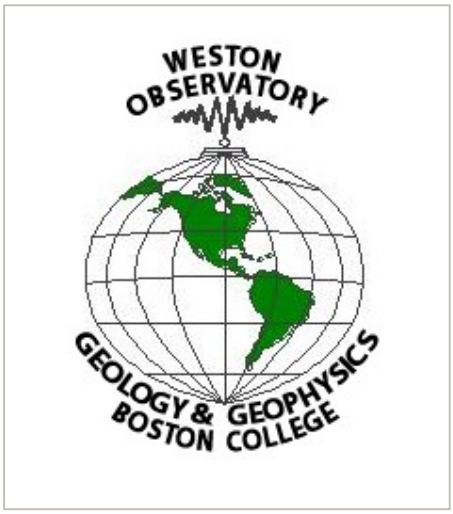
A STUDY OF NEW ENGLAND SEISMICITY

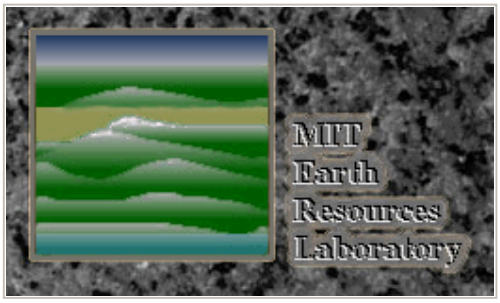
Quarterly Earthquake Report

April - June 1998

New England

Seismic Network





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NEW ENGLAND SEISMIC NETWORK

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for

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Notice

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Quarterly Earthquake Report

April - June 1998

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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 April - June 1998. 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 3 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 11 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 11 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 4 more broadband instruments scheduled for installation in 1999. 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. Personnel at ERL are in the process of installing a new three-component, high dynamic range instrument at Station WFM. 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. WES and ERL record some stations in analog format on helicorders to provide additional data for analysis.

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Seismicity

There were 3 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 header lists the hypocenter and geographic location information adopted from the authoritative network.

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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 earthquake activity to 1991. This will be updated as new Northeastern U.S. Seismic Network Bulletins are produced.

The entire MIT/ERL earthquake database can be accessed through the World Wide Web using the address "http://www-erl.mit.edu/NESN/homepage.html". For extraction of waveforms (recorded by the MIT stations of the NESN through March 1995) and hypocenter data, use our database search engine. Link to "Seismic Event Server at MIT ERL (SESAME)" and then click on "Interactive query form" under the heading "Custom Materials". Alternatively, the more recent local earthquake data, recorded by the MIT stations, may be accessed by logging in to our anonymous FTP directory ("ftp sunda.mit.edu"). To be added to the list of users permitted to access this FTP directory, contact Charles Doll. The waveform files are in SAC format at both sites. Waveforms are downloaded as a Unix-compressed tar volume from our web-site and as individual, Unix-compressed, station files from our FTP site.

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@bcvms.bc.edu
Alan Kafka	Research Seismologist	617-552-8300	kafka@bcvms.bc.edu
Susan O'Connor	Seismic Analyst	617-552-8337	dannolfo@bcvms.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	nafi@erl.mit.edu
Charles Doll	Research Seismologist	617-253-7863	doll@erl.mit.edu
Charles Doll	Seismic Analyst	617-253-6290	doll@erl.mit.edu
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

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

April - June 1998

Date	Time	Lat	Long	Depth	Mag	Int	Location
Yr/Mo/Dy	Hr:Mn:Sec			(km)			
1998/04/18	16:22:52.05	45.574	-74.904	5.00	3.4		Ontario, Eastern
1998/06/07	11:52:06.67	46.690	-69.004	6.02	1.9*		Me, 75 km W of Presque Isle
1998/06/09	08:53:52.12	44.809	-73.683	0.92	2.9		NY, SW of Plattsburgh

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TABLE 4

EARTHQUAKE PHASE DATA LIST
NEW ENGLAND AND ADJACENT REGIONS
April - June 1998

```
  NORTHWEST MAINE CRUSTAL STRUCTURE
  ONT, EASTERN

  DATE     ORIGIN    LAT N    LONG W   DEPTH   MN  MC  ML GAP   RMS  ERH  ERZ Q
  980418 1622 52.05 45-34.43  74-54.23  5.00   3.4 3.5     116  0.44  2.3 5.2 C

STN  DIST AZM  RMK HRMN   SEC   TOBS   TCAL   RES   WT AMX PRX XMAG FMP FMAG
MSNY  64.0 177 IPC1 1622 63.11  11.06  10.49  0.55 1.29
               S 0 1622 70.80  18.75  18.68  0.05 1.79
PTN 111.5 183  EP 0 1622  70.16  18.11  18.02  0.05 1.69
               S 1 1622 83.28  31.23  32.08 -0.92 1.07
PNY 134.1 128  EPD0 1622 73.59  21.54  21.62 -0.11 1.63
               S 1 1622 90.11  38.06  38.48 -0.48 1.20
FLET 180.4 122 EPD0 1622 81.12  29.07  28.74  0.33 1.51
HBVT 197.9 133 EPD01622 83.24  31.19  30.89  0.24 1.49
MIV 199.0 147  EPD0 1622 83.24  31.19  31.03  0.16 1.49
```

```
MOQ 209.5  98  P 2 1623 25.55  33.50  32.32  1.03 0.53
EEO 343.5 290  P 2 1623 39.54  47.49  48.87 -1.39 0.21
DAQ 385.7  46  P 0 1623 46.24  54.19  54.08 - 0.05 1.06
LMQ 413.8  58  P 0 1623 49.30  57.25  57.54 -0.37 0.99
               S 4 1623 97.77 105.72 102.43  3.16 0.00
DNH 420.2 130  P 4 1623 63.40  71.35  58.33 13.01 0.00  230  3.5
WFM 427.9 140  EP 4 1623 57.50  65.45  59.29  6.14 0.00  259  3.6
A61 437.7  57  P 0 1623 52.48  60.43  60.49 -0.08 0.94
               S 4 1623 96.51 104.46 107.68 -3.24 0.00
WES 456.2 141  EPC4 1623 65.71  73.66  62.78 10.86 0.00 177 .43  3.4   0  3.4
A64 458.0  57  P 4 1623 50.0157.96  63.00 -5.07 0.00
A21 464.4  59  P 1 1623 56.38  64.33  63.80  0.53 0.64
CNQ 661.5  51  P 2 1623 78.87  86.82  88.13 -1.34 0.09
ICQ 723.5  53  P 0 1623 87.38  95.33  95.78 -0.46 0.28
LMN 787.1  88  P 1 1623 95.02102.97 103.63 -0.67 0.10

NORTHWEST MAINE CRUSTAL STRUCTURE
98JUN07 ME, 75 KM W OF PRESQUE ISLE
DATE     ORIGIN    LAT N    LONG W   DEPTH   MN  MC  ML GAP   RMS  ERH  ERZ Q
980607 1152  6.67 46-41.37  69- 0.21   6.02  1.9*        104  0.13  3.0 6.3 C
STN  DIST AZM  RMK HRMN   SEC   TOBS   TCAL   RES   WT AMX PRX XMAG FMP FMAG
MIM 160.7 181 EPC1 1152 32.61  25.94  25.82  0.10 1.20
               S 0 1152 52.55  45.88  45.95 -0.11 1.60
DPQ 288.6 270  P 0 1152 48.75  42.08  41.99  0.09 1.08
CNQ 298.7  13  P 1 1152 49.74  43.07  43.23 -0.19 0.73
               S 4 1152 79.64  72.97  76.94 -4.02 0.00
LMN 336.5 106  P 2 1152 54.80  48.13  47.90  0.23 0.39
               S 4 1152 90.27  83.60  85.26 -1.66 0.00
ICQ 340.3  22  S 4 1152 96.44  89.77  86.09  3.66 0.00
TRQ 429.3 263  S 4 1152 60.87  54.20 105.66-51.46 0.00

NORTHERN NY AND ADIRONDACKS
98JUN09 NY, SW OF PLATSBURGH
DATE     ORIGIN    LAT N    LONGW   DEPTH   MN  MC  ML GAP RMS  ERH  ERZ Q
980609  853 52.12 44-48.53  73-40.99   0.92  2.9 3.0     210  0.79  3.3  3.4 D

STN  DIST AZM  RMK HRMN   SEC   TOBS   TCAL   RES   WT AMX PRX XMAG FMP FMAG
VT1  90.9 126  EPC0  854  6.84  14.72  14.21  0.48 2.87 647 .12  3.1 125 2.7
                S 2  854 16.40  24.28  25.30 -1.06 1.38
HNH 165.8 138  IPC2  854 17.20  25.08  25.56 -0.51 1.26
                S 3  854 35.97  43.85  45.49 -1.70 0.54
NH1 219.2 130  EPC0  854 25.57  33.45  33.28  0.17 2.31
               ES 0 854 51.87  59.75  59.23  0.52 2.31
TRY 230.9 180  IPC1  854 26.35  34.23  34.71 -0.49 1.68 155 .22  3.0 180  3.1
               IS 3  854 52.52  60.40  61.79 -1.39 0.52
DNH 291.8 130  EP 1  854 33.80  41.68  42.23 -0.55 1.48 154  3.0
               S 0  854 67.60  75.48  75.17  0.31 2.00
QUA2 301.0 159 EPC2  854 34.38  42.26  43.37 -1.15 0.94
                  ES 2  854 71.47  79.35  77.20  2.09 0.71
WFM 301.5 144  EP 3  854 33.97  41.85  43.43 -1.60 0.43 139  3.0
               S 4  854 80.36  88.24  77.31 10.91 0.00
WES 330.0 145  EPD2  854 38.50  46.38  46.95 -0.58 0.91  38 .23  2.6 150  3.1
               S 4  854 80.12  88.00  83.57  4.41 0.00
BCX 341.7 144 EPD4  854 47.00  54.88 48.39  6.49 0.00
               S 3  854 81.72  89.60  86.13  3.47 0.01
BRY 365.1 152 EPD0  854 43.53  51.41  51.29  0.12 1.68
               S 1  854 83.39  91.27  91.29 -0.03 1.26
MIM 369.3  82 IPD1  854 43.48  51.36  51.80 -0.46 1.24
               S 4  854 92.22 100.10 92.20  7.86 0.00
A11 382.2  45  S 3  854 84.78  92.66  95.04 -2.40 0.17
A54 388.0  41  P 0  854 46.44  54.32  54.12  0.14 1.58
               S 0  854 88.44  96.32  96.33 -0.12 1.58
DXB 389.4 142 EP 4  854 55.80  63.68 54.28  9.39 0.00
               S 2  854 91.30  99.18  96.62  2.55 0.34
LMQ 399.8  40  P 1  854 48.27  56.15  55.57  0.51 1.14
                S 3  854 89.00  96.88  98.91 -2.16 0.24
A16 409.9  44  P 1  854 49.47  57.35  56.82  0.53 1.11
               S 3  854 91.20 99.08 101.13 -2.06 0.25
A61 423.6  41  P 2  854 51.72  59.60  58.50  1.09 0.69
               S 0  854 96.34 104.22 104.13  0.07 1.42
A64 444.9  41  P 0  854 53.53  61.41  61.13  0.26 1.33
A21 445.2  44  P 2  854 54.92 62.80  61.17  1.63 0.59
CNQ 656.4  40  P 0  854 79.33  87.21  87.24 -0.07 0.41
GSQ 677.6  48  P 1  854 82.71  90.59  89.86  0.71 0.23
LMN 705.9  81  P 0  854 85.40  93.28  93.36 -0.08 0.19
ICQ 714.5  43  P 0  854 86.79  94.67  94.42  0.24 0.15
MNQ 735.3  30  P 0  854 88.98  96.86  96.99 -0.13 0.06
```

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TABLE 5

MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

Date	Sta	Arrival Time
Yr/Mo/Dy		Hr:Mn:Sec

None recorded this quarter

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NESN Station Map

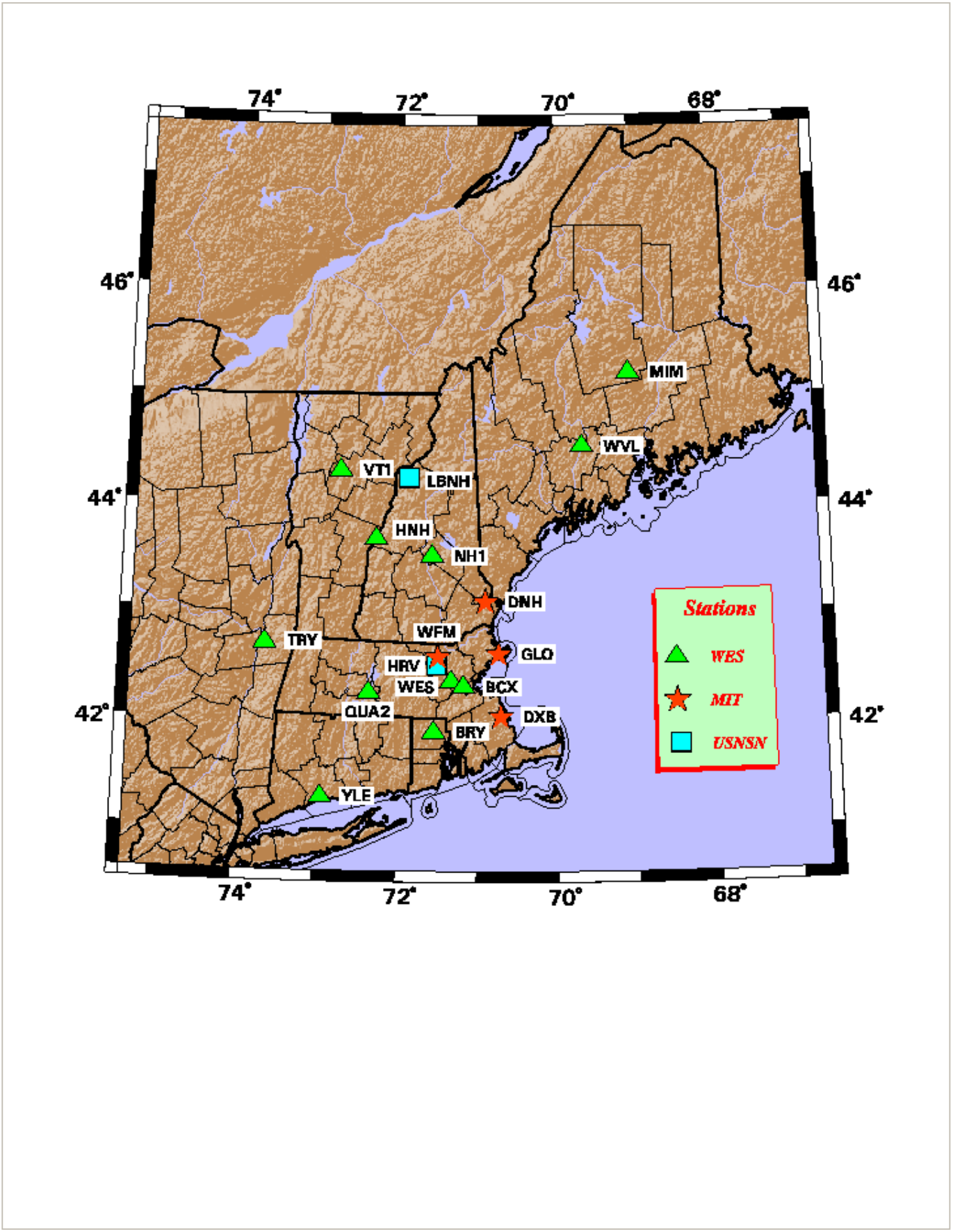

Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period April - June, 1998. Also included are the US National Seismic Network stations operating in New England during this period.

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NESN Strong-Motion Station Map

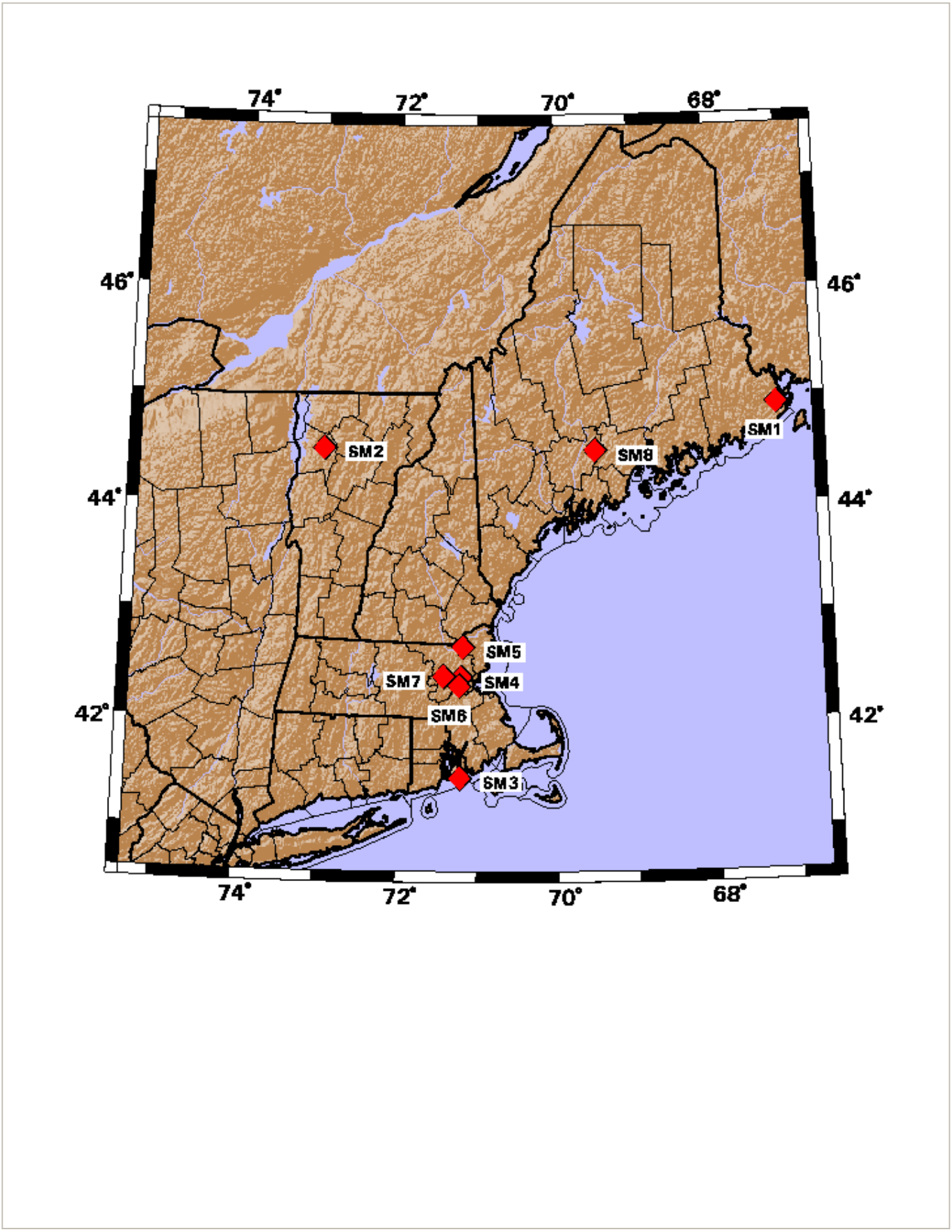

Figure 2: Map of strong-motion stations of the New England Seismic Network (NESN) in operation during period April - June, 1998.

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NESN Quarterly Seismicity Map

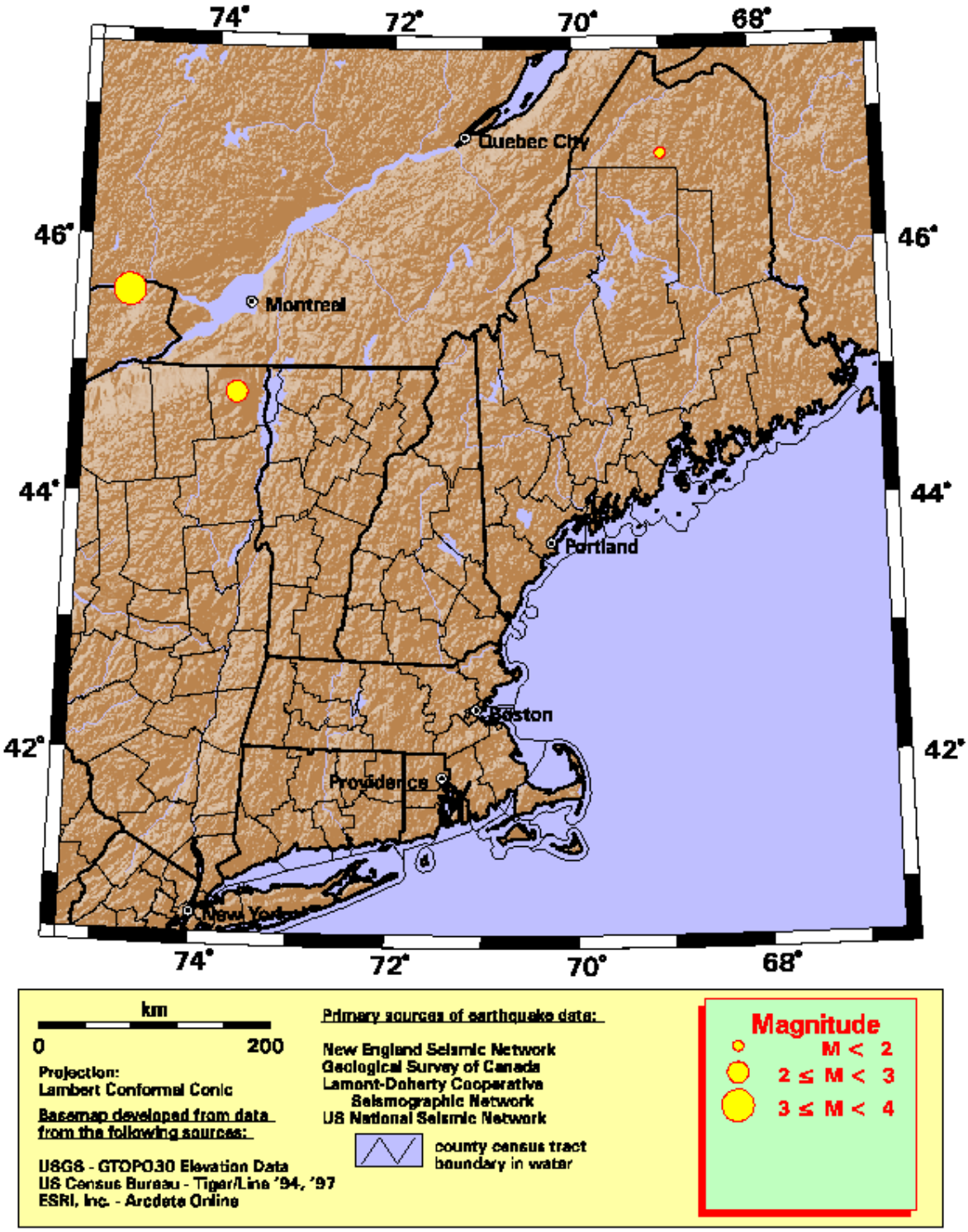

Figure 3: Earthquake epicenters located by the NESN during period April - June, 1998.

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NESN Cumulative Seismicity Map

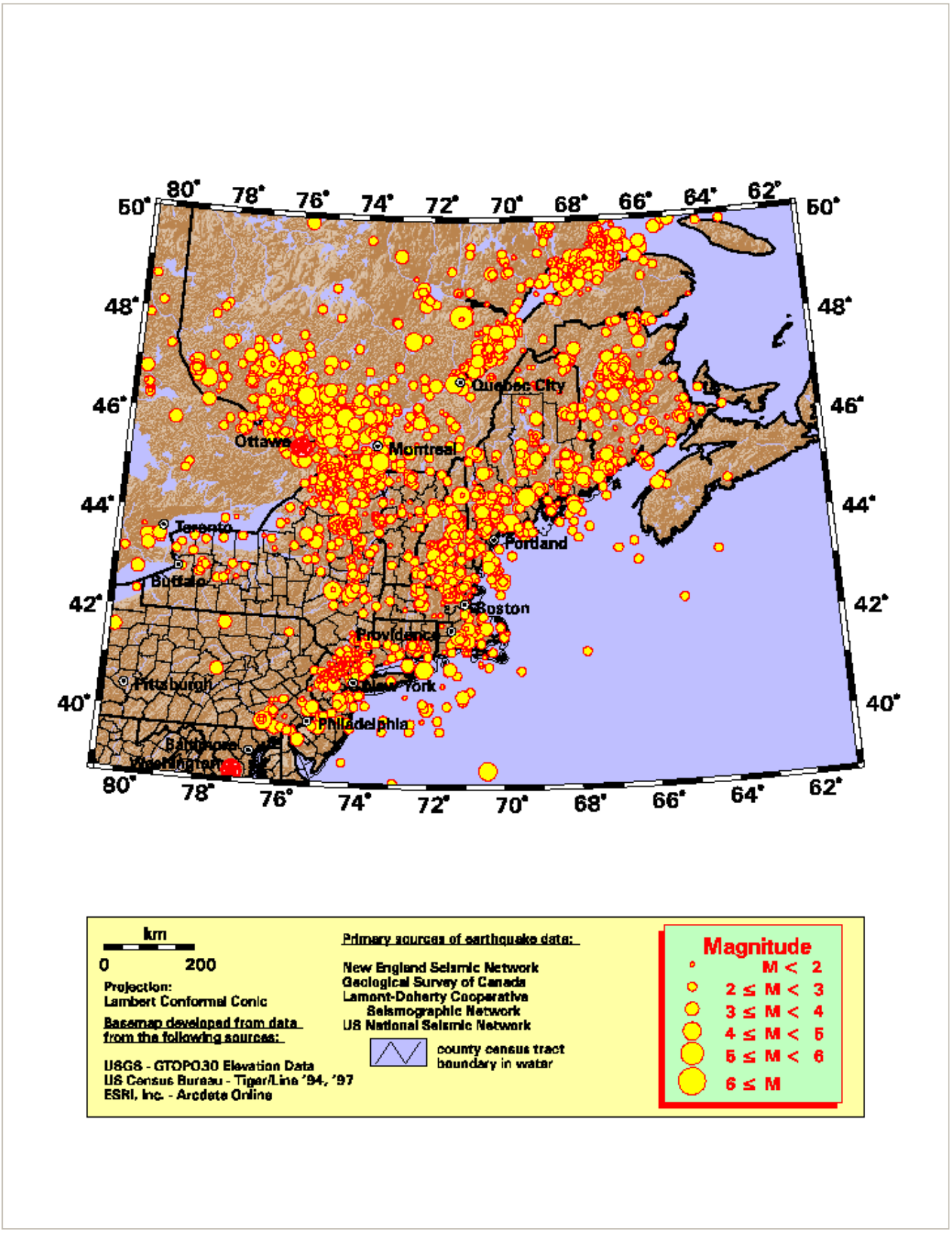

Figure 4: Seismicity for period October, 1975 - June, 1998.

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Acknowledgments

We would like to thank the Undergraduate Research Opportunities Program (UROP) of MIT for its support to the network. Our map database has been developed in-house using ARCINFO and in part basemap data provided by ESRI, Inc. (Arcdata Online), USGS GTOPO30 Elevation Data, and TIGER/Line '94 and '97 (US Census Bureau) spatial data.

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