

## The New England Seismic Network Operated Collaboratively by M.I.T. and Boston College

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### Investigations Undertaken

The Earth Resources Lab (ERL) of MIT and the Weston Observatory (WES) of Boston College operate jointly the New England Seismic Network (NESN). The objectives of the NESN are:

- to continuously monitor and report earthquakes to agencies responsible for public safety,
- to educate the public about seismic hazard by providing general and technical information about earthquakes,
- to use the recorded data to conduct seismological research aimed at reducing earthquake hazard in New England.

The results of investigations aimed at achieving the three objectives listed above are obtained through three main activities:

- Seismic Network Monitoring,
- Data Management and Dissemination,

- Seismic Hazard Research.

This report includes a Non-Technical Summary which provides a brief overview of the objectives of this project.

## **Results**

### *Seismic Network Monitoring*

From November 1, 1997 - October 31, 1998, the Earth Resources Lab at MIT operated five digitally recording short-period stations located in central and southern New Hampshire and eastern Massachusetts (Figure 1). Data from these stations are streamed continuously in analog mode to a central digitizer at ERL. An STA/LTA algorithm running on a PC processes the digitized ground motion to search for seismic events. Event triggers are manually scanned to discriminate different types of seismic events (i.e., teleseisms, explosions, local and regional earthquakes).

The waveforms of regional and local earthquakes are analyzed to provide hypocentral and arrival time information for earthquakes in and adjacent to New England. The hypocentral parameters and associated earthquake maps are compiled continuously and made available to the public on our web-site, <http://www-erl.mit.edu/NESN/homepage.html>.

A number of changes to the MIT NESN have been initiated during the period of this report to improve the quality of recorded ground-motion data, to further reduce the cost of data transmission, and to advance the cooperative monitoring of earthquakes between ERL and WES. First, the siting of Station NH1 (operated by WES), covering the same general area as MIT Station ONH in central New Hampshire, permitted closing the latter station. This action greatly reduced data transmission costs from this region and provided funds to help procure much needed new recording hardware for other stations.

The cooperative monitoring plan of ERL and WES calls for ERL to concentrate most of its stations in eastern Massachusetts, while WES distributes stations broadly throughout New England. This plan insures that the region with the highest seismic risk (eastern Massachusetts) is provided with the densest station coverage to measure earthquake ground motion, while still monitoring the widely scattered source zones of potentially strong earthquakes throughout New England. The high seismic risk in eastern Massachusetts is due partly to the great density

of population and buildings of poor earthquake-resistant design. ERL has begun upgrading its eastern Massachusetts seismic stations with new instruments. In 1998, a new three-component, broadband recording system was purchased from Refraction Technology and Guralp for Station WFM. This included a 24-bit data acquisition subsystem (field unit), a CMG-40T sensor, and a central processing station (Pentium PC, modem/recorder unit with storage disks and DAT). In-house testing of the system, including learning the Reftek acquisition and analysis software as well as writing some software upgrades, is almost complete. Field deployment of the new instrument is scheduled for December 1998.

Year 2 funding for the current 3-year network contract was recently approved by the USGS. Part of this funding will be used to acquire two more broadband instruments to upgrade Stations GLO and DXB in eastern Massachusetts. We expect to be able to deploy these instruments in the spring of 1999. In addition, the search is underway for a fifth site for a new seismic station at the eastern end of Cape Cod, Massachusetts. This location will extend coverage to the east of Massachusetts in an area previously unoccupied. This will provide wider azimuthal coverage of the greater Boston area and potentially expand detection of seismicity. Initially, we will equip this station with a short-period, vertical sensor and continuous analog telemetry to our central digitizer at ERL. Our goal is to upgrade this station with the broadband instrument in Year 3 of this contract.

As before, all stations of the MIT portion of the NESN will maintain continuous telemetry from the field site to ERL. This mode of transmission augments the NESN as a whole, providing real-time data at ERL for preliminary information on the location and magnitude of New England earthquakes for well recorded events, while other data is being retrieved by dial-up and Internet connections to the remainder of the NESN stations (WES).

In addition to the MIT stations, the NESN consists of one other short-period, vertical and ten broadband, three-component stations operated by WES of Boston College. Digitally recorded ground-motion data from seismic events is downloaded from the field sites to WES for processing via dial-up communications and the Internet. The modernization of the NESN is continuing with four additional broadband stations and upgrading of the one short-period station to broadband, three-component status scheduled to be completed in 1999. The establishment of Internet connections to the WES stations in the future should enable direct access from ERL to these stations to

retrieve ground-motion data. This will increase the manpower and computer resources available to process and disseminate earthquake information rapidly to users.

The epicenters of all local and regional earthquakes recorded and located by the MIT NESN for the period November 1, 1997 - October 31, 1998 are displayed in Figure 2. Five earthquakes, with magnitudes of 2.3 - 4.8, occurred during this period. Two of these earthquakes (magnitudes = 2.9 and 3.3), occurring about two months apart, have very similar epicenters and are located in the general area of the epicenter proposed for the 1755 Cape Ann earthquake (The Historical Seismicity of New England, 1977). The 1755 event is believed to have been one of the largest in New England with an estimated maximum magnitude of about 6.2 (Street and LaCroix, 1979).

### **Data Management and Dissemination**

During the period of this report ERL invested much time and effort further developing our in-house map library in ARCINFO formats (e.g., shaded-relief grids, theme maps of natural, cultural, geopolitical features). This work has been continued for multiple purposes, including the creation of the NESN "unified" earthquake bulletin, the rapid posting of epicentral maps for current earthquakes (NEWSFLASH), maps for reports, and the spatial analysis software for research.

Personnel at WES and ERL have worked together this year to achieve the goal of providing hypocenter data about NESN earthquakes to the CNSS Composite Catalog. Progress was made in identifying system software incompatibilities between WES and U.C. Berkeley computer facilities causing the data transmission to fail. WES is working to correct these incompatibilities. ERL will continue to provide its station arrival times and magnitude parameters via FTP to WES for incorporation into the event hypocenter solutions to be eventually shipped to the CNSS Catalog.

In 1998, ERL and WES collaborated to design and generate a "unified" quarterly earthquake bulletin. This bulletin is replacing the quarterly progress and earthquake bulletin formerly published separately by each network operator as a preliminary report on earthquakes in and adjacent to New England. Many of these older NESN reports contained information on earthquakes using data recorded primarily by stations of the individual network operator (i.e., WES or ERL). The new unified bulletin will combine datasets for MIT and WES stations for all

earthquakes recorded by either or both networks into one source. Technical changes in network status for the entire NESN can also be reported in a single document. In addition, data collected from stations operated by the United States National Seismic Network (USNSN), the Geological Survey of Canada, and the Lamont-Doherty Cooperative Seismographic Network will continue to supplement the NESN data for some earthquakes to improve location and magnitude accuracy. The prototype is nearly finished, and the first issue, covering January through March 1998, will be published on the ERL and WES web-sites in November 1998. This bulletin is not intended to replace the Northeastern United States Seismic Network (NEUSSN) Bulletin. It is designed to yield a more timely, more complete, and more widely accessible report on earthquakes in and near New England than the previous individual operator reports generated by WES and ERL.

C++ code was written to streamline the process of building the MIT quarterly earthquake bulletins in HTML format. This code may be used in the future to compile the NESN unified bulletin.

### **Data Availability**

We continue to provide two internet utilities, the [MIT/ERL web-site](#) 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, epicenter and station maps (including an archive of recent seismic events), and gives access to the waveform database search engine. The [search engine](#) performs the waveform search on our digital archive (complete through March 1995) based on the event hypocentral parameters provided by the client. The waveforms are downloaded in SAC format as a Unix-compressed tar volume.

Two changes to the FTP site have been made. First, the site has been renamed from "erl-dialup.mit.edu" to "sunda.mit.edu", and second, the client machine IP number must now 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 (April 1995 through 1997), in Unix-compressed SAC files, are accessed through the anonymous FTP directory. A "readme" file offers further explanation about the data.

Detailed information about events (arrival times, crustal model, azimuthal coverage plots, etc.) is published in quarterly seismic bulletins currently available in hard copy for the period October 1979 -

December 1997, and as HTML documents on our web-site for 1996 and 1997. For more information contact [Charles Doll](#) at 617-253-7863.

Seismic Hazard Research During the period covered by this report we focused on expanding our ARCINFO analysis software and map database in part to facilitate research. Previously, routines were written in AML (Arc Macro Language) to sort earthquakes by hypocentral parameters, identify their attributes by "point-and-click", and plot them in an interactive, graphical environment along with other types of features (e.g., topographic, hydrographic, political, cultural) selected by the user. The AML routines are executed in a menu-driven program. New routines have been initiated to grid a region and measure quantities in the grid cells. For example, one option counts the number of earthquakes in each cell and displays a grid of the cells with the numbers and their assigned color codes, which may be overlain on other map features. The gridding routines will be expanded to compute and display the cell distribution of other quantities relevant to seismic hazard analysis such as cumulative seismic energy release, and will also permit temporal analysis of the gridded quantities. New routines will continue to be incorporated into the menu-driven program to enable interactively changing input parameters (e.g., cell size) and replotting new results "on-the-fly". In the past year, much effort was also spent building and editing grids and coverages to generate new map layers.

**Reports Published** None during this period.

## References

Street, R., and A. Lacroix, 1979. An empirical study of New England seismicity: 1727-1977, Bull. Seism. Soc. Am., 69, 159-175.

The Historical Seismicity of New England, 1977. Published by Weston Geophysical Research, Inc., Nuclear Regulatory Commission submittal docket No. So-471(DE S67601), 641 p.

## Figures

*NESN Station Map*

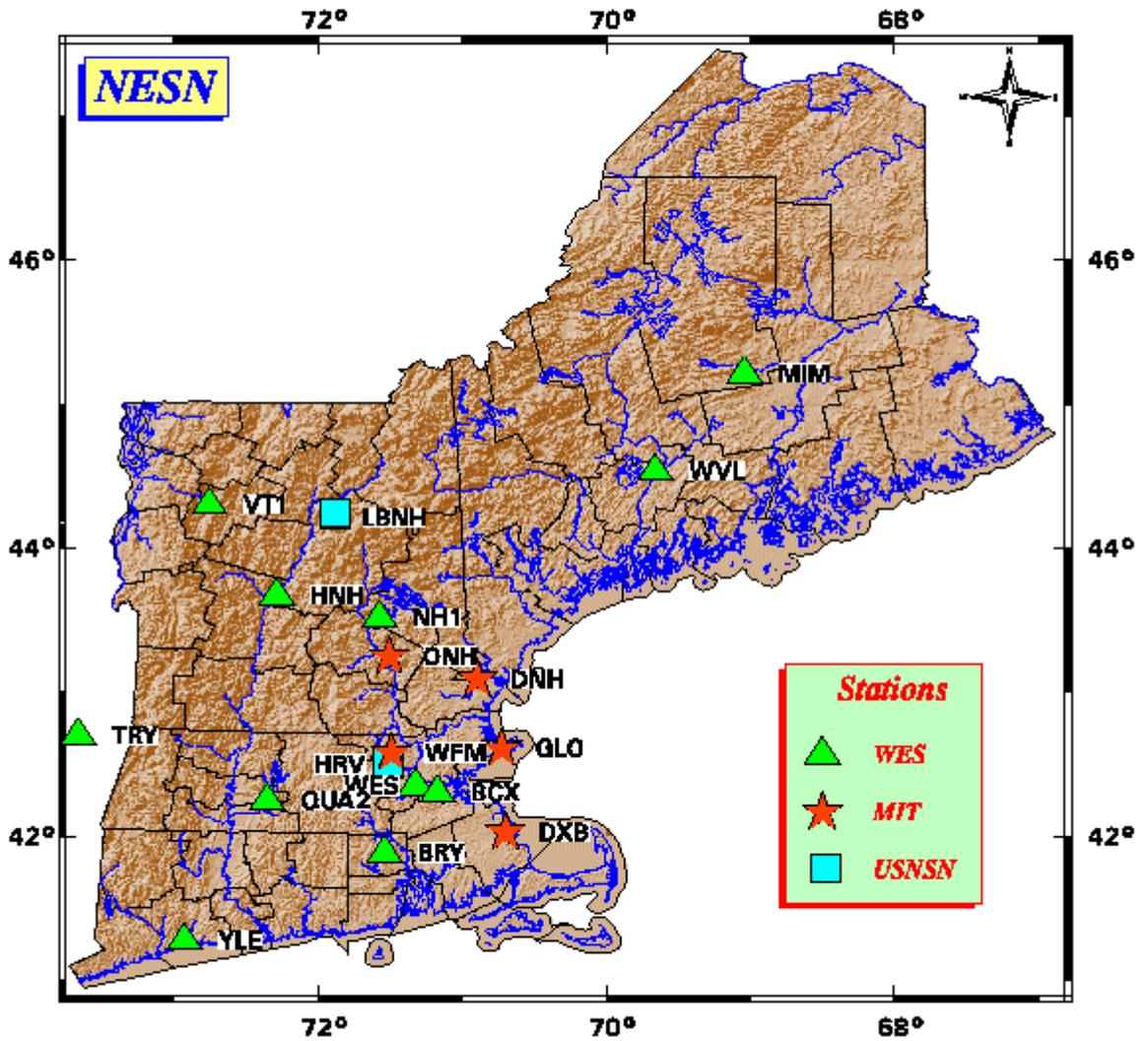


Figure 1: Stations of the New England Seismic Network (NESN) and USNSN stations in New England.

*MIT NESN Seismicity Map*

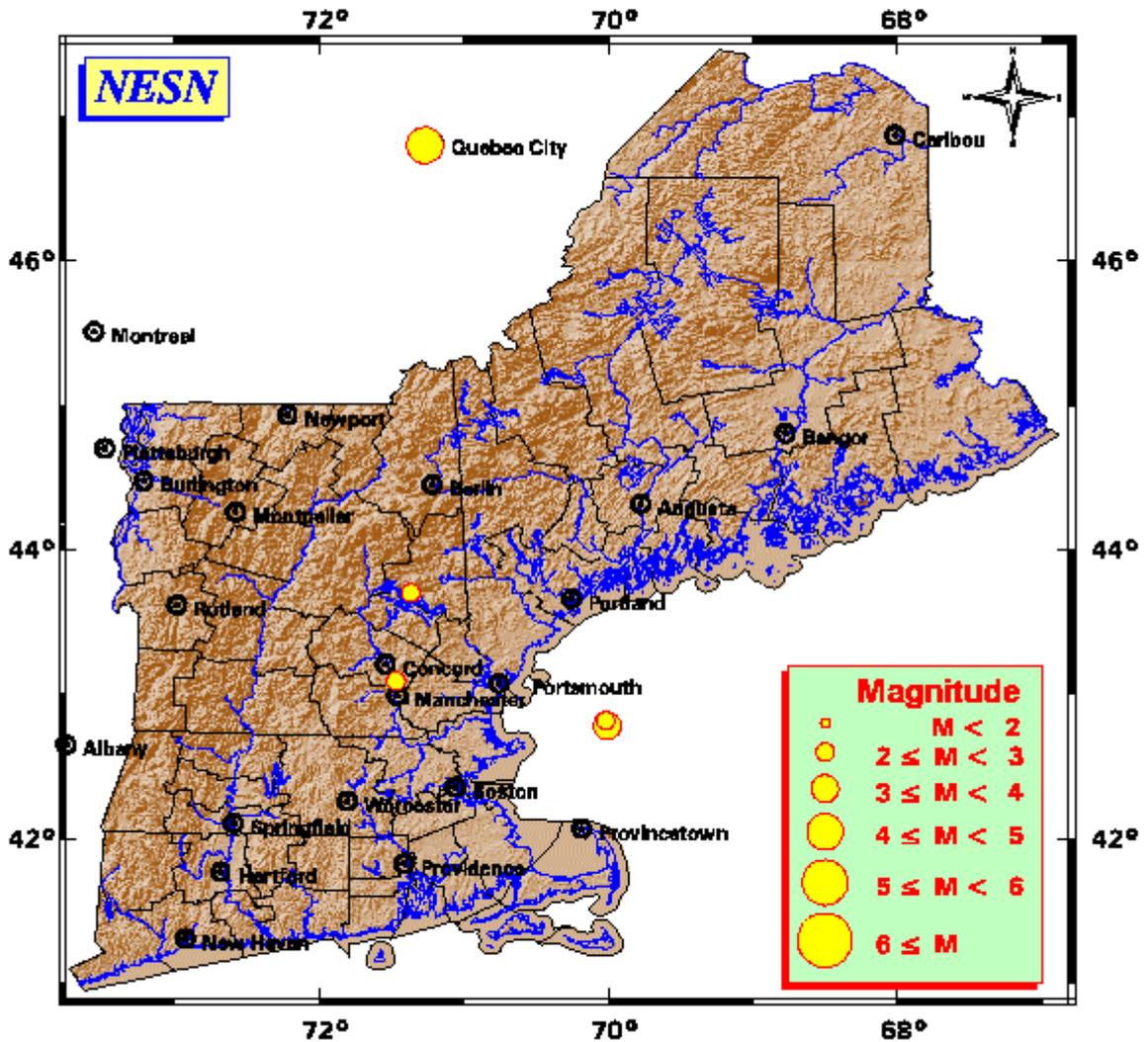


Figure 2: Seismicity located by the MIT NESN from November 1, 1997 through October 31, 1998.

### Non-technical Project Summary

MIT and Boston College collaboratively operate the New England Seismic Network (NESN). Locations and magnitudes of earthquakes recorded by the NESN are reported to public safety agencies and the public. Data dissemination tools are developed to rapidly deliver earthquake information in a high quality format on our web-sites. A

periodically updated archive of digital ground-motion data is maintained on-line for easy access by the research community and other seismic networks via the Internet. Earthquake source properties and the effect of seismic wave propagation on ground motions in an urban area are studied to characterize earthquake hazard in New England.

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[External Research Program Home](#)

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*URL: <http://erp-web.er.usgs.gov/reports/Vol40/net/A01926.htm>*

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