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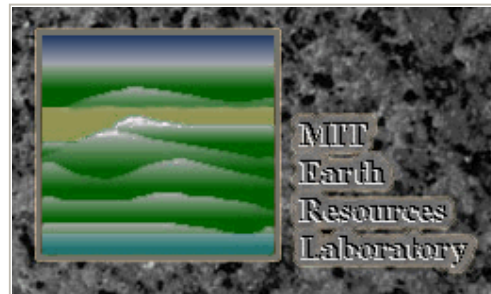
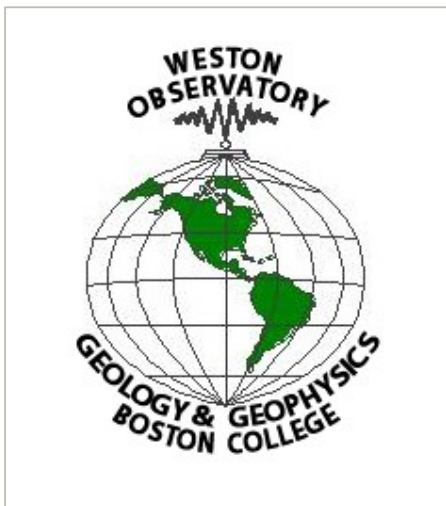
NESN

A STUDY OF NEW ENGLAND SEISMICITY

Quarterly Earthquake Report

April - June 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

John E. Ebel, Principal Investigator	M. Nafi Toksöz, Principal Investigator
Weston Observatory	Earth Resources Lab
Dept. of Geology and Geophysics	Dept. of Earth, Atmospheric, and Planetary Sciences
Boston College	Massachusetts Institute of Technology
381 Concord Road	42 Carleton Street
Weston, MA 02493	Cambridge, MA 02142
Email: ebel@bc.edu	Email: toksoz@mit.edu
Award # 1434-HQ-98-AG-01943	Award # 1434-HQ-98-AG-01926

Prepared by Charles Doll, Jr.

Email: doll@erl.mit.edu

and Susan O'Connor

Email: dannolfo@bc.edu

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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. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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 April - June, 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 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 12 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. 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 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 construction. 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](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:

Charles Doll

MIT Earth Resources Lab

42 Carleton Street

Cambridge, MA 02142

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

Prof. John Ebel

Weston Observatory

381 Concord Road

Weston, MA 02493

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

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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@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
Weston Observatory		617-552-8300	
		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
Sara Brydges	Administrator	617-253-7797	sara@erl.mit.edu
Earth Resources Lab		617-253-8027	
		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

April - June, 1999

Date	Time	Lat	Long	Depth	Mag Int	Location
Yr/Mo/Dy	Hr:Mn:Sec			(km)		
1999/05/17	23:36:31.60	43.6293	-72.2872	7.93	1.0	NH, 3 km WSW of Lebanon
1999/06/03	06:32:14.73	43.4666	-71.1132	0.0	2.3*	NH, 8.7 km ENE of Alton
1999/06/09	06:03:01.49	44.3987	-67.8893	10.27	1.8	ME, E of Petit Manan Pt.

*coda magnitude

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TABLE 4

EARTHQUAKE PHASE DATA LIST
NEW ENGLAND AND ADJACENT REGIONS
April - June 1999

HUGHES AND LUETGERT NH

99MAY17 NH, 3 KM WSW OF LEBANON

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q		
990517	2336	31.60	43-37.76	72-17.23	7.93	1.0	2.1	211	0.29	4.9	7.2	C		
STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
HNH	8.5	1	IPCO	2336	33.51	1.91	1.96	-0.09	1.30	51	.10	0.9	78	2.0
			S	0	2336	34.92	3.32	3.49	-0.23	1.29				
NH1	58.3	99	IPC1	2336	42.03	10.43	9.81	0.62	0.68	11	.10	1.1	75	2.2
			S	0	2336	49.12	17.52	17.45	0.06	1.18				
DNH	126.1	117	S	0	2336	68.50	36.90	36.71	0.19	1.01				
WFM	130.4	150	EP	0	2336	53.20	21.60	21.30	0.28	0.98				
			S	1	2336	69.30	37.70	37.92	-0.24	0.75				
GLO	167.9	131	S	0	2336	79.40	47.80	48.26	-0.47	0.82				
WVL	232.5	65	EP	4	2336	60.91	29.31	35.12	-5.83	0.00				

HUGHES AND LUETGERT NH

99JUN03 NH, 8.7 KM ENE OF ALTON

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q
990603	632	14.73	43-28.00	71- 6.79	0.00		2.3	317	0.24	4.2	6.7	C

STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
DNH	42.1	155	EP 0	632	21.60	6.87	7.27	-0.40	1.02				88	2.2
			S 0	632	27.72	12.99	12.95	0.04	1.17					
GLO	97.0	161	EP 0	632	31.30	16.57	16.42	0.15	1.03				92	2.4
			S 0	632	43.76	29.03	29.22	-0.19	1.03					
WFM	100.0	198	EP 0	632	31.78	17.05	16.90	0.15	1.02				74	2.2
			S 0	632	44.60	29.87	30.07	-0.22	1.01					
DXB	159.8	168	EP 0	632	41.48	26.75	26.38	0.37	0.82				86	2.5
			S 0	632	61.88	47.15	46.96	0.19	0.89					

SOUTHEAST MAINE CRUSTAL MODEL
99JUN09 ME, E OF PETIT MANAN PT (OFFSHORE)

DATE	ORIGIN	LAT N	LONG W	DEPTH	MN	MC	ML	GAP	RMS	ERH	ERZ	Q
990609	6 3	1.49	44-23.92	67-53.36	10.27			1.8	220	0.27	1.9	1.4 B

STN	DIST	AZM	RMK	HRMN	SEC	TOBS	TCAL	RES	WT	AMX	PRX	XMAG	FMP	FMAG
MIM	130.8	316	IPDO	6 3	22.67	21.18	21.04	0.12	2.08	20	.12	1.8		
			S 0	6 3	38.78	37.29	37.46	-0.20	2.06					
WVL	142.1	276	IPD1	6 3	24.36	22.87	22.78	0.08	1.52	22	.16	1.9		
			S 4	6 3	40.08	38.59	40.55	-1.97	0.00					
LMN	291.5	56	P 2	6 3	43.82	42.33	41.23	1.10	0.12					
			S 0	6 3	74.72	73.23	73.39	-0.15	1.27					
MOQ	359.4	286	S 0	6 3	89.84	88.35	88.30	-0.20	0.94					
A16	378.8	334	P 1	6 3	52.89	51.40	52.00	-0.60	0.54					
			S 0	6 3	94.45	92.96	92.56	0.40	0.82					
A21	392.9	339	P 0	6 3	55.58	54.09	53.74	0.36	0.76					
			S 0	6 3	97.20	95.71	95.65	0.06	0.78					
GSQ	505.5	7	P 2	6 3	68.66	67.17	67.65	-0.48	0.10					

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TABLE 5

MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

Date	Arrival Time
Yr/Mo/Dy	Sta Hr:Mn:Sec
None recorded this quarter	

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NESN Station Map

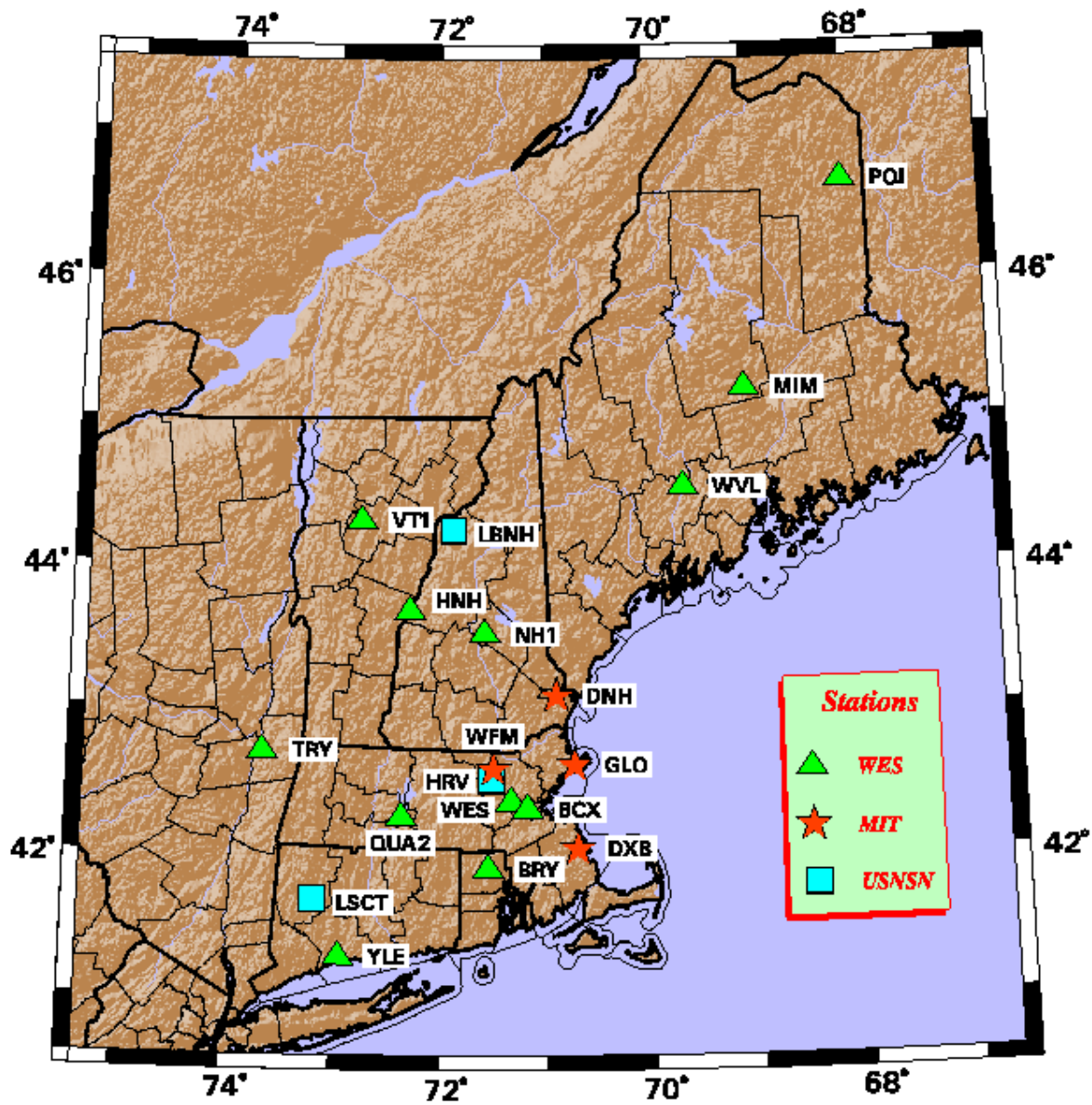


Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period April - June, 1999. Also included are the US National Seismic Network stations operating in New England during this period.

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NESN Strong-Motion Station Map

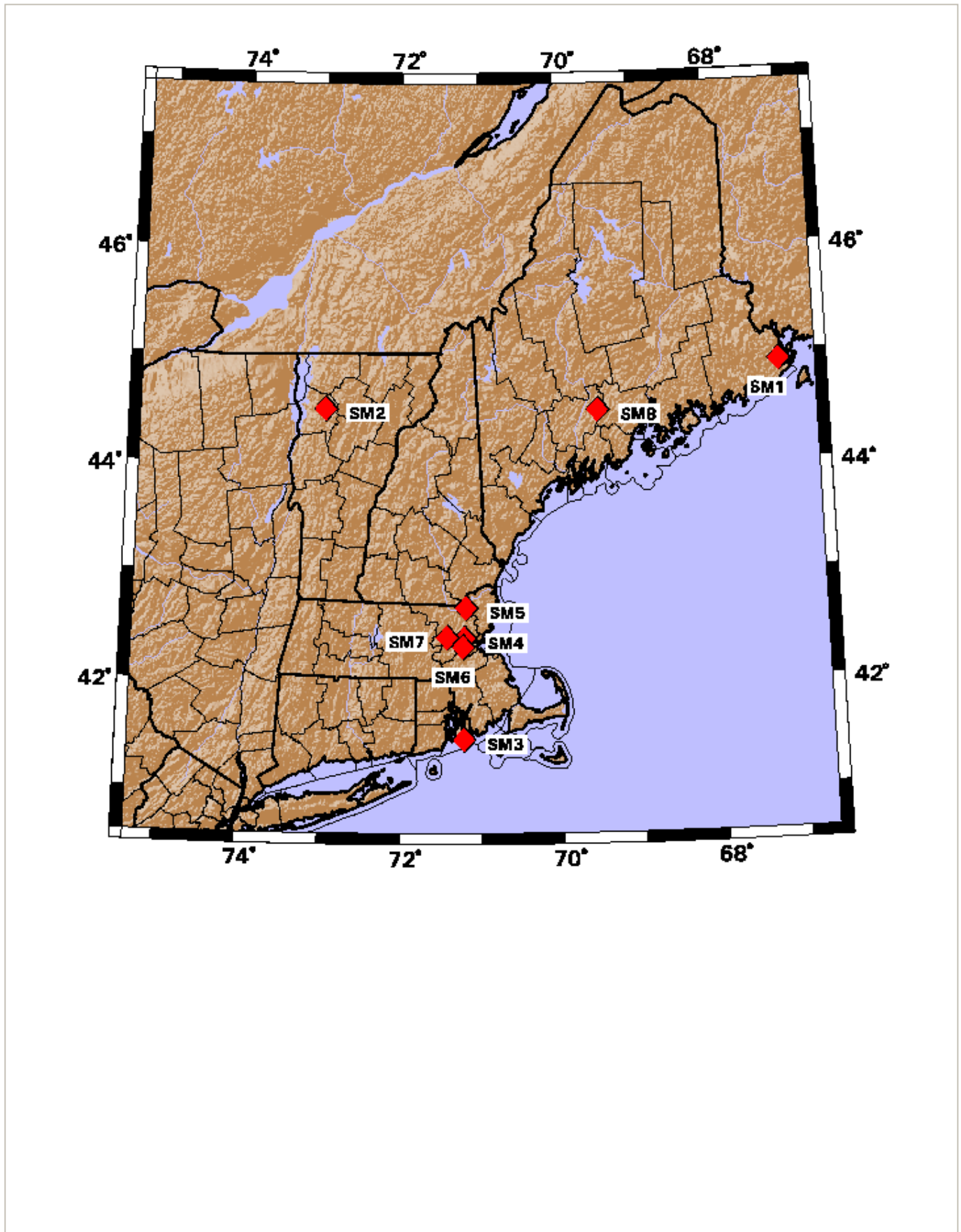


Figure 2: Map of strong-motion stations of the New England Seismic Network (NESN) in operation during period April - June, 1999.

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NESN Quarterly Seismicity Map

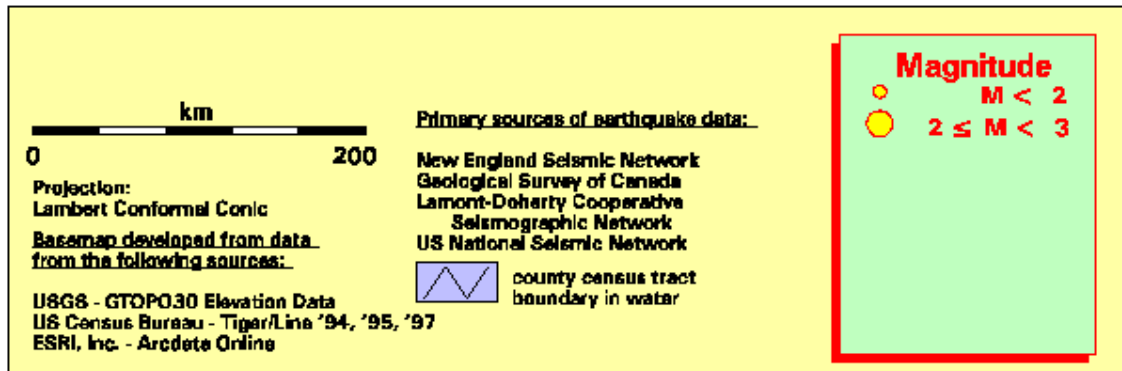
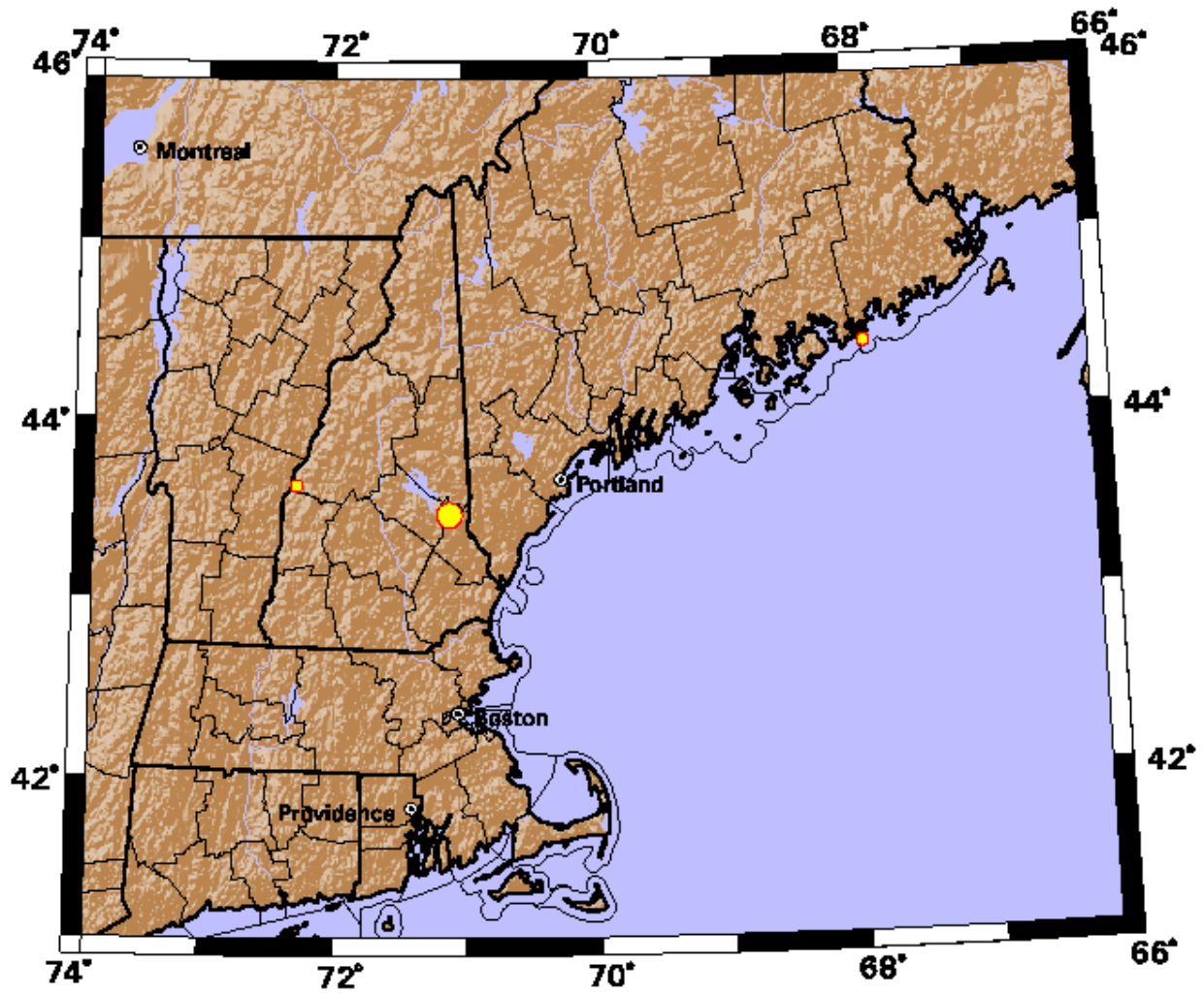
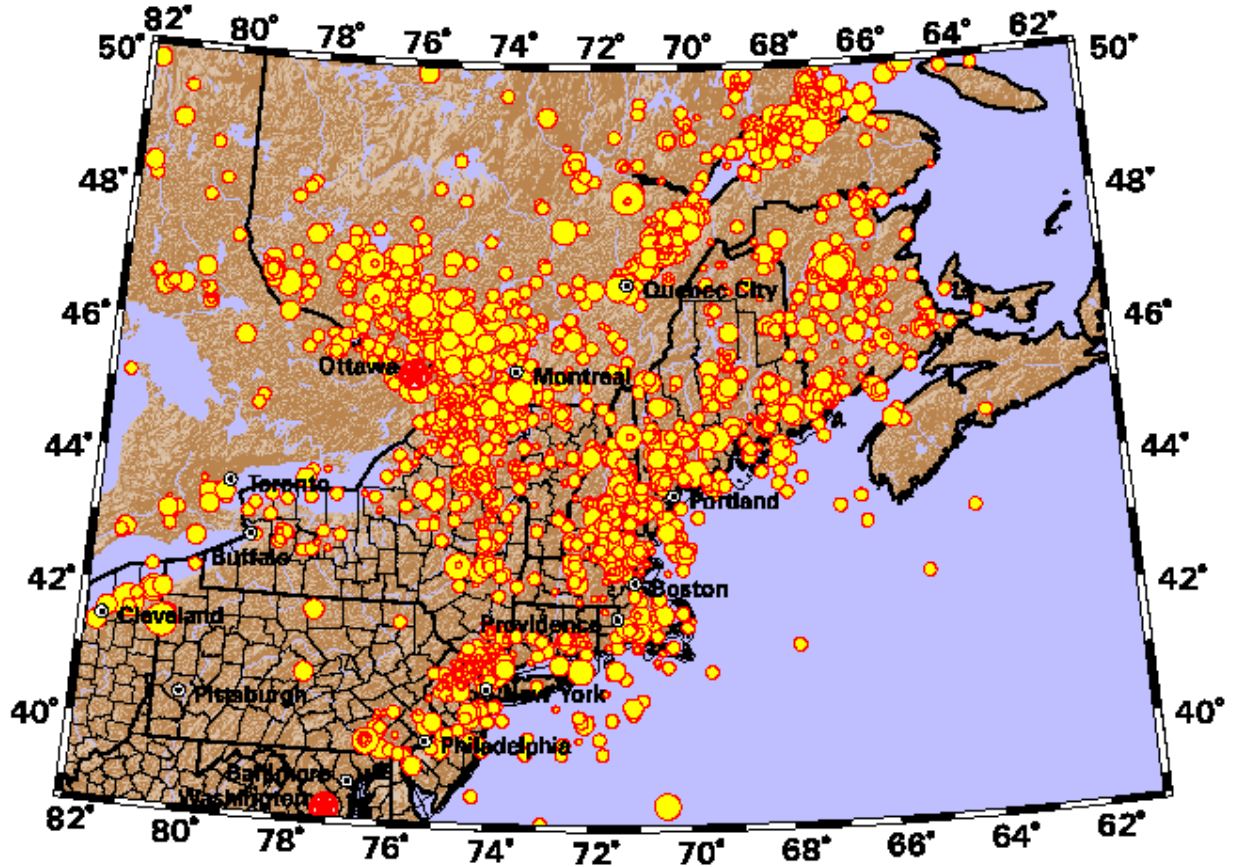


Figure 3: Earthquake epicenters located by the NESN during period April - June, 1999.

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km
 0 200

Projection:
 Lambert Conformal Conic

Basemap developed from data from the following sources:
 USGS - GTOPO30 Elevation Data
 US Census Bureau - Tiger/Line '94, '95, '97
 ESRI, Inc. - Arcdata Online

Primary sources of earthquake data:
 New England Seismic Network
 Geological Survey of Canada
 Lamont-Doherty Cooperative Seismographic Network
 US National Seismic Network

 county census tract boundary in water

Magnitude

- $M < 2$
- $2 \leq M < 3$
- $3 \leq M < 4$
- $4 \leq M < 5$
- $5 \leq M < 6$
- $6 \leq M$

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

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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, '95, and '97 (US Census Bureau) spatial data.

References

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

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