A STUDY OF NEW ENGLAND SEISMICITY
Quarterly Earthquake Report
July - September, 2002
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for

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Notice

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July - September, 2002

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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 July - September, 2002. 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 placed in central New Hampshire. Station MIM, in central Massachusetts, 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 events detected in the short-period data streams and saves them to disk for manual analysis. Station WFM also has a new three-component, highdynamic 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 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 U.S. earthquake activity to 1992. This will be updated as new Northeastern U.S. Seismic Network Bulletins 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, rep. 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 to 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:80/bc_org/avp/cas/wesobs/ or contact:
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
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 millimeters, 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. XMG = Nutti 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

<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>617-552-8319</td>
<td><a href="mailto:ebel@bc.edu">ebel@bc.edu</a></td>
</tr>
<tr>
<td>Alan Kafka</td>
<td>Research Seismologist</td>
<td>617-552-8300</td>
<td><a href="mailto:kafka@bc.edu">kafka@bc.edu</a></td>
</tr>
<tr>
<td>Anastasia Macherides Moulis</td>
<td>Seismic Analyst</td>
<td>617-552-8325</td>
<td><a href="mailto:weston.observatory@bc.edu">weston.observatory@bc.edu</a></td>
</tr>
<tr>
<td>Edward Johnson</td>
<td>Project Engineer</td>
<td>617-552-8332</td>
<td><a href="mailto:johnson@bc.edu">johnson@bc.edu</a></td>
</tr>
<tr>
<td>Patricia Tassia</td>
<td>Administrative Secretary</td>
<td>617-552-8311</td>
<td><a href="mailto:tassia@bc.edu">tassia@bc.edu</a></td>
</tr>
<tr>
<td>W. Richard Ott, S.J.</td>
<td>Assistant to the Director</td>
<td>617-552-8335</td>
<td><a href="mailto:ottwi@mail1.bc.edu">ottwi@mail1.bc.edu</a></td>
</tr>
<tr>
<td>Weston Observatory</td>
<td></td>
<td>617-552-8300</td>
<td>617-552-8388 (FAX)</td>
</tr>
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MIT/ERL PERSONNEL

<table>
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<th>voice phone</th>
<th>email address</th>
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<tbody>
<tr>
<td>M. Nafi Toksöz</td>
<td>Principal Investigator</td>
<td>617-253-7852</td>
<td><a href="mailto:toksoz@mit.edu">toksoz@mit.edu</a></td>
</tr>
<tr>
<td>Robert Cicerone</td>
<td>Research Seismologist</td>
<td>617-253-7863</td>
<td><a href="mailto:cicerone@erl.mit.edu">cicerone@erl.mit.edu</a></td>
</tr>
<tr>
<td>Heather Hooper</td>
<td>Seismic Analyst</td>
<td>617-253-6290</td>
<td></td>
</tr>
<tr>
<td>Sara Brydges</td>
<td>Administrator</td>
<td>617-253-7797</td>
<td><a href="mailto:sara@erl.mit.edu">sara@erl.mit.edu</a></td>
</tr>
<tr>
<td>Earth Resources Lab</td>
<td></td>
<td>617-253-8027</td>
<td>617-253-6385 (FAX)</td>
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</tbody>
</table>
TABLE 2

SEISMIC STATIONS OF THE NEW ENGLAND SEISMIC NETWORK

<table>
<thead>
<tr>
<th>Code</th>
<th>Lat</th>
<th>Long</th>
<th>Elev (m)</th>
<th>Location</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCX</td>
<td>42.3350</td>
<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>-71.5388</td>
<td>380.0</td>
<td>Smithfield, RI</td>
<td>WES</td>
</tr>
<tr>
<td>DNH</td>
<td>43.1225</td>
<td>-70.8948</td>
<td>24.0</td>
<td>Durham, NH</td>
<td>MIT</td>
</tr>
<tr>
<td>DXB</td>
<td>42.0610</td>
<td>-70.6992</td>
<td>8.0</td>
<td>Duxbury, MA</td>
<td>MIT</td>
</tr>
<tr>
<td>FFD</td>
<td>43.4702</td>
<td>-71.6533</td>
<td>131.0</td>
<td>Franklin Falls Dam, NH</td>
<td>WES</td>
</tr>
<tr>
<td>GLO</td>
<td>42.6403</td>
<td>-70.7272</td>
<td>15.2</td>
<td>Gloucester, MA</td>
<td>MIT</td>
</tr>
<tr>
<td>HNH</td>
<td>43.7050</td>
<td>-72.2860</td>
<td>180.0</td>
<td>Hanover, NH</td>
<td>WES</td>
</tr>
<tr>
<td>NH1</td>
<td>43.5473</td>
<td>-71.5743</td>
<td>402.0</td>
<td>Sanbornton, NH</td>
<td>WES</td>
</tr>
<tr>
<td>QUA2</td>
<td>42.2789</td>
<td>-72.3525</td>
<td>168.0</td>
<td>Belchertown, MA</td>
<td>WES</td>
</tr>
<tr>
<td>TRY</td>
<td>42.7311</td>
<td>-73.6669</td>
<td>131.0</td>
<td>Troy, NY</td>
<td>WES</td>
</tr>
<tr>
<td>UMM</td>
<td>44.7100</td>
<td>-67.4583</td>
<td>35.0</td>
<td>Machias, ME</td>
<td>WES</td>
</tr>
<tr>
<td>VT1</td>
<td>44.3317</td>
<td>-7 2.7536</td>
<td>410.0</td>
<td>Waterbury, VT</td>
<td>WES</td>
</tr>
<tr>
<td>WES</td>
<td>42.3850</td>
<td>-71.3220</td>
<td>60.0</td>
<td>Weston, MA</td>
<td>WES</td>
</tr>
<tr>
<td>WFM</td>
<td>42.6106</td>
<td>-71.4906</td>
<td>87.5</td>
<td>Westford, MA</td>
<td>MIT</td>
</tr>
<tr>
<td>WVL</td>
<td>44.5648</td>
<td>-69.6575</td>
<td>85.0</td>
<td>Waterville, ME</td>
<td>WES</td>
</tr>
<tr>
<td>YLE</td>
<td>41.3100</td>
<td>-72.9269</td>
<td>914.0</td>
<td>New Haven, CT</td>
<td>WES</td>
</tr>
<tr>
<td>PQ1</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

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<th>Code</th>
<th>Lat</th>
<th>Long</th>
<th>Location</th>
<th>Operator</th>
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<tbody>
<tr>
<td>SM1</td>
<td>44.90</td>
<td>-67.25</td>
<td>Dennysville, ME</td>
<td>WES</td>
</tr>
<tr>
<td>SM2</td>
<td>44.49</td>
<td>-73.10</td>
<td>Essex Junction, VT</td>
<td>WES</td>
</tr>
<tr>
<td>SM3</td>
<td>41.45</td>
<td>-71.33</td>
<td>Newport, RI</td>
<td>WES</td>
</tr>
<tr>
<td>SM4</td>
<td>42.38</td>
<td>-71.32</td>
<td>Weston, MA</td>
<td>WES</td>
</tr>
<tr>
<td>SM5</td>
<td>42.66</td>
<td>-71.30</td>
<td>Lowell, MA</td>
<td>WES</td>
</tr>
<tr>
<td>SM6</td>
<td>42.30</td>
<td>-71.34</td>
<td>Natick, MA</td>
<td>WES</td>
</tr>
<tr>
<td>SM7</td>
<td>42.39</td>
<td>-71.54</td>
<td>Hudson, MA</td>
<td>WES</td>
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<tr>
<td>SM8</td>
<td>44.48</td>
<td>-69.61</td>
<td>North Vassalboro, ME</td>
<td>WES</td>
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TABLE 3

EARTHQUAKE HYPOCENTER LIST
NEW ENGLAND AND ADJACENT REGIONS
July - September, 2002

<table>
<thead>
<tr>
<th>Date Yr/Mo/Dy</th>
<th>Time Hr:Min:Sec</th>
<th>Lat</th>
<th>Long</th>
<th>Depth (km)</th>
<th>Mag</th>
<th>Int</th>
<th>Location</th>
</tr>
</thead>
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<tr>
<td>2002/07/11</td>
<td>21:53:43.37</td>
<td>40.3507</td>
<td>-70.7907</td>
<td>2.05</td>
<td>3.0</td>
<td></td>
<td>NY, 115 KM S OF MARTHA'S VINEYARD</td>
</tr>
<tr>
<td>2002/07/23</td>
<td>02:09:02.05</td>
<td>49.3413</td>
<td>-66.7960</td>
<td>18.00</td>
<td>3.6</td>
<td></td>
<td>QUEBEC CANADA, 50 MI OF SEPT-ILES</td>
</tr>
<tr>
<td>2002/08/17</td>
<td>05:53:56.07</td>
<td>47.3182</td>
<td>-70.4935</td>
<td>22.61</td>
<td>3.3</td>
<td></td>
<td>QUEBEC CANADA, 10 KM S FROM BAIE-ST .PAUL</td>
</tr>
<tr>
<td>2002/08/22</td>
<td>18:58:38.62</td>
<td>41.8800</td>
<td>-72.5163</td>
<td>0.24</td>
<td>2.2</td>
<td></td>
<td>CT, 4 KM SE OF BROAD BROOK</td>
</tr>
<tr>
<td>2002/09/28</td>
<td>23:47:27.13</td>
<td>42.8593</td>
<td>-71.7248</td>
<td>2.71</td>
<td>2.6</td>
<td></td>
<td>NH, 1 MI NNE OF WILTON CENTER</td>
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</table>

* indicates Mc rather than Mn.
TABLE 5

MICROEARTHQUAKES AND OTHER NON-LOCATABLE EVENTS

<table>
<thead>
<tr>
<th>Date (Yr/Mo/Dy)</th>
<th>Sta</th>
<th>Arrival Time (Hr:Mn:Sec)</th>
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</thead>
<tbody>
<tr>
<td>None recorded this period.</td>
<td></td>
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NESN Station Map
Figure 1: Map of stations of the New England Seismic Network (NESN) in operation during period July - September, 2002. 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 July - September, 2002.
NESP Quarterly Seismicity Map

Figure 3: Earthquake epicenters located by the NESP during period July - September, 2002.

NESP Cumulative Seismicity Map
Figure 4: Seismicity for period October, 1975 - September, 2002.

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

