A STUDY OF NEW ENGLAND SEISMICITY

Quarterly Earthquake Report

July - September, 2003

NEW ENGLAND
SEISMIC NETWORK

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October, 2003

for

United States Geological Survey

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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.

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Table of Contents

- Introduction
- Current Network Operation and Status
- Seismicity
- Data Management
- Tables
  - Explanation of Tables
  - Table 1 Project Personnel
  - Table 2 Seismic Stations
  - Table 3 Earthquake Hypocenter List
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, 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 5 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 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 helicopters to provide additional data for analysis.

Seismicity

There were 5 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.
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/NESSN/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 NESP. 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/NESSN and www.bc.edu/westonobservatory or contact:

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Explanation of Tables

Table 1: List of personnel operating the NESP

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
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. Lon = 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. PMAG = 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)

Return to Table of Contents

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
</table>

**WESTON OBSERVATORY PERSONNEL**
617-552-8319kafka@bc.edu617-552-8332johnson@bc.edu

<table>
<thead>
<tr>
<th>Name</th>
<th>Network Position</th>
<th>voice phone</th>
<th>email address</th>
</tr>
</thead>
<tbody>
<tr>
<td>John E. Ebel</td>
<td>Principal Investigator</td>
<td><a href="mailto:ebel@bc.edu">ebel@bc.edu</a></td>
<td>617-552-8300</td>
</tr>
<tr>
<td>Alan Kafka</td>
<td>Research Seismologist</td>
<td>617-552-8325</td>
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</tr>
<tr>
<td>Anastasia Macherides Moulis</td>
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<td>617-552-8311</td>
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</tr>
<tr>
<td>Edward Johnson</td>
<td>Project Engineer</td>
<td>617-552-8335</td>
<td><a href="mailto:dina.smith.1@bc.edu">dina.smith.1@bc.edu</a></td>
</tr>
<tr>
<td>Patricia Tassia</td>
<td>Administrative Secretary</td>
<td>617-552-8300</td>
<td></td>
</tr>
<tr>
<td>Dina Smith</td>
<td>Assistant to the Director</td>
<td>617-552-8388</td>
<td>(FAX)</td>
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</table>

Weston Observatory
617-552-8388 (FAX)

**MIT/ERL PERSONNEL**
Principal Investigator617-253-7863cicerone@erl.mit.eduAdministrator617-253-7797

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<th>Name</th>
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<th>email address</th>
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<tr>
<td>M. Nafi Toksöz</td>
<td>617-253-7852</td>
<td><a href="mailto:toksoz@mit.edu">toksoz@mit.edu</a></td>
<td></td>
</tr>
<tr>
<td>Robert Cicerone</td>
<td>Research Seismologist</td>
<td>617-253-6290</td>
<td></td>
</tr>
<tr>
<td>Heather Hooper</td>
<td>Seismic Analyst</td>
<td>617-253-8027</td>
<td></td>
</tr>
<tr>
<td>Sara Brydges</td>
<td><a href="mailto:sara@erl.mit.edu">sara@erl.mit.edu</a></td>
<td>617-253-6385</td>
<td>(FAX)</td>
</tr>
</tbody>
</table>

Earth Resources Lab

Return to Table of Contents

Table 2

| Table 2 |

**SEISMIC STATIONS OF THE NEW ENGLAND SEISMIC NETWORK**

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<thead>
<tr>
<th>Code</th>
<th>Lat (°)</th>
<th>Long (°)</th>
<th>Elev (m)</th>
<th>Location</th>
<th>Operator</th>
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<tbody>
<tr>
<td>BCX</td>
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<td>-71.1705</td>
<td>61.0</td>
<td>Chestnut Hill, MA</td>
<td>WES</td>
</tr>
<tr>
<td>BRY</td>
<td>41.9178</td>
<td>-71.5338</td>
<td>380.0</td>
<td>Smithfield, RI</td>
<td>WES</td>
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<tr>
<td>DNH</td>
<td>43.1225</td>
<td>-70.8948</td>
<td>24.0</td>
<td>Durham, NH</td>
<td>MIT</td>
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<tr>
<td>DXB</td>
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<td>8.0</td>
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<td>MIT</td>
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<tr>
<td>FFD</td>
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<td>131.0</td>
<td>Franklin Falls Dam, NH</td>
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<td>GLO</td>
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<td>MIT</td>
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<td>HNH</td>
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<td>VT1</td>
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<td>WFM</td>
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<tr>
<td>WVL</td>
<td>44.5648</td>
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<td>85.0</td>
<td>Waterville, ME</td>
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<tr>
<td>YLE</td>
<td>41.3100</td>
<td>-72.9269</td>
<td>10.0</td>
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<tr>
<td>PQI</td>
<td>46.6710</td>
<td>-68.0168</td>
<td>175.0</td>
<td>Presque Isle, ME</td>
<td>WES</td>
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**STRONG MOTION STATIONS OF THE NEW ENGLAND SEISMIC NETWORK**
SM2-73.10Newport, RISM4-71.30WES42.39-71.54WES

https://www.bc.edu/research/westonobservatory/nessie03c.html
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<th>Code</th>
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<th>Long</th>
<th>Location</th>
<th>Operator</th>
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<tr>
<td>SM1</td>
<td>44.90</td>
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<td>Dennysville, ME</td>
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<tr>
<td>44.49 Essex Junction, VT</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SM3</td>
<td>41.45</td>
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<td>42.38</td>
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<tr>
<td>SM5</td>
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<td>Lowell, MA</td>
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<tr>
<td>SM7</td>
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<td>-69.61</td>
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Return to Table of Contents

### TABLE 3

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<th>Date</th>
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<th>Depth (km)</th>
<th>Mag Int</th>
<th>Location</th>
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<tr>
<td>2003/07/22</td>
<td>11:41:15.66</td>
<td>42.7723</td>
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<td>11.04</td>
<td>3.6</td>
<td>MA, 57.9 KM ENE OF GLOUCESTER</td>
</tr>
<tr>
<td>2003/08/20</td>
<td>01:58:18.96</td>
<td>46.3992</td>
<td>-75.0597</td>
<td>0.27</td>
<td>3.2</td>
<td>CANADA, 37 KM SSE OF MONT-LAURIER ONTARIO</td>
</tr>
<tr>
<td>2003/08/22</td>
<td>18:31:25.84</td>
<td>44.5317</td>
<td>-69.7765</td>
<td>16.66</td>
<td>2.2</td>
<td>ME, 9.3 KM WSW OF WATerville</td>
</tr>
<tr>
<td>2003/08/22</td>
<td>18:32:38.75</td>
<td>44.4322</td>
<td>-69.6683</td>
<td>16.13</td>
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<td>ME, 13 KM S OF WATerville</td>
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<tr>
<td>2003/08/26</td>
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<td>40.6110</td>
<td>-75.0850</td>
<td>0.77</td>
<td>3.6</td>
<td>NJ, 4.5 KM N OF MILFORD</td>
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* indicates M<sub>c</sub> rather than M<sub>n</sub>.

Return to Table of Contents

### TABLE 4

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<tr>
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Return to Table of Contents
TABLE 5
MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

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<tr>
<th>Date</th>
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<tr>
<td>Yr/Mo/Dy</td>
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<td>Hr:Min:Sec</td>
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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 July - September, 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 July - September, 2003.

Return to Table of Contents
Figure 3: Earthquake epicenters located by the NESN during period July - September, 2003.

NESN Cumulative Seismicity Map
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

