A STUDY OF NEW ENGLAND SEISMICITY

Quarterly Earthquake Report

January - March, 2003

New England
Seismic Network

Weston Observatory
381 Concord Road
Weston, MA 02493

Earth Resources Lab
Massachusetts Institute of Technology
42 C arleton Street
Cambridge, MA 02142

NEW ENGLAND SEISMIC NETWORK

John E. Ebel, Principal Investigator
Weston Observator y

M. Nafi Toksöz, Principal Investigator
Earth Resources Lab

Dept. of Geology and Geophysics
Boston College
381 Concord Road
Weston, MA 02493
Email: ebel@bc.edu
Award # 1434-HQ-98-AG-01943

Dept. of Earth, A tmospheric, and Planetary Sciences
Massachusetts Institute of Technology
42 Carleton Street
Cambridge, MA 02142
Email: toksoz@mit.edu
Award # 1434-HQ-98-AG-01926

Prepared by Anastasia Macherides Moulis
Email: macherid@bc.edu< br> July, 2003

for
United States Geological Survey
905 National Center
12201 Sunrise Valley Drive
Reston, Virginia 20192

Notice

Network operation supported by the U.S. Geological Survey (USGS), Department of the Interior, under USGS award number 1434-HQ-98-AG-01943 and award number 1434-HQ-98-AG-01926. Theviews and conclusions contained in this document are those of the authors andshould not be interpreted as necessarily representing the official policies,either expressed or implied, of the U.S. Government.

Quarterly Earthquake Report
January - March, 2003

Table of Contents

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 ofthe 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 ofthe NESN for the period January - March, 2003. 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.

Return to Table of Contents

Current Network Operation and Status

The New England Seismic Network currently consists of 14 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 now operates 13 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. During the year 2001, two new seismic stations were added to the WES network. Station UMM was placed in northeastern Maine and station FFD was placed in central New Hampshire. Station MIM, in central Maine was dismantled. 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 sensorand 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.

Return to Table of Contents

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.

Return to Table of Contents

Data Management

Recent event locations are available at www.bc.edu/westonobservatory. Waveform data are saved in Nanometrics, ASCII, and SEED formats and are available through personal contact, Anastasia Macherides Moulis, via email at macherid@bc.edu. Earthquake lists can be found at www.bc.edu/westonobservatory. Currently available on the Weston Observatory web page is the full catalog of northeastern U.S. earthquake activity to 2003. This will be updated as new Northeastern U.S. Seismic Network Quarterly Earthquake Reports 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/westonobservatory or contact:

Robert Cicerone
MITEarth Resources Lab
42 Carleton Street
Cambridge, MA 02142

Voice: 617-253-7863 / FAX: 617-253-6385 / Email: cicerone@erl.mit.edu

Prof. John Ebe l
Weston Observatory
381 Concord Road
Weston, MA 02493

Voice: 617-552-8319 / FAX: 617-552-8388 / Email: ebel@bc.edu

Return to Table of Contents Return to Table of Contents

Explanation of Tables

Table 1: List of personnel operating the NESN

Table 2: List of Seismic and Strong Motion Stations

1. Code = st ation 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. D ate = 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< p>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 se paration, 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 arr ival

   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 arriva l
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 = sign al 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 = neares t station recording event
3. Arrival Time = phase arrival time, Hr (hour):Mn (minute):Sec (second)

Return to Table of Contents

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@bc.edu
Anastasia Macherides Moulis	Seismic Analyst	617-552-8325	macherid@bc.edu
Edward Johnson	Project Engineer	617-552-8332	johnson@bc.edu
Patricia Tassia	Administrative Secretary	617-552-8311	tassia@bc.edu
Dina Smith	Assistant to the Director	617-552-8335	dina.smith.1@bc.edu
Weston Observatory		617-552-8300 617-552-8388 (FAX)	

MIT/ERL PERSONNEL

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

Return to Table of Contents

TABLE 4

EARTHQUAKE PHASE DATA LIST
NEW ENGLAND AND ADJACENT REGIONS
January - March, 2003

```
NORTHWEST MAINE CRUSTAL STRUCTURE
03FEB09 24 KM E OF MONT-LAURIER QUEBEC, CANADA
 DATE     ORIGIN     LAT N     LONG W    DEPTH    MN  MC  ML GAP    RMS  ERH  ERZ Q
 30209 1618  3.08 46-39.00   75-13.94   21.19  3.0  .0      154    .51  1.9  3.6 D
 STN   DIST AZM  RMK HRMN    SEC    TOBS    TCAL    RES    WT AMX PRX XMAG FMP FMAG
CRLO 178.9 248 EP 0 1618 30.21   27.13   26.94    .17 2.15
 WBO 183.4 181 EP 0 1618 30.42   27.34   27.49   -.15 2.13
MSNY 185.8 171 EP 3 1618 29.87   26.79   27.79 -1.00  .53
 DPQ 187.8  89 EP 0 1618 30.99   27.91   28.03   -.12 2.10
               ES 0 1618 53.52   50.44   49.89    .55 2.10
 PTN 231.7 175 EP 0 1618 37.00   33.92   33.45    .44 1.85
VLDQ 233.5 314 EP 4 1618 41.10   38.02   33.68  4.33  .00
 MOQ 274.5 123 EP 0 1618 42.23   39.15   38.73    .28 1.60
               ES 0 1618 72.07   68.99   68.94   -.20 1.60
KGNO 286.8 200 EP 1 1618 43.93   40.85   40.25    .59 1.15
               ES 0 1618 74.58   71.50   71.65   -.16 1.53
 EEO 294.3 270 EP 3 1618 45.74   42.66   41.18   1.41  .37
               ES 2 1618 75.88   72.80   73.30   -.62  .74
 QCQ 302.6  87 EP 2 1618 44.53   41.45   42.21   -.77  .72
 NCB 308.1 165 EP 0 1618 45.67   42.59   42.88   -.38 1.40
 MIV 315.8 155 EP 3 1618 46.06   42.98   43.83   -.89  .34
 DAQ 335.3  64 EP 4 1618 52.51   49.43   46.24   3.04  .00
               ES 3 1618 87.99   84.91   82.30   2.33  .31
SADO 369.3 236 EP 1 1618 53.20   50.12   50.44   -.36  .79
               ES 4 1618 91.20   88.12   89.78 -1.73  .00
LBNH 372.5 136 EP 3 1618 55.14   52.06   50.83   1.17  .26
 A54 376.7  76 EP 0 1618 54.46   51.38   51.35   -.03 1.01
               ES 0 1618 94.45   91.37   91.40   -.14 1.01
ACCN 383.4 161 EP 3 1618 56.55   53.47   52.17   1.24  .24
 LMQ 385.6  75 EP 0 1618 55.38   52.30   52.45   -.21  .95
               ES 3 1618 95.63   92.55   93.35   -.93  .24
 A11 389.3  80 EP 0 1618 55.75   52.67   52.90   -.24  .93
               ES 4 1618 93.41   90.33   94.16 -3.84  .00
 HNH 400.9 145 ES 4 1619 47.59 104.51   96.72   7.74  .00  14 .20  2.5
 A61 406.5  73 EP 0 1618 58.37   55.29   55.03    .26  .83
               ES 0 1618   .00   -3.08   97.95******  .00
 A16 406.8  77 ES 2 1619 40.39   97.31   98.01   -.69  .42
 A64 425.4  72 EP 4 1619  4.18   61.10   57.36   3.73  .00
               ES 1 1619 44.78 101.70 102.10   -.43  .54
 A21 436.0  74 EP 1 1619  1.23   58.15   58.67   -.53  .50
               ES 0 1619 47.29 104.21 104.44   -.24  .66
 FFD 451.9 141 ES 4 1619 65.82 122.74 107.94 14.77  .00 188 .33  3.5
BINY 498.9 187 EP 4 1618 72.29   69.21   66.43   2.70  .00
 MNQ 643.0  48 EP 0 1619 27.65   84.57   84.22    .26  .00
               ES 3 1619 91.74 148.66 149.91 -1.41  .00
 GGN 674.6 105 ES 4 1619 96.83 153.75 156.86 -3.13  .00
 SMQ 746.2  58 EP 3 1619 38.47   95.39   96.96 -1.63  .00
 LMN 808.2  96 EP 4 1619 45.98 102.90 104.62 -1.78  .00
SOUTHEAST MAINE CRUSTAL MODEL
03MAR16 ME, 21 KM W OF BORHAM
 DATE     ORIGIN     LAT N     LONG W    DEPTH    MN  MC  ML GAP    RMS  ERH  ERZ Q
 30316  345 18.40 43-41.34   70-41.63    1.38  1.8  .0      156    .42  3.1  7.6 C
 STN   DIST AZM  RMK HRMN    SEC    TOBS    TCAL    RES    WT AMX PRX XMAG FMP FMAG
 FFD  81.2 253 EP 4  345 24.44    6.04   13.30 -7.28  .00  81 .16  2.1
               S 0  345 42.65   24.25   23.68    .54 1.69
 WVL 124.5  41 EP 4  345 36.01   17.61   20.17 -2.57  .00  23 .14  1.8
               S 4  345 51.39   32.99   35.90 -2.93  .00
 HNH 128.3 271 EP 0  345 39.34   20.94   20.78    .13 1.54  13 .16  1.6
               S 0  345 54.89   36.49   36.99   -.55 1.49
 WES 153.7 199 IPC2  345 42.72   24.32   24.81   -.50  .70  12 .20  1.6
               S 1  345 62.55   44.15   44.16   -.02 1.08
QUA2 207.0 221 EP 4  346  6.93   48.53   31.71 16.79  .00   7 .20  1.6
               S 3  346 17.02   58.62   56.45   2.11  .01
 UMM 282.4  66 EPC4  346 24.70   66.30   41.03 25.26  .00   6 .17  1.8
               S 2  346 31.57   73.17   73.03    .12  .49
SOUTHEAST MAINE CRUSTAL MODEL
03MAR16 ME, 17 KM W OF BORHAM
 DATE     ORIGIN     LAT N     LONG W    DEPTH    MN  MC  ML GAP    RMS  ERH  ERZ Q
 30316  346 15.13 43-40.69   70-39.59    2.96  2.2  .0      155    .34  2.4  5.2 C
 STN   DIST AZM  RMK HRMN    SEC    TOBS    TCAL    RES    WT AMX PRX XMAG FMP FMAG
 FFD  83.5 254 EP 0  346 28.60   13.47   13.58   -.14 1.22
               S 0  346 40.03   24.90   24.18    .68  .99
 WVL 123.6  40 EPD4  346 32.60   17.47   19.95 -2.50  .00  82 .16  2.3
               S 4  346 45.46   30.33   35.52 -5.21  .00
 HNH 131.1 271 EPD0  346 35.94   20.81   21.14   -.36 1.06  37 .14  2.0
               S 0  346 52.45   37.32   37.63   -.36 1.06
 WES 153.5 201 IPC0  346 40.17   25.04   24.70    .33 1.02  46 .19  2.2
               S 0  346 59.00   43.87   43.96   -.11 1.04
QUA2 207.9 222 EPD0  346 46.69   31.56   31.65   -.12  .90  24 .18  2.1
               S 4  346 69.70   54.57   56.34 -1.83  .00
 UMM 280.4  66 EP 4  346 60.99   45.86   40.61   5.24  .00  25 .21  2.3
               S 0  346 87.65   72.52   72.28    .22  .70
 PQI 392.1  32 EP 4  347 52.72   97.59   54.39 43.16  .00
               S 4  347 68.22 113.09   96.82 16.21  .00
SOUTHEAST MAINE CRUSTAL MODEL
03MAR16 ME, 17 KM NW OF BORHAM
 DATE     ORIGIN     LAT N     LONG W    DEPTH    MN  MC  ML GAP    RMS  ERH  ERZ Q
 30316  351 32.05 43-47.20   70-36.35    5.00  1.4  .0      158    .48  6.8  8.6 D
 STN   DIST AZM  RMK HRMN    SEC    TOBS    TCAL    RES    WT AMX PRX XMAG FMP FMAG
 FFD  91.6 247 EP 2  351 45.93   13.88   14.79   -.93  .70
               S 1  351 58.76   26.71   26.33    .35 1.23
 WVL 111.6  42 EP 1  351 49.57   17.52   17.97   -.45 1.17  13 .16  1.5
               S 0  351 64.48   32.43   31.98    .43 1.55
```

```
 HNH 135.7 266 EP 2  351 52.91  20.86  21.79  -.96  .61   4 .13  1.1
               S 1  351 71.10  39.05  38.79   .21 1.13
 WES 166.3 201 EPD2  351 58.87  26.82  26.30   .52  .67   8 .21  1.5
               S 1  351 78.84  46.79  46.81  -.03 1.04
QUA2 219.9 220 EP 1  351 65.10  33.05  32.91   .12  .90   5 .22  1.4
               S 4  351 85.25  53.20  58.58 -5.43  .00
```

TABLE 5

MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

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

None recorded this period.

Return to Table of Contents

NESN Station Map

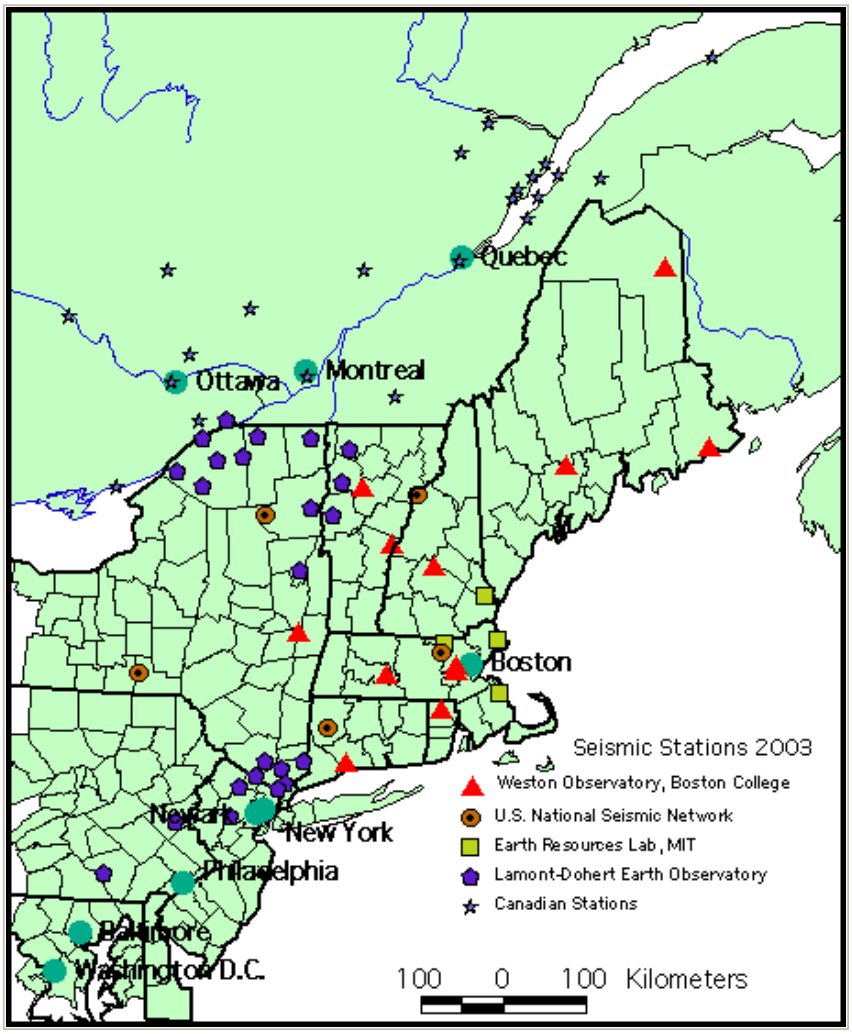

Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period January - March, 2003. Also included are the US National Seismic Network stations operating in New England during this period.

Return to Table of Contents

NESN Strong-Motion Station Map

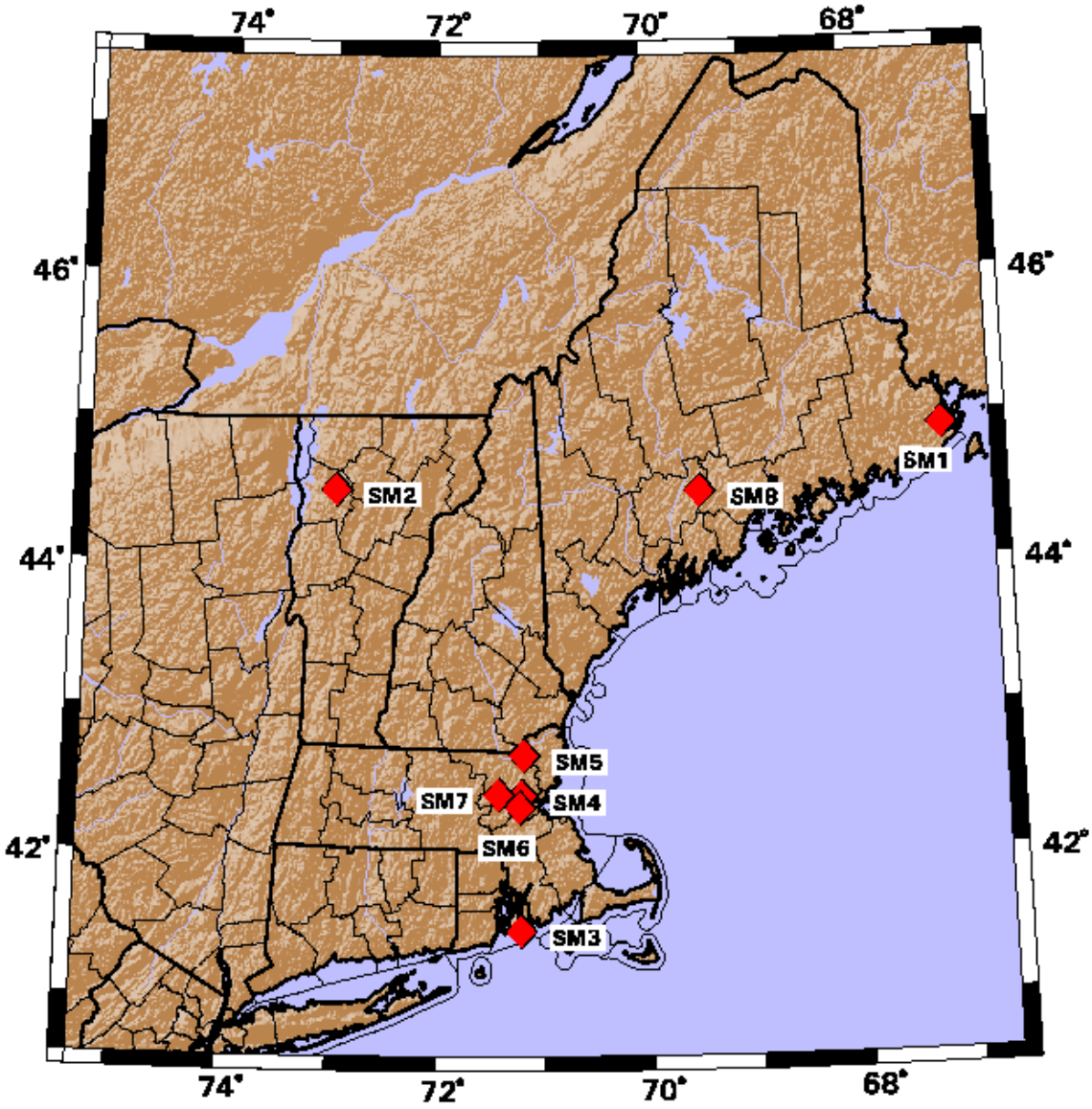

Figure 2: Map of strong-motion stations of the New England Seismic Network (NESN) in operation during period January - March, 2003.

Return to Table of Contents

NESN Quarterly Seismicity Map

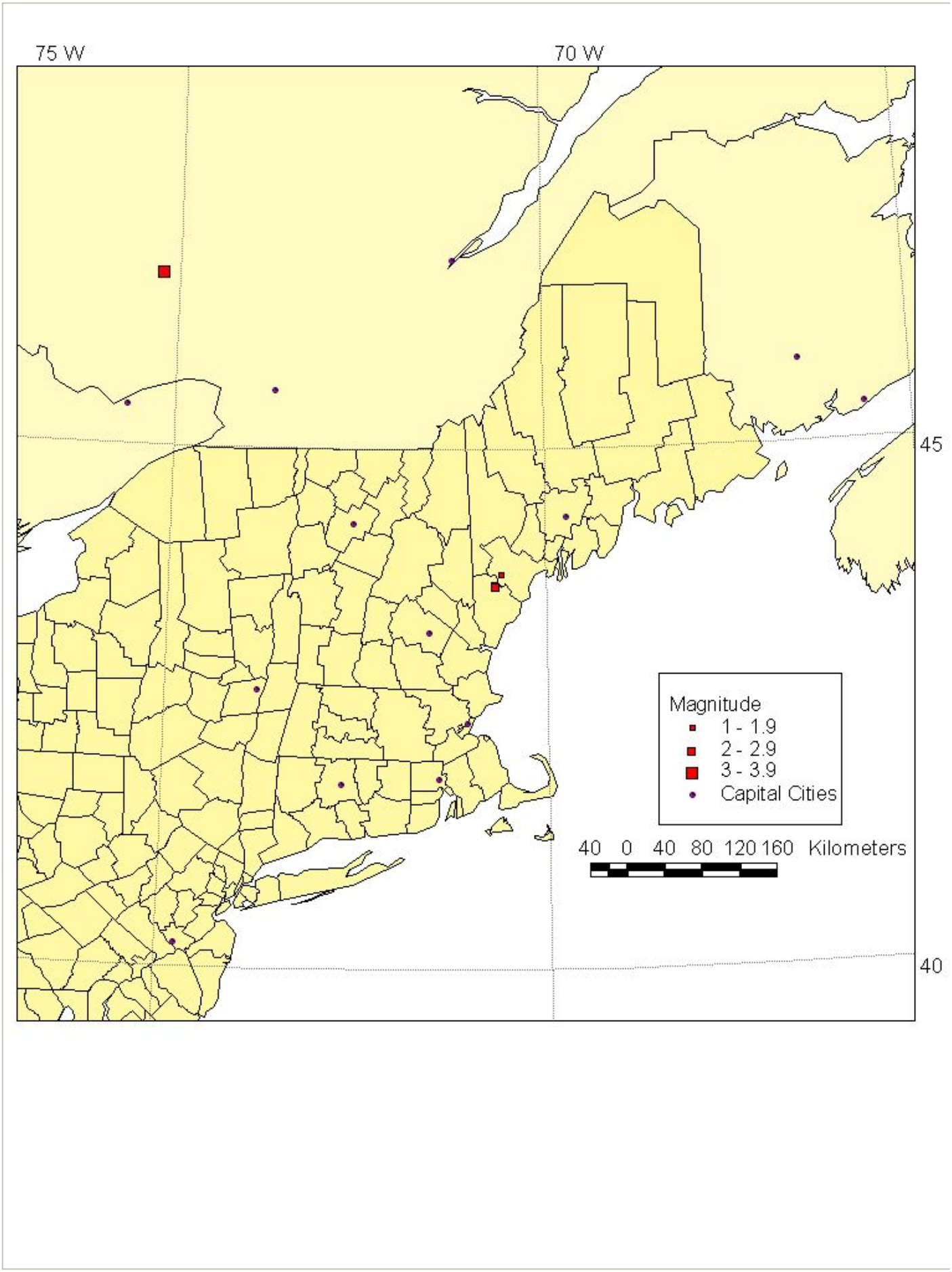

Figure 3: Earthquake epicenters located by the NESN during period January - March, 2003.

Return to Table of Contents

NESN Cumulative Seismicity Map

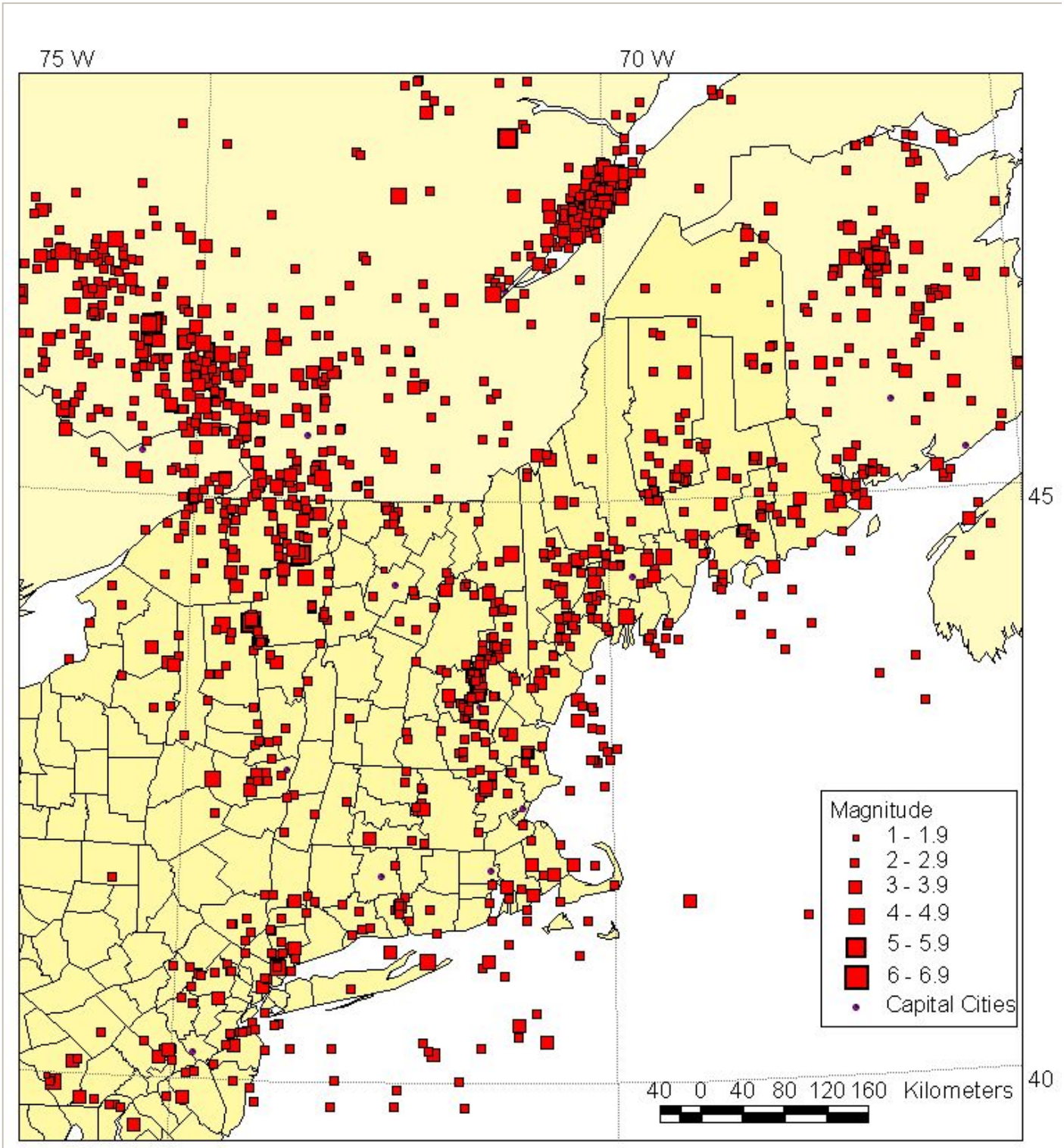
75 W
70 W
45
40
Magnitude
1 - 1.9
2 - 2.9
3 - 3.9
4 - 4.9
5 - 5.9
6 - 6.9
Capital Cities
40 0 40 80 120 160 Kilometers

Figure 4: Seismicity for period October, 1975 - March, 2003.

Return to Table of Contents

Acknowledgments

We would like to thank the Undergraduate Research Opportunities Program (UROP) of MITfor its support to the network. Our map database has been developedin-house using ARCINFO and in part basemap data provided byESRI, Inc. (Arcdata Online), USGS GTOPO30 Elevation Data, and TIGER/Line '94, '95, and '97 (US Census Bureau) spatial data.

References

Chaplin, M.P., Taylor, S.R., and Toksöz, M.N. (1980), A coda lengthmagnitude scale for New England, *Earthquake Notes, 51,* 15-22.

Ebel, J.E. (1982), M_L measurements for northeastern UnitedStates earthquakes, *Bull. Seism. Soc. Am., 72,* 1367-1378.

Rosario, M. (1979), A coda duration magnitude scale for the New EnglandSeismic Network, *Master's Thesis,* Boston College, 82 pp.

Return to Table of Contents

Updated: July 12, 2011
Maintained by: Weston Observatory