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NESN

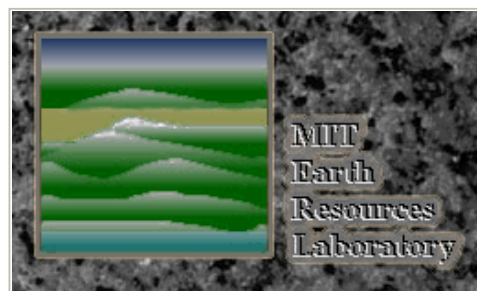
A STUDY OF NEW ENGLAND SEISMICITY

Quarterly Earthquake Report

October-December, 2003

NEW ENGLAND

SEISMIC NETWORK



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December, 2003

for

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Notice

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Quarterly Earthquake Report

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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 October-December, 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 6 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 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 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 6 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 at www.bc.edu/westonobservatory. Waveform data are saved in Nanometrics, ASCII, and SEED formats and are available by contacting, 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:

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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: $2.23 \text{ Log(FMP)} + 0.12 \text{ Log(Dist)} - 2.36$ (Rosario, 1979)
MIT: $2.21 \text{ Log(FMP)} - 1.7$ (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@bc.edu
Anastasia Macherides Moulis	Seismic Analyst	617-552-8325	macherid@bc.edu
Edward Johnson	Project Engineer	617-552-8332	johnson@bc.edu
Dina Smith	Assistant to the Director	617-552-8335	dina.smith.1@bc.edu
		617-552-8300	
Weston Observatory		617-552-8388 (FAX)	

MIT/ERL PERSONNEL

Principal Investigator 617-253-7863 cicerone@erl.mit.edu Administrator 617-253-7797

Name	Network Position	voice phone	email address
M. Nafi Toksöz	617-253-7852	toksoz@mit.edu	
Robert Cicerone	Research Seismologist		
Heather Hooper	Seismic Analyst	617-253-6290	
Sara Brydges	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

WESHNH43.7050-72.3525 Belchertown, MA Troy, NY WESUMMWES42.3850-71.4906 Westford, MA MITWESYLEPQI46.6710

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
FFD	43.4702	-71.6533	131.0	Franklin Falls Dam, NH	
GLO	42.6403	-70.7272	15.2	Gloucester, MA	MIT
-72.2860	180.0	Hanover, NH	WES		

QUA2	42.2789	168.0	WES		
TRY	42.7311	-73.6669	131.0		
44.7100	-67.4583	35.0	Machias, ME	WES	
VT1	44.3317	-72.7536	410.0	Waterbury, VT	WES
-71.3220	60.0	Weston, MA	WES		
WFM	42.6106	87.5			
WVL	44.5648	-69.6575	85.0	Waterville, ME	
41.3100	-72.9269	10.0	New Haven, CT	WES	
-68.0168	175.0	Presque Isle, ME	WES		

STRONG MOTION STATIONS OF THE NEW ENGLAND SEISMIC NETWORK

SM2-73.10Newport, RISM4-71.30WESSM742.39-71.54WES

Code	Lat	Long	Location	Operator
SM1	44.90	-67.25	Dennysville, ME	WES
44.49	Essex Junction, VT	WES		
SM3	41.45	-71.33	WES	
42.38	-71.32	Weston, MA	WES	
SM5	42.66	Lowell, MA		
SM6	42.30	-71.34	Natick, MA	WES
Huds on, MA	WES			
SM8	44.48	-69.61	North Vassalboro, ME	

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TABLE 3

NEW ENGLAND AND ADJACENT REGIONS

October-December, 2003

Date	Time	Lat	Long	Depth	Mag Int	Location
M/D/Y	Hr:Mn:Sec			(km)		
10/1/2003	08:07:56.49	40.5925	-75.1000	00.97	2.4	NJ, 2.4 KM (1.5 MI) N OF MILFORD
10/7/2003	01:32:03.19	41.7315	-71.5707	06.23	1.8	RI, 6 KM (3.73 MI) NW OF WEST WARWICK
10/11/2003	00:10:02.59	47.5515	-69.8977	27.57	2.9	CANADA, 8.25 KM (5.13 MI) WNW OF ST-PASCAL
10/12/2003	08:26:07.84	47.0102	-76.2757	23.81	4.0	CANADA, 14KM NE OF LAC-DESMARAIS
10/15/2003	04:13:15.09	45.0428	-66.9757	20.43	3.1	CANADA, 10 KM SE OF ST. ANDREWS
10/18/2003	16:25:07.46	46.9397	-67.2087	21.70	3.3	CANADA, 41 KM (25.5 MI) ESE OF GRAND FALLS

* indicates Mc rather than Mn.

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TABLE 4

**EARTHQUAKE PHASE DATA LIST
NEW ENGLAND AND ADJACENT REGIONS**

October-December, 2003

SOUTHEAST MAINE CRUSTAL MODEL
10/01/03 NJ, 2.4 KM (1.5 MI) N OF MILFORD

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q		
STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
31001	8 7	56.49	40-35.55	75-	6.00	.97	.0	.0	151	.26	1.2	1.8	B	
LUPA	23.0	272	EP 0	8 8	.25	3.76	3.89	-.17	1.83					
			S 0	8 8	3.21	6.72	6.92	-.27	1.83					
GPD	71.7	49	EP 0	8 8	8.52	12.03	11.81	.16	1.68					
			S 2	8 8	17.41	20.92	21.03	-.21	.83					
TBR	95.9	50	EP 0	8 8	12.35	15.86	15.65	.17	1.59					
			S 2	8 8	24.13	27.64	27.86	-.29	.78					
CPNY	98.8	77	EP 0	8 8	12.62	16.13	16.12	.01	1.58					
			S 0	8 8	25.17	28.68	28.69	-.02	1.58					
PAL	110.4	66	EP 0	8 8	14.67	18.18	17.96	.20	1.54					
			S 4	8 8	24.07	27.58	31.96	-4.42	.00					
ARNY	114.6	46	EP 1	8 8	14.93	18.44	18.62	-.25	1.13					
			S 0	8 8	29.78	33.29	33.14	.02	1.53					
MVL	125.1	238	EP 0	8 8	17.27	20.78	20.29	.47	1.44					
MANY	125.1	56	EP 2	8 8	16.57	20.08	20.29	-.23	.74					
			S 3	8 8	32.13	35.64	36.12	-.52	.34					
BINY	192.5	337	EP 3	8 8	28.15	31.66	29.98	1.60	.01					
			S 0	8 8	50.25	53.76	53.36	.25	1.25					
SDMD	198.3	229	EP 3	8 8	28.50	32.01	30.69	1.32	.05					

			ES	2	1625	87.00	79.54	79.87	-.61	.69			
SMQ	367.0	6	EP	2	1625	58.06	50.60	50.11	.43	.57			
			ES	3	1625	95.43	87.97	89.19	-1.33	.20			
HAL	380.0	132	EP	2	1626	.20	52.74	51.72	1.01	.44			
			ES	2	1626	39.56	92.10	92.06	.02	.54			
MNQ	415.5	344	EP	2	1626	4.00	56.54	56.10	.36	.42			
			ES	3	1626	46.07	98.61	99.85	-1.40	.13			
DPQ	426.1	266	EP	0	1626	5.14	57.68	57.41	.27	.78			
			ES	3	1626	48.37	100.91	102.18	-1.27	.14			
MOQ	430.1	245	EP	0	1626	5.80	58.34	57.89	.31	.75			
			ES	3	1626	49.59	102.13	103.05	-1.17	.15			
LBNH	474.9	231	EP	0	1626	11.38	63.92	63.43	.43	.47			
			ES	4	1626	58.30	110.84	112.90	-2.17	.00			
FFD	520.2	222	EP	0	1626	16.83	69.37	69.03	.32	.19			
			ES	4	1626	90.76	143.30	122.87	20.40	.00			
MNT	520.2	252	EP	0	1626	16.50	69.04	69.03	-.01	.19			
			ES	4	1626	68.03	120.57	122.87	-2.33	.00			
VT1	520.8	236	ES	4	1627	41.05	153.59	122.99	30.57	.00			
HNH	536.4	228	ES	4	1627	40.96	153.50	126.43	27.02	.00			
TRQ	568.6	262	EP	0	1626	22.48	75.02	75.00	.02	.00			
			ES	4	1626	78.59	131.13	133.50	-2.36	.00			
BCX	600.7	212	ES	4	1627	56.08	168.62	140.55	28.02	.00	111	.35	3.5
HRV	601.3	215	ES	4	1627	56.03	168.57	140.69	27.83	.00			
WES	602.1	213	EP	0	1626	26.67	79.21	79.14	.06	.00			
NCB	639.9	239	EP	4	1626	33.61	86.15	83.80	2.25	.00			
GAC	651.8	258	EP	0	1626	32.72	85.26	85.27	-.02	.00			
			ES	4	1626	96.23	148.77	151.78	-3.03	.00			
BRY	656.0	212	ES	4	1627	77.08	189.62	152.71	36.81	.00			
QUA2	659.6	218	EP	4	1626	56.82	109.36	86.24	23.10	.00			
WBO	661.0	251	EP	0	1626	33.95	86.49	86.41	.07	.00			
			ES	4	1626	98.15	150.69	153.81	-3.13	.00			
GRQ	661.5	267	EP	3	1626	33.44	85.98	86.47	-.54	.00			
			ES	4	1626	98.38	150.92	153.92	-3.08	.00			
YLE	775.2	216	ES	4	1627	41.80	154.34	178.90	-24.56	.00			
VLDQ	782.9	280	EP	3	1626	49.85	102.39	101.45	.92	.00			
CRLO	787.2	263	EP	4	1626	47.65	100.19	101.99	-1.83	.00			
EEO	906.4	268	EP	4	1626	62.44	114.98	116.70	-1.79	.00			
SADO	957.0	255	EP	1	1626	70.03	122.57	122.95	-.42	.00			

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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 period.		

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NESN Station Map

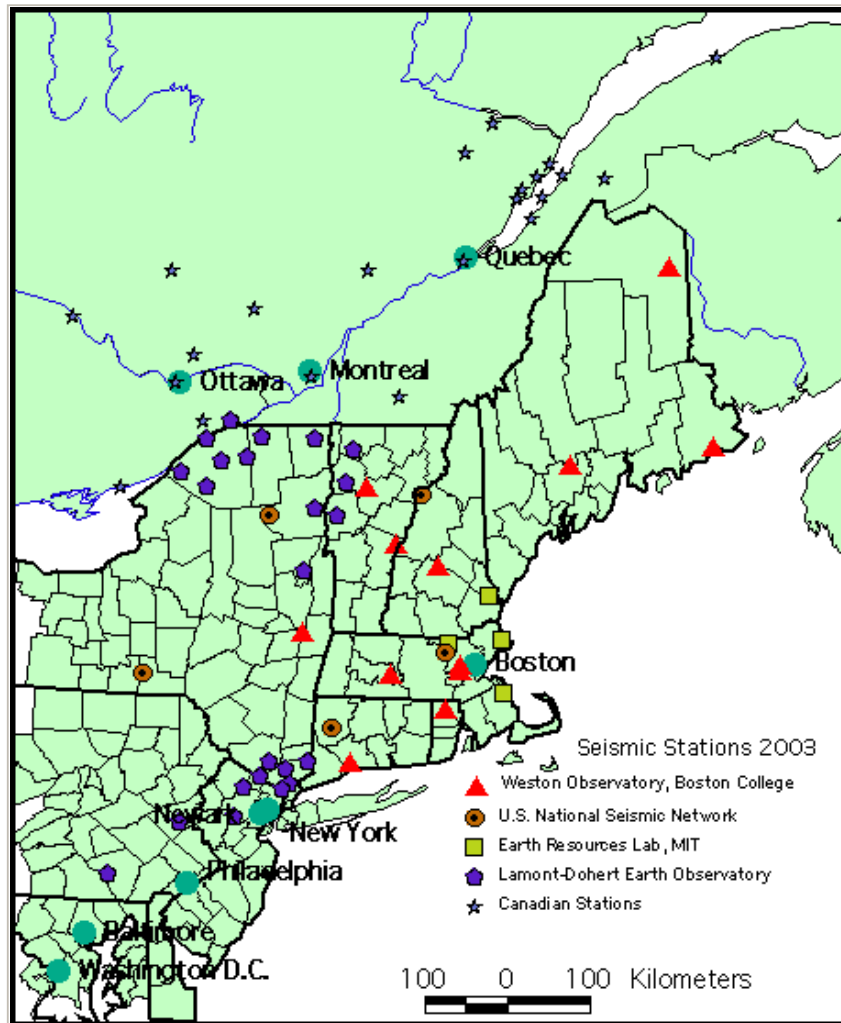


Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period October-December, 2003. Also included are the US National Seismic Network stations operating in New England during this period.

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NESN Strong-Motion Station Map

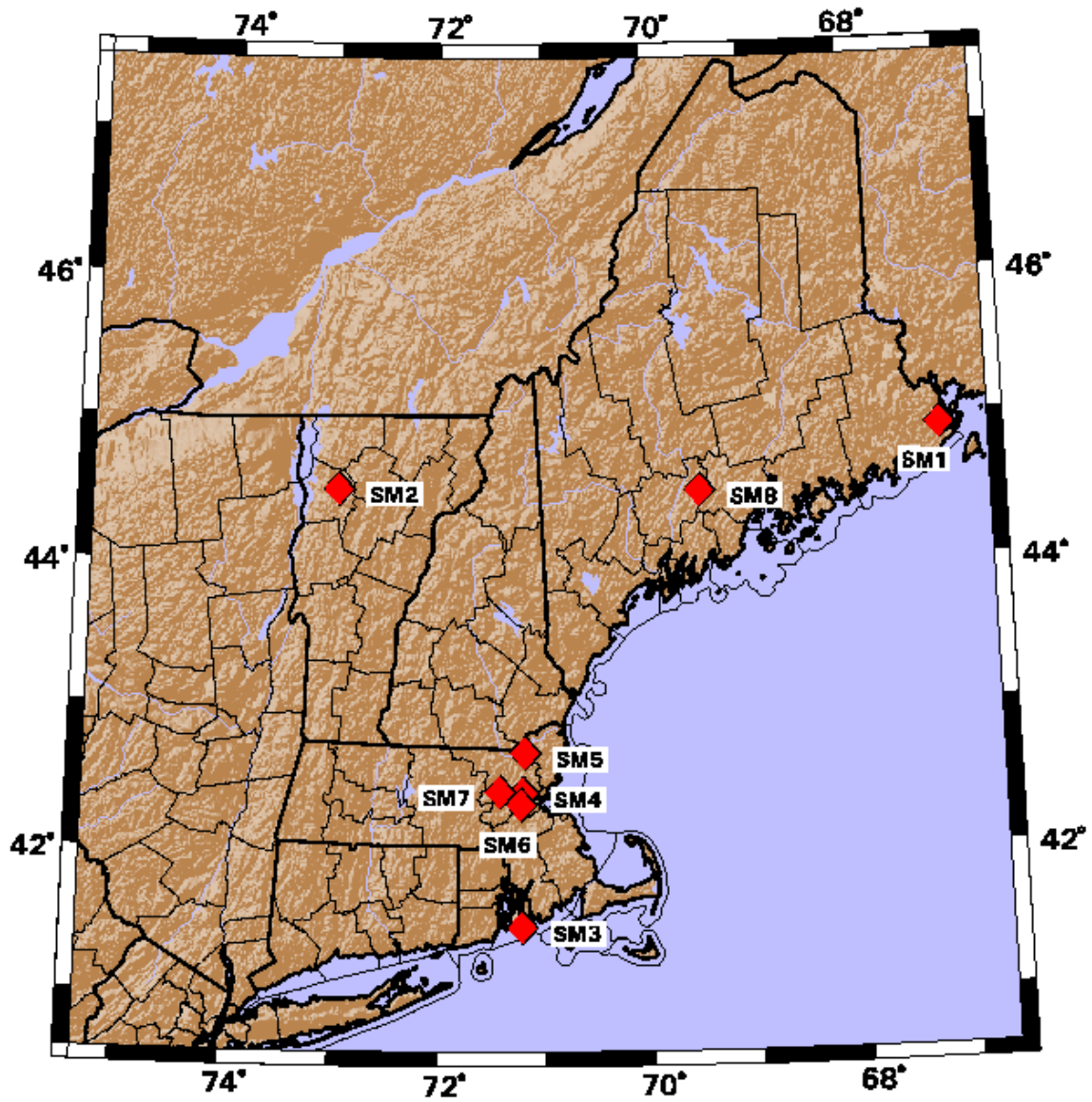


Figure 2: Map of strong-motion stations of the New England Seismic Network (NESN) in operation during period October-December, 2003.

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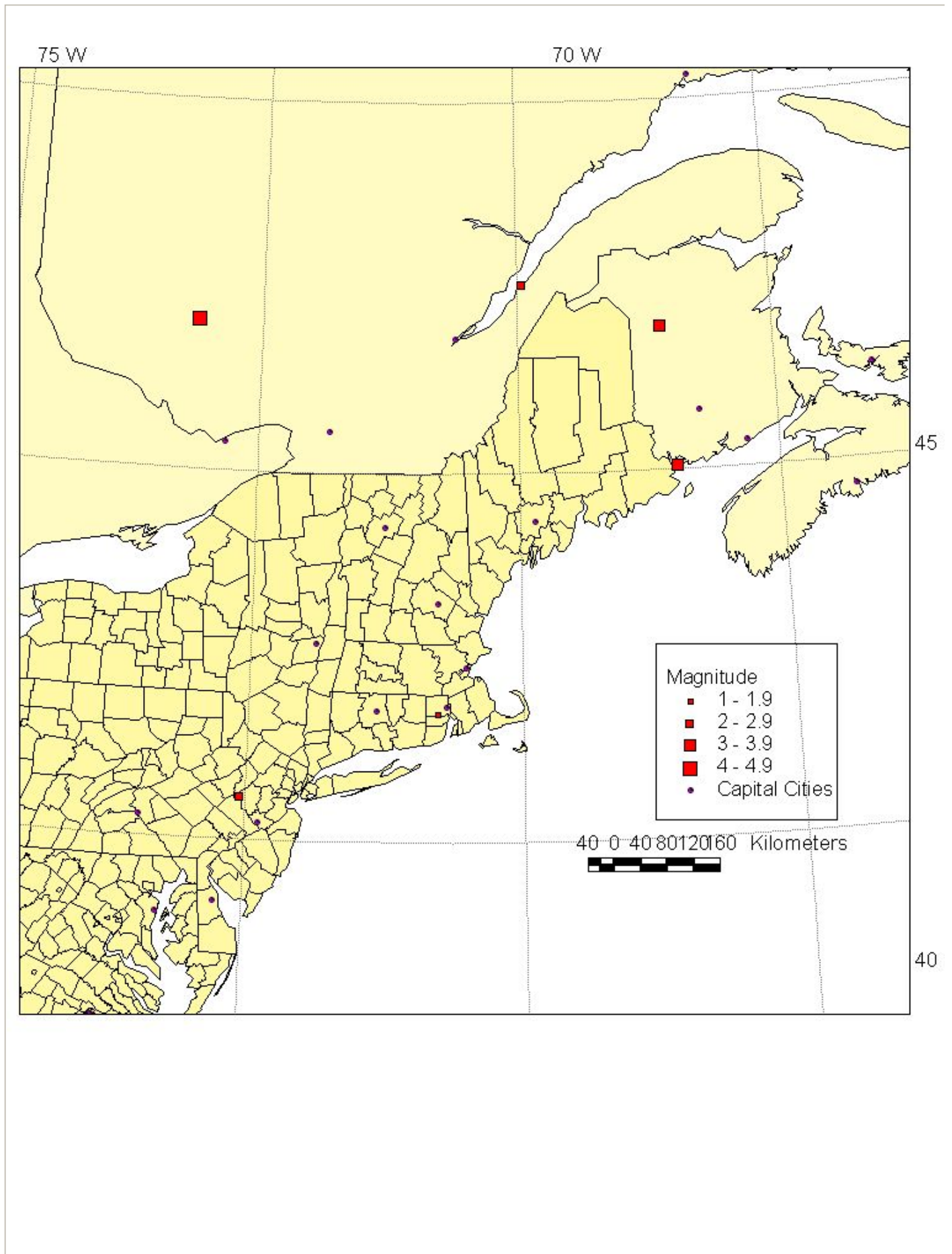


Figure 3: Earthquake epicenters located by the NESN during period October-December, 2003.

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NESN Cumulative Seismicity Map

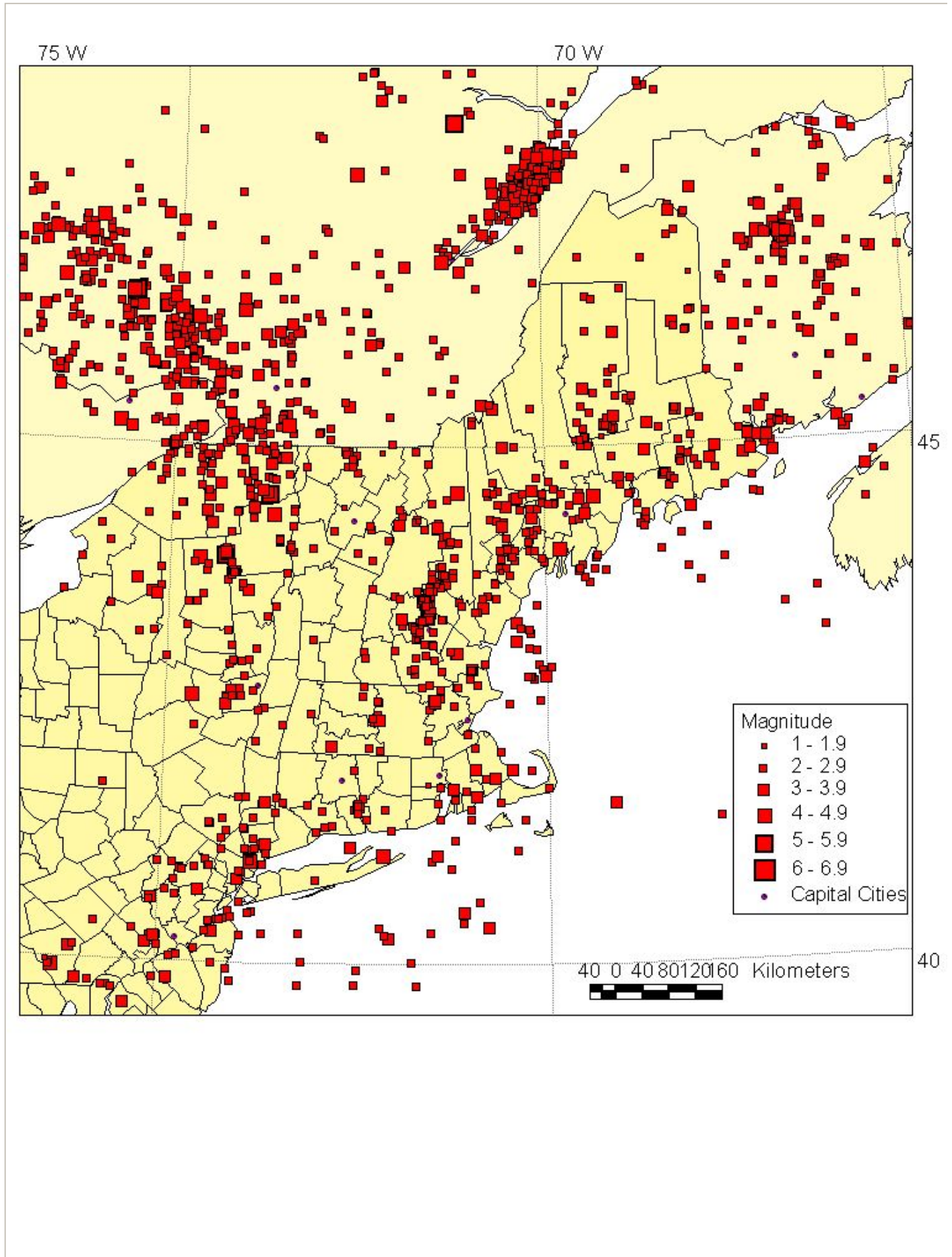


Figure 4: Seismicity for period October, 1975 - December, 2003.

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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 ArcView and in part basemap data provided by ESRI, Inc. (Arcdata Online), USGS GTOPO30 Elevation Data, and TIGER/Line '94, '95, and '97 (US Census Bureau) spatial data.

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