NESN

A STUDY OF NEW ENGLAND SEISMICITY

Quarterly Earthquake Report

July - September, 1999

New England
Seismic Network

Weston Observatory

381 Concord Road

Weston, MA 02493

Earth Resources Lab

Massachusetts Institute of Technology

42 Carleton Street

Cambridge, MA 02142

NEW ENGLAND SEISMIC NETWORK

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Notice

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Introduction

The New England Seismic Network (NESN) is operated collaboratively by the Weston Observatory (WES) of Boston College and the Earth Resources Lab (ERL) of the Massachusetts Institute of Technology. The mission of the NESN is to operate and maintain a regional seismic network with digital recording of seismic ground motions for the following purposes: 1) to determine the location and magnitude of earthquakes in and adjacent to New England and report felt events to public safety agencies, 2) to define the crust and upper mantle structure of the northeastern United States, 3) to derive the source parameters of New England earthquakes, and 4) to estimate the seismic hazard in the area.

This report summarizes the work of the NESN for the period July - September, 1999. It includes a brief summary of the network's equipment and operation, and a short discussion of data management procedures. A list of participating personnel is given in Table 1. There were 4 earthquakes that occurred within or near the network during this reporting period. Phase information for these earthquakes is included in this report.

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Current Network Operation and Status

The New England Seismic Network currently consists of 13 broadband three-component, 4 short-period vertical, and 8 strong-motion stations. The coordinates of the stations are given in Table 2, and maps of the weak- and strong-motion networks are shown in Figures 1 and 2, respectively.

WES operates 12 stations with broadband instruments consisting of Guralp CMG-40T three-component sensors. Ground motions recorded by these sensors are digitized at 100 sps with 16-bit resolution. Additional gain-ranging provides 126 dB dynamic range. These stations are operated in dialup mode with waveform segments of suspected events transmitted in digital mode to Weston Observatory for analysis and archiving. WES is continuing to upgrade its recording stations with 2 more broadband instruments scheduled for installation in 2000. WES also maintains 8 SMA-1 strong-motion instruments in New England.

ERL at MIT currently operates 4 short-period stations, all located within 100 km of Boston. The short- period instruments have 1.0 Hz L4C vertical seismometers. Data recorded by these seismometers is transmitted continuously in analog mode to ERL and digitized (12-bit) into a PC at 50 sps. A data acquisition program on the PC triggers on events detected in the short-period data streams and saves them to a disk for manual analysis. Station WFM also has a new three-component, high dynamic range instrument. The instrument has a CMG-40T sensor and transmits 3-channel, 24-bit data at 100 sps continuously to a central processor (Pentium PC) at ERL. Waveform windows of suspected events are extracted from the data stream, analyzed and archived with the short-period data. WES and ERL record some stations in analog format on helicorders to provide additional data for analysis.

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Seismicity

There were 4 earthquakes that occurred in or adjacent to the NESN during this reporting period. A summary of the location data is given in Table 3. Figure 3 shows the locations of these events. Figure 4 shows the locations of all events since the beginning of network operation in October, 1975.

Table 4 gives the station phase data and detailed hypocenter data for each event listed in Table 3. In addition to NESN data, arrival time and magnitude data sometimes are contributed for seismic stations operated by the Geological Survey of Canada (GSC), the Lamont-Doherty Cooperative Seismographic Network., and the US National Seismic Network. Final locations for this section were computed using the program HYPO78. For regional events (those too far from the NESN to obtain accurate locations and magnitudes) phase data are given for NESN stations, but the entry in Table 3 lists the hypocenter and geographic location information adopted from the authoritative network. Accordingly, the epicenter is plotted on the maps using the entry from Table 3.

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Data Management

Recent event locations are available via FTP at: SEISMOEAGLE.BC.EDU. Waveform data are saved in Nanometrics, ASCII, and SEED formats and are available via SEISMOEAGLE.BC.EDU or through personal contact. Earthquake lists can be fingered at QUAKE@SEISMOEAGLE.BC.EDU. Weston Observatory maintains two web pages with information about local earthquakes: "http://www.bc.edu:80/bc_org/avp/cas/wesobs/" and "http://seismoeagle.bc.edu/". The latter page is still under contruction. Currently available on the seismoeagle web page is the full catalog of northeastern U.S. earthquake activity to 1992. This will be updated as new Northeastern U.S. Seismic Network Bulletins are produced.

MIT/ERL provides two internet utilities, the MIT/ERL web-site ("www-erl.mit.edu/NESN/homepage.html") and an anonymous FTP directory, to distribute seismic data. SESAME (Seismic Event Server at MIT/ERL) is the web data server that distributes catalogs, reports, earthquake bulletins, and epicenter and station maps (including an archive of recent seismic events). The FTP site, named "sunda.mit.edu", is the current facility available to download waveform data recorded by the MIT NESN. The client machine IP number must be forwarded to us for the client to gain access to the anonymous FTP directory. After logging on, the user changes directories to "pub/seismic". Waveforms of individual events for the period April 1995 through the present are accessed as Unix-compressed SAC files, through the anonymous FTP directory. A "readme" file offers further explanation about the data. Older waveform data in SAC format (1981 - March 1995) will be made available on the FTP site upon request.

For more information on matters discussed in this report or general earthquake information (reports, maps, catalogs, etc.) consult our web-sites www-erl.mit.edu/NESN and www.bc.edu:80/bc_org/avp/cas/wesobs/ or contact:

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Explanation of Tables

Table 1: List of personnel operating the NESN

Table 2: List of Seismic and Strong Motion Stations

1. Code = station name

2. Lat = station latitude, degrees north
3. Long = station longitude, degrees west
4. Elev = station elevation in meters
5. Location = geographic location
6. Operator = network operator

Table 3: Earthquake Hypocenter List

1. Date = date event occurred, Yr (year)/Mo (month)/Dy (day)
2. Time = origin time of event, Hr (hour):Mn (minute):Sec (second)

   in UCT (Universal Coordinated Time, same as Greenwich Mean Time)
3. Lat = event location, latitude north in degrees
4. Long = event location, longitude west in degrees
5. Depth = event depth in kilometers
6. Mag = event magnitude
7. Int = event epicentral intensity
8. Location = event geographic location

Table 4: Earthquake detailed hypocenter and phase data list

Table Header: detailed hypocenter data

1. Geographic location
2. DATE = date event occurred, yr/mo/dy (year/month/day)
3. ORIGIN = event origin time (UCT) in hours, minutes, and seconds
4. LAT N = latitude north in degrees and minutes
5. LONG W = longitude west in degrees and minutes
6. DEPTH = event depth in kilometers
7. MN = Nuttli Lg phase magnitude with amplitude divided by period
8. MC = signal duration (coda) magnitude

   WES: 2.23 Log(FMP) + 0.12Log(Dist) - 2.36 (Rosario, 1979)
   MIT: 2.21 Log(FMP) - 1.7 (Chaplin *et al.*, 1980)

9. ML = local magnitude

   WES: calculated from Wood-Anderson seismograms (Ebel, 1982)
   GSC (Geological Survey of Canada): Richter Lg magnitude

10. GAP = largest azimuthal separation, in degrees, between stations
11. RMS = root mean square error of travel time residual in seconds
12. ERH = standard error of epicenter in kilometers
13. ERZ = standard error of event depth in kilometers
14. Q = solution quality of hypocenter

    A = excellent
    B = good
    C = fair
    D = poor

Table Body: earthquake phase data

1. STN = station name
2. DIST = epicentral distance in kilometers
3. AZM = azimuthal angle in degrees measured clockwise between true north and vector pointing from epicenter to station
4. Description of onset of phase arrival

   I = impulsive
   E = emergent

5. R = phase

   P = first P arrival
   S = first S arrival

6. M = first motion direction of phase arrival

   U = up or compression
   D = down or dilatation

7. K = weight of arrival

   0 = full weight (1.0)
   1 = 0.75 weight
   2 = 0.50 weight
   3 = 0.25 weight
   4 = no weight (0.0)

8. HRMN = hour and minute of phase arrival
9. SEC = second of phase arrival
10. TCAL = calculated travel time of phase in seconds
11. RES = travel time residual (error) of phase arrival
12. WT = weight of phase used in hypocentral solution

13. AMX = peak-to-peak ground motion, in millimicrons, of the maximum envelope amplitude of vertical-component signal, corrected for system response
14. PRX = period in seconds of the signal from which amplitude was measured
15. XMAG = Nuttli magnitude recorded at station
16. FMP = signal duration (coda), in seconds, measured from first P arrival
17. FMAG = coda magnitude recorded at station

Table 5: Microearthquakes and other non-locatable events

1. Date = date event occurred, Yr (year)/Mo (month)/Dy (day)
2. Sta = nearest station recording event
3. Arrival Time = phase arrival time, Hr (hour):Mn (minute):Sec (second)

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TABLE 1

WESTON OBSERVATORY PERSONNEL

Name	Network Position	voice phone	email address
John E. Ebel	Principal Investigator	617-552-8319	ebel@bc.edu
Alan Kafka	Research Seismologist	617-552-8300	kafka@bcvms.bc.edu
Susan O'Connor	Seismic Analyst	617-552-8337	dannolfo@bc.edu
Edward Johnson	Project Engineer	617-552-8332	johnson@bcvms.bc.edu
Patricia Tassia	Administrative Secretary	617-552-8311	tassia@bcvms.bc.edu
W. Richard Ott, S.J.	Assistant to the Director	617-552-8335	ottwi@mail1.bc.edu
		617-552-8300	
Weston Observatory		617-552-8388 (FAX)	

MIT/ERL PERSONNEL

Name	Network Position	voice phone	email address
M. Nafi Toksöz	Principal Investigator	617-253-7852	toksoz@mit.edu
Charles Doll	Research Seismologist	617-253-7863	doll@erl.mit.edu
Charles Doll	Seismic Analyst	617-253-6290	doll@erl.mit.edu
Heather Hooper	Seismic Analyst	617-253-6290	
Sara Brydges	Administrator	617-253-7797	sara@erl.mit.edu
		617-253-8027	
Earth Resources Lab		617-253-6385 (FAX)	

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TABLE 2

SEISMIC STATIONS OF THE NEW ENGLAND SEISMIC NETWORK

Code	Lat	Long	Elev (m)	Location	Operator
BCX	42.3350	-71.1705	61.0	Chestnut Hill, MA	WES
BRY	41.9178	-71.5388	380.0	Smithfield, RI	WES
DNH	43.1225	-70.8948	24.0	Durham, NH	MIT
DXB	42.0610	-70.6992	8.0	Duxbury, MA	MIT
GLO	42.6403	-70.7272	15.2	Gloucester, MA	MIT
HNH	43.7050	-72.2860	180.0	Hanover, NH	WES
MIM	45.2436	-69.0403	140.0	Milo, ME	WES
NH1	43.5473	-71.5743	402.0	Sanbornton, NH	WES
QUA2	42.2789	-72.3525	168.0	Belchertown, MA	WES

TRY	42.7311	-73.6669	131.0	Troy, NY	WES
VT1	44.3317	-72.7536	410.0	Waterbury, VT	WES
WES	42.3850	-71.3220	60.0	Weston, MA	WES
WFM	42.6106	-71.4906	87.5	Westford, MA	MIT
WVL	44.5648	-69.6575	85.0	Waterville, ME	WES
YLE	41.3100	-72.9269	914.0	New Haven, CT	WES
PQI	46.6710	-68.0168	175.0	Presque Isle, ME	WES

STRONG MOTION STATIONS OF THE NEW ENGLAND SEISMIC NETWORK

Code	Lat	Long	Location	Operator
SM1	44.90	-67.25	Dennysville, ME	WES
SM2	44.49	-73.10	Essex Junction, VT	WES
SM3	41.45	-71.33	Newport, RI	WES
SM4	42.38	-71.32	Weston, MA	WES
SM5	42.66	-71.30	Lowell, MA	WES
SM6	42.30	-71.34	Natick, MA	WES
SM7	42.39	-71.54	Hudson, MA	WES
SM8	44.48	-69.61	North Vassalboro, ME	WES

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TABLE 3

EARTHQUAKE HYPOCENTER LIST

NEW ENGLAND AND ADJACENT REGIONS

July - September, 1999

Date	Time	Lat	Long	Depth	Mag	Int	Location
Yr/Mo/Dy	Hr:Mn:Sec			(km)			
1999/07/16	14:55:38.31	47.4773	-65.9913	9.91	2.8		NB, BATHURST
1999/07/27	12:23:06.69	46.5110	-68.9118	5.00	2.7		ME, 73 KM WSW OF PRESQUE ISLE
1999/09/10	13:41:45.58	47.0638	-66.0815	14.99	3.0		NB, MIRAMICHI
1999/09/28	18:47:18.40	46.9878	-66.5636	16.08	2.8		NB, MIRAMICHI

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TABLE 4

EARTHQUAKE PHASE DATA LIST
NEW ENGLAND AND ADJACENT REGIONS
July - September, 1999

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NORTHWEST MAINE CRUSTAL STRUCTURE

99JUL16 NB, BATHURST

 DATE     ORIGIN    LAT N     LONG W    DEPTH    MN  MC  ML GAP   RMS   ERH   ERZ Q

990716 1455 38.31 47-28.64  65-59.48    9.91  2.8          163  0.39  1.8   3.5 C

 STN   DIST AZM   RMK HRMN    SEC    TOBS    TCAL    RES    WT AMX PRX XMAG FMP FMAG

 GSQ 180.1 332   P 2 1456   7.25   28.94   28.20   0.73 1.19

 LMN 202.2 153   P 3 1456   8.32   30.01   30.92  -0.91 0.56

                 S 0 1456  33.40   55.09   55.05   0.05 2.35
```

```
 CNQ 254.9 323   P 0 1456 15.75  37.44  37.43 -0.02 2.00
                 S 3 1456 41.89  63.58  66.63 -3.10 0.00
 A21 279.3 275   P 2 1456 19.19  40.88  40.44  0.44 0.91
 A64 295.3 278   P 0 1456 20.51  42.20  42.42 -0.24 1.72
                 S 4 1456 47.58  69.27  75.51 -6.27 0.00
 A16 302.8 270   P 3 1456 22.78  44.47  43.35  1.13 0.34
                 S 3 1456 55.59  77.28  77.16  0.12 0.42
 A61 309.3 274   P 0 1456 22.27  43.96  44.15 -0.20 1.63
 SMQ 309.7 350   P 0 1456 22.46  44.15  44.20 -0.11 1.63
                 S 2 1456 56.77  78.46  78.68 -0.33 0.81
 A11 318.6 265   P 0 1456 23.23  44.92  45.30 -0.39 1.57
 LMQ 326.8 271   P 1 1456 24.65  46.34  46.31 -0.03 1.13
                 S 3 1456 60.78  82.47  82.42 -0.08 0.38
 A54 333.2 270   P 2 1456 26.02  47.71  47.10  0.56 0.71
 MIM 341.5 223 IPD2 1456 27.16  48.85  48.13  0.71 0.68  34 .18  2.7
                 S 4 1456 76.34  98.03  85.67 12.33 0.00
 MNQ 395.7 329   P 4 1456 30.54  52.23  54.82 -2.59 0.00
                 S 3 1456 75.62  97.31  97.58 -0.27 0.26
 WVL 434.0 221 IPD1 1456 37.48  59.17  59.55 -0.39 0.59  39 .26  2.9
 DPQ 522.7 260   P 1 1456 49.03  70.72  70.50  0.22 0.14


SOUTHEAST MAINE CRUSTAL MODEL
99JUL27 ME, 73KM WSW OF PRESQUE ISLE

 DATE     ORIGIN    LAT N    LONG W   DEPTH   MN  MC  ML GAP   RMS  ERH  ERZ Q
990727 1223  6.69 46-30.66  68-54.71   5.00  2.7          98  0.38  4.0  6.3 C

 STN  DIST AZM  RMK HRMN   SEC   TOBS   TCAL   RES   WT AMX PRX XMAG FMP FMAG
 A11 127.3 310   S 4 1223 39.92  33.23  36.43 -3.21 0.00
 MIM 141.2 184 IPD0 1223 29.32  22.63  22.67 -0.06 2.43 207 .14  2.8
                 S 4 1223 46.05  39.36  40.35 -1.02 0.00
 WVL 228.0 195 IPD3 1223 42.24  35.55  33.91  1.64 0.09  61 .20  2.6
                 S 4 1223 65.31  58.62  60.35 -1.75 0.00
 MOQ 291.6 243   P 1 1223 48.32  41.63  41.77 -0.27 1.14
                 S 4 1223 78.82  72.13  74.34 -2.46 0.00
 DPQ 296.8 274   P 1 1223 48.64  41.95  42.41 -0.45 1.09
                 S 4 1223 80.17  73.48  75.48 -2.00 0.00
 GSQ 299.5  27   P 3 1223 50.74  44.05  42.73  1.31 0.21
                 S 4 1223 81.52  74.83  76.07 -1.25 0.00
 CNQ 316.6  11   P 1 1223 51.98  45.29  44.85  0.41 1.03
                 S 4 1223 84.55  77.86  79.83 -2.02 0.00
 LMN 325.3 103   P 2 1223 52.33  45.64  45.92 -0.28 0.66
                 S 4 1223 88.65  81.96  81.74  0.22 0.00
LBNH 345.5 223   P 0 1223 55.54  48.85  48.42  0.37 1.21
                 S 4 1223 92.76  86.07  86.19 -0.23 0.00
 ICQ 356.4  20   P 0 1223 56.32  49.63  49.77 -0.14 1.15
 DNH 408.0 203   S 4 1224 43.90  97.21  99.91 -2.70 0.00
 GLO 453.7 199  ES 4 1224 54.10 107.41 109.95 -2.54 0.00
 WFM 479.4 205  ES 4 1224 60.80 114.11 115.61 -1.51 0.00
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NORTHWEST MAINE CRUSTAL STRUCTURE

99SEP10 NB, MIRAMICHI

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q
990910	1341 45.58	47- 3.83	66- 4.89	14.99	3.0	3.1		232	0.34	3.7	4.4	C

STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
PQI	153.8	254	IPC0	1342	10.03	24.45	24.45	-0.02	2.11					
			S 1	1342	29.57	43.99	43.52	0.42	1.53					
GSQ	219.6	340	EP 3	1342	19.14	33.56	32.57	0.98	0.23					
			S 1	1342	43.35	57.77	57.98	-0.22	1.41					
A21	281.5	285	P 4	1342	23.76	38.18	40.22	-2.03	0.00					
			S 1	1342	56.96	71.38	71.58	-0.20	1.24					
CNQ	289.6	329	P 1	1342	26.56	40.98	41.22	-0.26	1.21					
			S 1	1342	58.86	73.28	73.37	-0.13	1.22					
A64	299.8	286	P 1	1342	28.44	42.86	42.48	0.37	1.16					
			S 1	1342	60.86	75.28	75.61	-0.36	1.17					
A16	300.5	279	P 0	1342	27.99	42.41	42.56	-0.14	1.59					
MIM	305.1	228	EPC3	1342	27.63	42.05	43.13	-1.09	0.14	55	.16	2.9	175	3.1
			S 4	1342	71.88	86.30	76.77	9.50	0.00					
A11	312.5	274	P 4	1342	30.69	45.11	44.05	1.06	0.00					
LMQ	325.6	280	P 1	1342	31.55	45.97	45.65	0.25	1.12					
SMQ	354.3	353	P 0	1342	34.85	49.27	49.19	0.02	1.40					
			S 1	1342	73.89	88.31	87.56	0.64	0.92					
WVL	396.3	225	EPC2	1342	38.96	53.38	54.38	-1.00	0.31	41	.21	2.9		
			S 4	1342	94.88	109.30	96.79	12.49	0.00					
DAQ	401.6	284	P 1	1342	41.09	55.51	55.03	0.32	0.92					
MNQ	433.1	333	P 2	1342	43.90	58.32	58.93	-0.61	0.51					
			S 1	1342	90.26	104.68	104.90	-0.21	0.84					
DPQ	512.0	265	P 1	1342	54.54	68.96	68.67	0.29	0.63					
NH1	581.7	228	EPC4	1343	10.31	84.73	77.27	7.46	0.00	38	.27	3.2		
			S 4	1343	84.02	158.44	137.54	20.90	0.00					
HNH	612.6	232	S 4	1343	95.85	170.27	144.34	25.88	0.00	58	.46	3.1		
GLO	613.5	217	ES 4	1343	98.00	172.42	144.52	27.90	0.00					
WFM	654.3	221	EP 4	1343	32.10	106.52	86.24	20.28	0.00					
TRQ	656.1	262	P 0	1342	72.03	86.45	86.45	0.00	0.33					
			S 4	1342	77.38	91.80	153.89	-62.08	0.00					

NORTHWEST MAINE CRUSTAL STRUCTURE

99SEP28 NB, MIRAMICHI

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q
990928	1847 18.40	46-59.27	66-33.82	16.08	2.8	3.0		144	0.35	1.9	2.1	C

STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
PQI	116.4	252	EPC0	1847	37.37	18.97	18.87	0.07	2.16				131	2.7
			S 4	1847	49.81	31.41	33.58	-2.23	0.00					
LMN	185.0	133	P 0	1847	46.60	28.20	28.18	0.02	1.89					
GSQ	218.0	349	P 1	1847	51.13	32.73	32.27	0.45	1.29					
A21	249.5	289	P 1	1847	54.31	35.91	36.15	-0.24	1.22					
A16	266.5	282	P 1	1847	56.36	37.96	38.26	-0.30	1.15					

```
A64 267.9 290   P 4 1847 85.79  67.39  38.43 28.94 0.00
MIM 272.5 225 EPC3 1847 58.50  40.10  38.99  1.09 0.26  71 .18  2.8 222  3.3
                S 4 1847 93.53  75.13  69.41  5.69 0.00
A11 277.3 276   P 3 1847 59.01  40.61  39.59  1.01 0.29
A61 278.1 286   P 2 1847 57.36  38.96  39.68 -0.73 0.67
CNQ 280.9 336   P 1 1847 58.17  39.77  40.02 -0.28 1.11
                S 3 1847 91.67  73.27  71.24  1.97 0.00
ICQ 286.6 349   P 0 1847 59.46  41.06  40.73  0.32 1.46
LMQ 291.3 282   P 0 1847 60.05  41.65  41.32  0.26 1.45
                S 1 1847 91.93  73.53  73.55 -0.14 1.09
A54 296.3 280   P 1 1847 60.15  41.75  41.93 -0.24 1.06
                S 1 1847 93.45  75.05  74.64  0.31 1.06
WVL 364.5 221 EPC4 1848 16.34  57.94  50.35  7.58 0.00  24 .17  2.7
                S 4 1848 59.06 100.66  89.61 11.03 0.00
DAQ 368.9 287   P 1 1847 69.30  50.90  50.89 -0.15 0.86
MNQ 426.0 338   P 2 1848 15.81  57.41  57.94 -0.53 0.44
                S 3 1848 59.87 101.47 103.13 -1.66 0.01
DPQ 475.6 266   P 1 1848 21.95  63.55  64.07 -0.52 0.51
                S 4 1848 69.81 111.41 114.04 -2.63 0.00
NH1 548.3 226 EPC4 1848 57.34  98.94  73.04 25.90 0.00  19 .20  3.0
HNH 578.4 231                                          25 .36  2.8
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TABLE 5

MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

Date	Sta	Arrival Time
Yr/Mo/Dy		Hr:Mn:Sec
99/07/29	MIM	12:54:49.50
99/07/29	PQI	12:54:27.92
99/07/29	WVL	12:55:01.60

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NESN Station Map

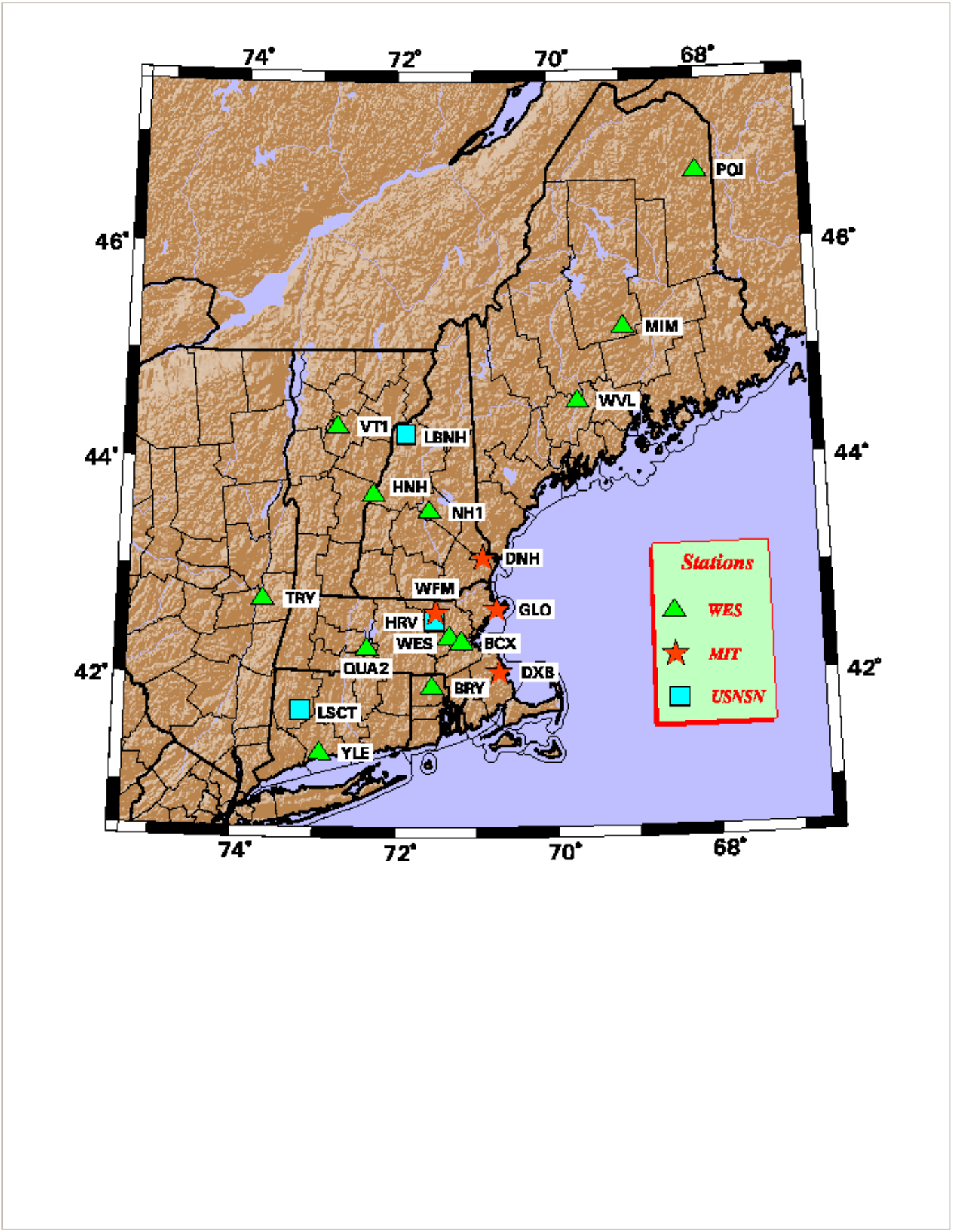

Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period July - September, 1999. Also included are the US National Seismic Network stations operating in New England during this period.

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NESN Strong-Motion Station Map

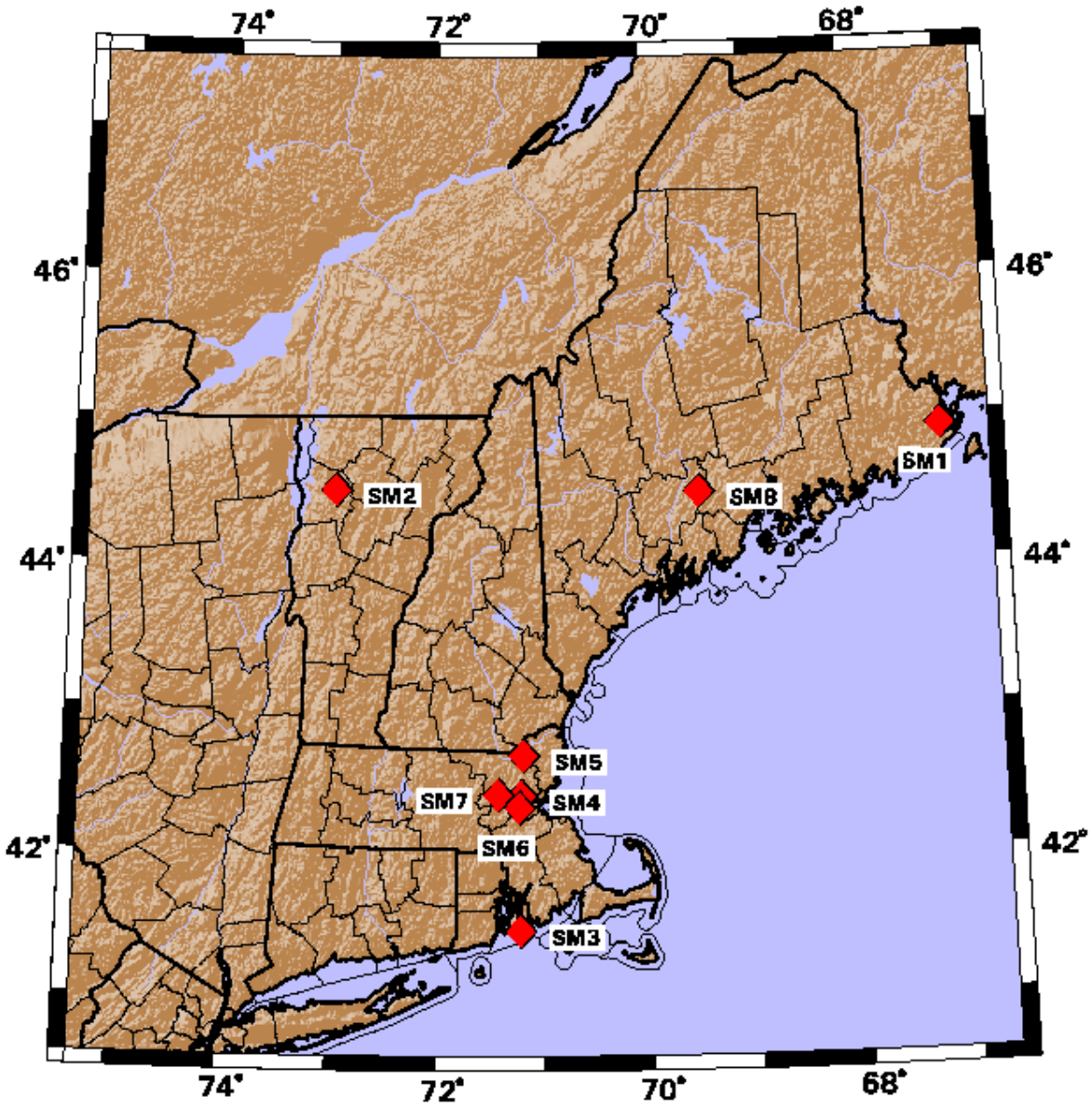

Figure 2: Map of strong-motion stations of the New England Seismic Network (NESN) in operation during period July - September, 1999.

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NESN Quarterly Seismicity Map

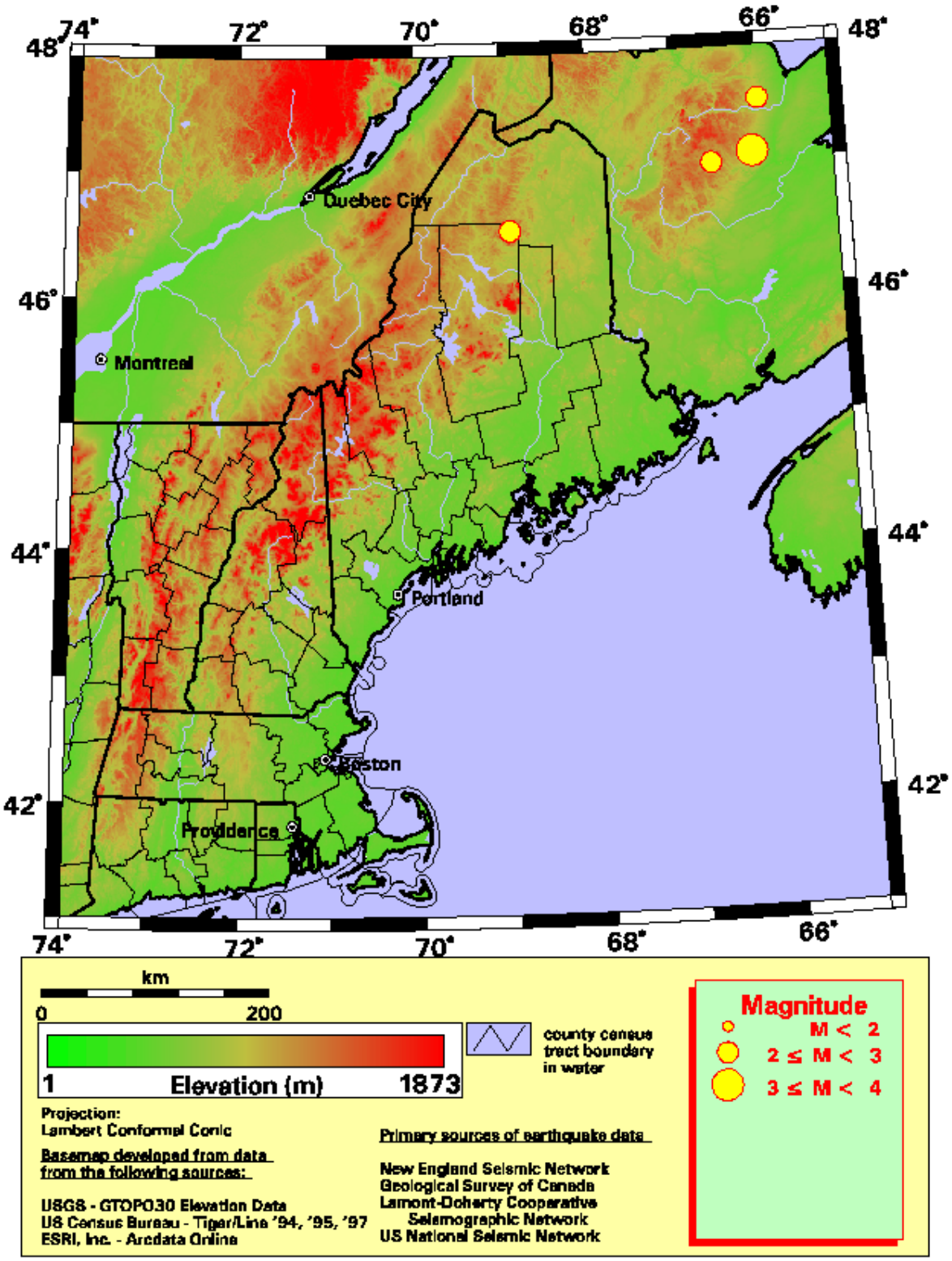

Figure 3: Earthquake epicenters located by the NESN during period July - September, 1999.

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NESN Cumulative Seismicity Map

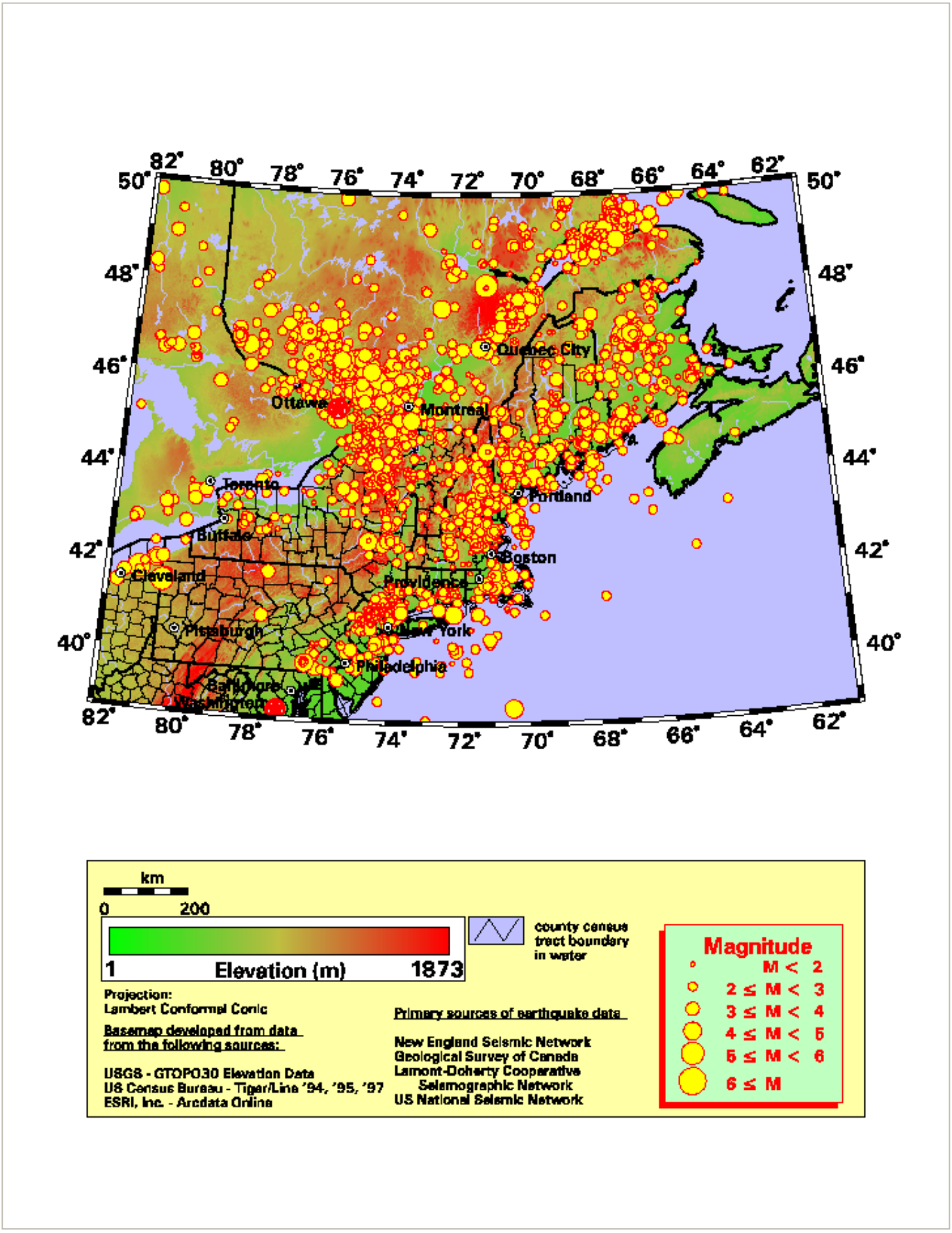

Figure 4: Seismicity for period October, 1975 - September, 1999.

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