LOCAL)	EXCERPTS TAKEN FROM ORIGINAL MINISTER'S RECORD BOOKS KEPT BY REV. MATTHIAS PLANT AT NEWBURY, MASSACHUSETTS	RECORD OF AFTERSHOCKS AT MARBLEHEAD, MASSACHUSETTS
October 31	10:00 a.m.		"...there was a pretty strong one."
	6:35 p.m.		"...an other;..."
	7:33 p.m.		"...an other;..."
	8:42 p.m.		"...and a Fourth Time...and I am told was heard several times in the Night after."
November 2	Night	"...somewhat abated..."	"...the Earthquake heard twice last night."
November 3	-- p.m.	"...3 very loud claps..." (i.e. referring to the three reported November 3-4; also at Marblehead, time given as evening and about midnight)	"...it was heard again last night;..."
November 4	4.00 a.m.	"...about ye Brake of day..."	"...and a very considerable one that made our windows jar."
November 4	10:00 p.m.	"...we also had it upon Saturday..." (no time given).	"...some say they heard it about 4..." (original illegible, Weston Geophysical).

TABLE 2 (Cont'd.)

DATE (O.S.)	TIME (LOCAL)	EXCERPTS TAKEN FROM ORIGINAL MINISTER'S RECORD BOOKS KEPT BY REV. MATTHIAS PLANT AT NEWBURY, MASSACHUSETTS	RECORD OF AFTERSHOCKS AT MARBLEHEAD, MASSACHUSETTS
November 5	4:30 --	"...we also had it...Sabbath..." (no time given).	"It was distinctly heard about 4^h 30^m just after we came from meeting."
November 5	11:00 p.m.		"...and I am told about 11 at night they heard it again."
November 6	10:00 a.m.	"...much abated in ye noise and terror."	
November 7	11:00 a.m.	Not reported by Plant	"...it was plainly heard..." "...so that it has been heard about 30 times in the compass of the 9 or 10 days past."
		Weston Geophysical Note: significant textural differences in the original Minister's Record and the account in the Philosophical transactions published years later. Descriptions are taken from the original record.	Weston Geophysical Note: the record ends on November 7, 1727. The letter, written at Marblehead, Massachusetts is dated November 8, 1727.

TABLE 3

AFTERSHOCKS OF THE 1755 EARTHQUAKE

DATE	TIME	REPORTING LOCALITIES
Nov. 18, 1755	5:29 a.m.	Massachusetts: Amesbury†, Boston, Chelmsford, Essex County, Marshfield, Northampton, Salem, Westborough, Worcester; Maine: York; New Hampshire: Bedford; Rhode Island: Exeter.
Nov. 18, 1755	4:00 p.m.	Kittery, Maine.
Nov. 19, 1755	10:00 p.m.	Massachusetts: Chelmsford, Ipswich; Maine: York.
Nov. 20, 1755	Not Given	York, Maine.
Nov. 22, 1755	8:27 p.m.	Massachusetts: Amesbury†, Boston, Chelmsford, Essex County, Lynn, Marshfield, Northampton, Plymouth, Worcester, Westborough; Maine: Portland, York; New Hampshire: Hampton, Portsmouth; Rhode Island: Exeter, Newport; New York: New York.
Dec. 19, 1755	10:00 p.m.	Massachusetts: Boston, Essex County, Marshfield; Maine: Portland.
Mar. 11, 1756	3:00-4:00 p.m.	Reported in "towns east of Boston."
Mar. 15, 1756	Not Given	Reported along the coast from Salem, Massachusetts to Wells, Maine.

†Amesbury reports are uncertain and are not used in consideration of aftershocks.

TABLE 4

SUMMARY OF OBSERVATIONS† ON AFTERSHOCKS

Chauncy (1755):

"...These are all the shocks we have had in this town, tho' elsewhere they have been more numerous. In some places they have felt 5 or 6; in others 10 or 11; & in others still, at least 20."

Mayhew (1755):

"...Many other shocks have been felt since the first and the greatest, to the eastward and northward of Boston; at 20, 30, 40, and 50 miles distance, if not farther."

Winthrop (1755):

"...Since the reading of this lecture, there has been another small shock, viz. on Friday the 19th of December in the evening, exactly at 10 o'clock; the sky being then perfectly clear, and a very gentle gale at S.W. It was preceded by the peculiar noise of an Earthquake about 3 or 4 seconds, and the jarring lasted near as long; causing the window-shutters and door of the chamber, in which I then was, to clatter. Those of my family, who were in a lower room, perceived nothing of the shake, though they heard the noise. These are the only shocks that I have been sensible of; though it is said, that many others have been felt in the Province of New-Hampshire, since the first great one."

Winthrop (1757):

"...These four are the only shocks, that I have been sensible of from the 18th of November last to this date; tho' more are said to have been felt in other parts of the country to the northward of us....

"The center of our former earthquakes, as well as of this, seems to have been near the river Merrimac, about the latitude of 43° north, and 40 miles north from hence; many shocks having been felt in that neighbourhood, which did not extend to this place."

Williams (1785):

"...Many others, but very small, were felt in different parts of the Massachusetts and New-Hampshire, for several months after."

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†Account arranged chronologically in order of publication.