

**The New England Seismic Network
Operated Collaboratively by M.I.T. and Boston College
Annual Project Summary 1999**

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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.

Non-technical Project Summary

November 1, 1998 - October 31, 1999

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, the effect of earth structure on ground motions in urban areas, and potential seismogenic structures are studied to characterize earthquake hazard in New England. 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, the effect of earth structure on ground motions in urban areas, and potential seismogenic structures are studied to characterize earthquake hazard in New England. Non-technical summary which provides a brief overview of the objectives of this project.

Results

Seismic Network Monitoring

From November 1, 1998 - October 31, 1999, the Earth Resources Lab at MIT operated four digitally recording short-period stations located in southern New Hampshire and eastern Massachusetts ([Figure 1](#)). In addition, a new three-component, broadband instrument began operation in June of 1999 at existing Station WFM ([Figure 2](#)) in northeastern Massachusetts. Data from the short-period 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 new broadband station digitizes (24-bit) ground motions on-site and the data is streamed continuously to the PC-based central processing station at ERL. The broadband sensor is a Guralp CMG40T with a frequency response flat to velocity from .03 seconds to 50 Hz. Two more existing stations in eastern Massachusetts (DXB and GLO, see [Figure 1](#)) will be upgraded with the same equipment, which has been received at ERL.

In 1999, WES added another broadband station at a new site near Presque Isle, Maine (PQI, see [Figure 1](#)). This brings the total number of NESN stations operating in New England to sixteen, with thirteen broadband and four short-period instruments.

Following the cooperative monitoring plan developed by ERL and WES, ERL operates its stations at local distances (<100 km) around Boston, 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 motions, while still monitoring the widely scattered source zones of potentially strong earthquakes throughout New England. Defining ground-motion hazard in urban areas is a major objective of the regional seismic networks in cooperation with the USGS, and WES and ERL are configuring the NESN to address that objective.

Year 3 funding for the current 3-year network contract of the MIT NESN was approved by the USGS. The funding for equipment has been used to acquire two more broadband instruments to upgrade Station DNH and a new station (site not chosen yet) in eastern Massachusetts. The field data acquisition system will be the same as the other three instrument upgrades, except that the sensor has been changed to the three-component. Broad-band Guralp CMG-3ESP with a nominal response similar to the CMG40T. This modification was suggested by the USGS because of a somewhat quieter instrument response of the CMG-3ESP. The new station site in eastern Massachusetts will be selected to provide wider azimuthal coverage of the greater Boston area and potentially expand detection of seismicity.

As before, all of the upgraded 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).

The modernization of the NESN is continuing with three additional broadband stations scheduled to be sited by WES in 2000. In addition, ERL will upgrade two short-period stations to three-component, broadband instruments. This will yield a total of 18 three-component, broadband stations operated by the NESN. With the addition of the last two upgrades to the MIT network in 2001, the NESN should have 20 modern stations running by the end of that year. Coverage of earthquakes in New England also will be enhanced in the near future by direct access of the MIT NESN to USNSN and other regional network stations operating in the northeastern US. For example, the establishment of Internet connections from ERL to the USNSN hub in Golden, Colorado will enable direct access to WES and USNSN stations to retrieve ground-motion data almost in real-time. The software interface to achieve this will be Earthworm, a software package that facilitates rapid exchange of waveform and parametric data among networks and fast location of earthquakes.

The epicenters of all local and regional earthquakes recorded and located by the NESN for the period November 1, 1998 - October 31, 1999 are displayed in [\(Figure 3.\)](#) Fifteen earthquakes, with magnitudes of 1.0 - 4.5, occurred during this period. A sequence of four of these earthquakes (magnitudes = 1.9 to 3.0), occurred over a period of five days and had very similar hypocenters. These events were very shallow, and at least three of them were heard and felt. They are located in the general area of the M5 earthquake that occurred on November 10, 1727 on Cape Ann, Massachusetts (Ebel, 1996).

Data Management and Dissemination

The waveforms of regional and local earthquakes are analyzed to provide hypo-central and arrival time information for earthquakes in and adjacent to New England. The arrival times and coda durations are measured from the seismograms recorded by the MIT seismic stations and combined with arrival time and magnitude data for the WES stations to determine the hypocenter solution for local and regional earthquakes. Data from stations operated by the Geological Survey of Canada and the Lamont-Doherty Cooperative Seismographic Network are also incorporated into the earthquake locations when appropriate. The hypo-central parameters and associated earthquake maps are compiled and made available to the public on our web-site, "www-erl.mit.edu/NESN/homepage.html". The homepage features a "Newsflash", which is an epicentral map of a current felt earthquake in, or adjacent to, New England. The "Newsflash" is posted as soon as possible after the earthquake, which is usually within a couple hours of its occurrence.

During the period of this report, ERL and WES initiated a unified quarterly seismic bulletin, which contains the hypocenter solutions for regional earthquakes in and adjacent to New England, and is based on the combined station nets operated by the two institutions. This replaces the bulletins previously published separately by the individual institutions, and addresses the two objectives of reducing duplication of effort between the two network operators and providing better hypocenter solutions (more station data) in one publication. This bulletin is not intended to replace the Northeastern United States Seismic Network (NEUSSN) Bulletin. Instead, it is a preliminary report that is designed to be more timely, complete, and widely accessible than past quarterly progress reports published by the individual institutions. The NEUSSN Bulletin remains as the final report on earthquake activity in and around the northeastern United States.

ERL has continued to develop its in-house map library and spatial database with ARCINFO (e.g., shaded-relief and elevation grids, theme maps of natural, cultural, geopolitical features). This work has 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 spatial analysis capabilities for earthquake research.

WES is working on distributing hypocenter data about NESN earthquakes to the CNSS Composite Catalog. For now ERL will continue to provide its station arrival times and magnitude parameters via FTP to WES for incorporation into the event hypo-center solutions to be eventually shipped to the CNSS Catalog.

Data Availability

We continue to provide 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, epicenter and station maps (including an archive of recent seismic events), and gives access to the waveform database search engine. The search engine, also accessed directly as "http://www-erl.mit.edu/NESN/seisquery.html", 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.

The FTP site is named "sunda.mit.edu". 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 (April 1995 through the present), 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 the quarterly seismic bulletins. These are currently available for the MIT portion of the NESN in hard copy for the period October 1979 - December 1997, and as HTML documents on our web-site for 1996 and 1997. The unified bulletins (WES and ERL stations) are accessible as HTML documents on our web-site for January 1998 - March 1999. Parametric data and epicenter maps for individual earthquakes are published up to the present on our web-site and the WES web-site ("www.bc.edu:80/bc_org/avp/cas/wesobs/"). For more information contact Charles Doll at <mailto:doll@erl.mit.edu> or 617-253-7863.

Reports Published

None during this period.

References

Ebel, J.E., 1996. The seventeenth century seismicity of northeastern North America, *Seism. Res. Lett.*, 67, 51-68.

NESN Station Map

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

NESN Station Map

Figure 2. Waveforms recorded by new broadband stations WFM for a local earthquake that occurred on October 13, 1999 near Westford, MA (M-24).

Figure 3: Seismicity located by the NESN from November 1, 1998 through October 31, 1999. The New England Seismic Network Operated Collaboratively by M.I.T. and Boston College.