The New England Seismic Network

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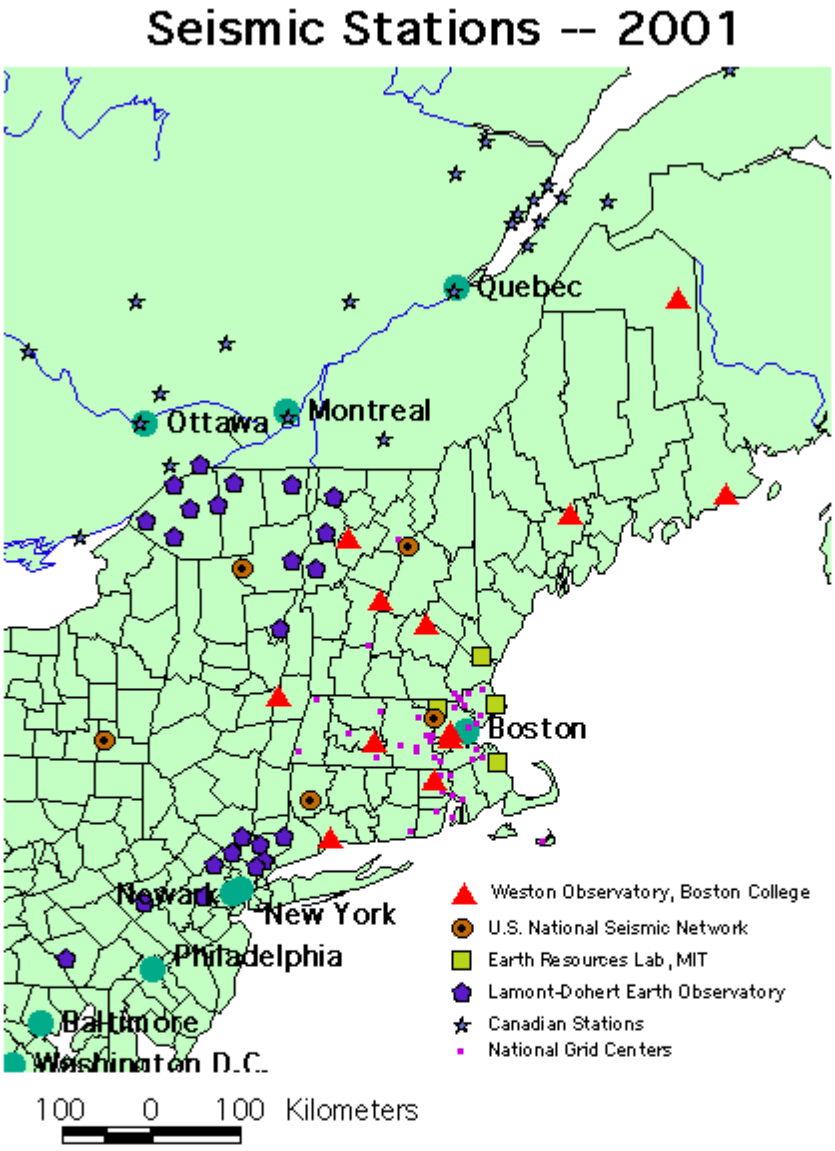
Investigations

The operation of a regional seismic network to monitor earthquake activity in New England and vicinity is supported under this project. The purpose of this earthquake monitoring is to compile a complete database of earthquake activity in New England to as low a magnitude as possible in order to understand the causes of the earthquakes in the region, to assess the potential for future damaging earthquakes, and to better constrain the patterns of strong ground motions from earthquakes in the region. The New England Seismic Network (NESN) is cooperatively operated by Weston Observatory of Boston College and the Earth Resources Laboratory of the Massachusetts Institute of Technology (MIT). The time period of this report is from October 1, 2000 to September 30, 2001. This report summarizes the work carried out under two consecutive USGS awards.

Network Status

The New England Seismic Network is operated by Weston Observatory of Boston College in cooperation with the Earth Resources Laboratory at MIT. During the time period of this report, the Weston Observatory component of the network was comprised of 12 seismic stations



(Figure 1), although one of the stations (TRY at Troy, New York) was not operational during most of the reporting period due to communication problems at the site. Some changes were made in the station configuration during the year of this report. In January 2001 a new seismic

station (EMMW) was installed on the campus of the University of Maine at Machias in eastern Maine. This site communicates via an internet connection, and data from the station is being fed directly to the USGS NEIC in Golden, Colorado. Also, in August 2001 a seismic station (FFD) was installed at a dam site run by the U.S. Army Corps of Engineers in Franklin Falls, New Hampshire. Communicatio! ns to this site is via a dial-up telephone connection. The Franklin Falls site was deemed inportant because of the amount of seismicity in central New Hampshire. The Army Corps of Engineers currently has analog strong-motion instruments at the Franklin Fall site. It is the joint plan of Weston Observatory and the Army Corps of Engineers to convert the strong-motion instruments to digital recording and then feed the digital data directly to the Weston Observatory via Earthworm. Another area where Weston Observatory has been seeking to locate a seismic station is in central Maine. The Maine Geological Survey has identified a potential station site in Guilford, Maine, and Weston Observatory is planning to investigate this site further in the near future to evaluate its suitability for a seismic station.

All of the Weston Observatory stations are PC-based with on-site recording, three-component broadband sensors, and dial-up telephone telemetry or direct internet links to the central station at Weston Observatory. The sensors are CMG-40T feedback geophones with a flat response to ground velocity between roughly 30 Hz and 30 sec. The digitizers are Nanometrics 16-bit with gain-ranging, yielding effectively 136 db dynamic range. The sensor signals are being digitized at a rate of 100 samples per second per channel. The output from the digitizer is sent to a PC computer using OS/2, a multitasking operating system, at the digitizing site. The software controlling the stations stores the signals from the sensor in a continuous disk loop. eight of the sites (BCX, BRY, EMMW, HNH, PQI, WES, WVL, and YLE) are available via internet connection to Weston Observatory, seven of which are also sending their data to the USGS NEIC in Golden, Colorado.

At each station the signals from the seismometer are recorded on a local hard disk. The datastream from the digitizer is examined by a program that uses a filter and STA/LTA scheme to test for possible events. When the STA/LTA threshold is exceeded, a notation of the time and duration of the exceedence is added to a text file on the recording computer. An analyst at Weston Observatory currently uses this detection file from a station to determine the possible times at which events may be contained on the remote disks. The analyst then uses these times to send requests to the remote stations to send windows of waveform data back to Weston Observatory for analysis. The retrieved waveforms from all stations are analyzed and archived at Weston Observatory.

In early 2001 an Earthworm station at Weston Observatory became operational. Data from six stations in New England and one from outside the region are currently being received by the Earthworm server. As experience is gained in working with the Earthworm data, the number of stations being received will increase.

In addition to the Weston Observatory NESN stations, the Earth Resources Laboratory (ERL) at MIT has 3 analog-telemetry seismic stations and one 3-component boradband digital seismic station Massachusetts. The data from these stations provide important additional data for locating earthquakes centered within New England. Also, there are two USNSN stations and one cooperating USNSN station operating in New England. Event arrival time readings, waveforms, and hypocentral information are routinely exchanged between the Weston Observatory and MIT.

Weston Observatory also obtains data from (and sends data to) the Geological Survey of Canada, Lamont-Doherty Earth Observatory, and the U.S. Geological Survey NEIC as required by the occurrences of earthquakes in the region. MIT and Weston Observatory produce a single, joint quarterly seismic network bulletin for the New England area. That bulletin is produced in html format and is posted on the NESN web pages of each institution.

Weston Observatory and MIT continue to archive independently the waveform data for the seismic stations which they are operating. Weston Observatory has the capability to convert the waveforms, routinely stored in Nanometrics format, to either ASCII, SAC or SEED format for external distribution. An ftp account can be set up to allow users from outside Weston Observatory to access waveforms recorded by the network. Weston Observatory also is in the process of developing the capabilities to deliver SEED waveforms of local events to the IRIS DMC. In addition, Weston observatory plans to begin the process of contributing hypocentral data to the CNSS composite catalog on a routine basis.

Weston Observatory maintains two web pages with information about local earthquakes:

- http://www.bc.edu/westonobservatory
- http://seismoeagle.bc.edu/

Currently available on the seismoeagle web page is the full catalog of northeastern earthquake activity to 1991 along with recent quarterly reports (joint with MIT) of the seismicity detected by the NESN.

Seismicity

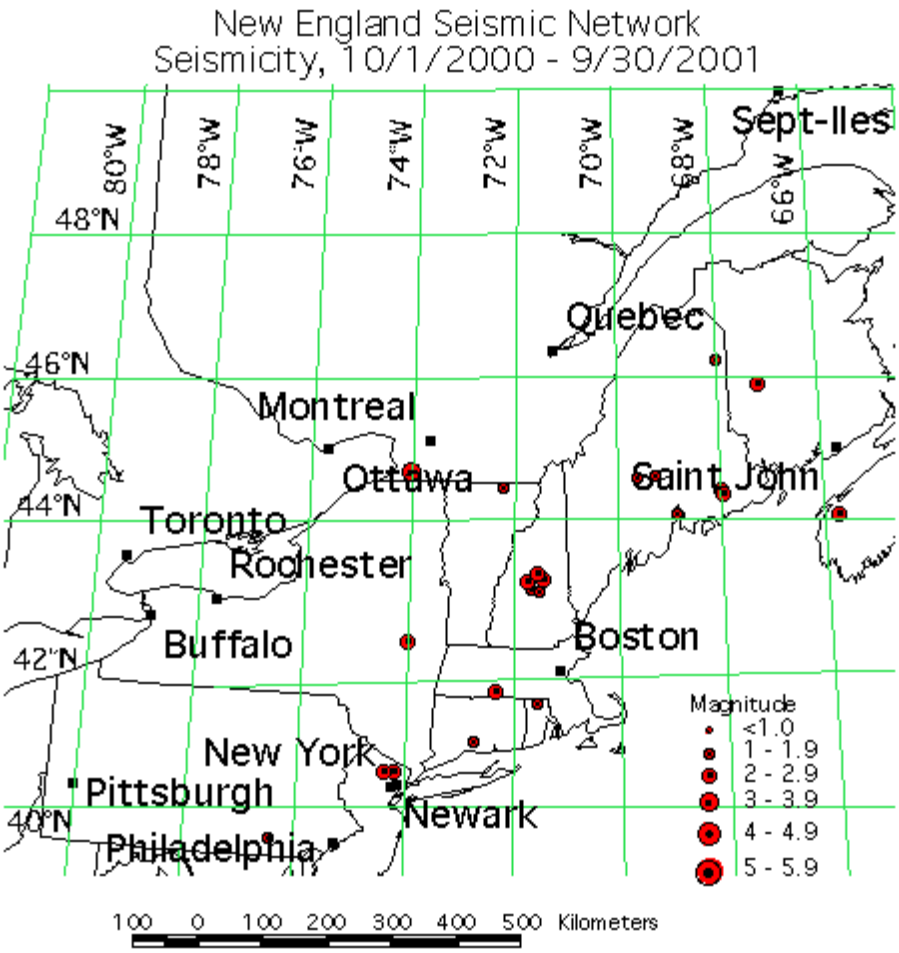


Figure 2 shows the local and regional earthquakes recorded by the Weston Observatory NESN seismic stations of Weston Observatory from October 1, 2000 to September 30, 2001. A total of 24 local earthquakes from New England and vicinity with magnitudes from 1.3 to 3.6 were detected and located by the network, some of which were felt. Of this total, 15 earthquakes, ranging in magnitude up to 2.4, were centered in New England itself. In addition to these events, some microearthquakes and suspected events, too small to be located, were detected by the network. The number of earthquakes during this reporting period is comparable to that from recent years.

Perhaps the most significant observation concerning the seismicity in New England itself is that for the first time since the regional seismic network became operational in 1975 there was no earthquake of magnitude 3.0 or greater centered within New England proper. According to Ebel (1984), the expected largest earthquake in New England each year should have a magnitude of 3.7. The largest New England earthquake of 2.4 during the period of this report was significantly below the expected value. Curiously, a number of very small earthquakes (magnitude less than 2.0) were reported felt in the region, and so the number of felt earthquakes during this reporting period was not significantly different from that during previous years. All of the felt reports from earthquakes during this reporting period came from localities within only a few kilometers from the epicenters, consistent with the small magnitudes computed for the events. It is not clear why the earthquake activity h! ad such low magnitudes during the reporting year since no change was made in the way that Weston Observatory locates earthquakes or computes earthquake magnitudes during this time.

The most seismically active area in New England during the reporting period was in central New Hampshire, with three events detected near Meredith and single events near Franklin and Belmont. During the past two decades, this area has been the most seismically active in all of New England, and it is where Ebel et al. (2000) speculated that the rupture zone of an MLg 6.5 earthquake in 1638 may have occurred.

One of the other New England earthquakes during this reporting period was in an interesting location. It was an earthquake of MLg 1.8 that was centered in North Branford, CT on February 3, 2001. Recent geologic work has indicated the possibility that Quaternary faulting may have taken place on the eastern border fault of the Connecticut rift basin in Branford (Thompson et al., 2000). The February 3, 2001 earthquake was located within a few kilomenters of the site of this possible Quaternary faulting.

Of the earthquakes from outside New England, probably the most important was an MLg 2.5 earthquake that was centered under northeastern Manhattan Island of New York City on January 17, 2001. This earthquake was felt by residents of northern Manhattan and western Queens. The event suggests that there may be a potential hazard from an earthquake centered in New York City itself.

Also pertinent to the earthquake monitoring in New England was the discovery of a non-random component in the temporal earthquake activity, as reported by Ebel and Kafka (2001). Ebel and Kafka (2001) noted that the New England earthquake catalog has more earthquakes of MLg >= 2.7 than would be expected from a Poisson (random) process. This means that once an earthquale of MLg >= 2.7 takes place in New England, there is an enhanced probability of

another such event centered somewhere in New England in the next several days. Specifically, the probability of a random earthquake of MLg >= 2.7 during any 7-day period in New England is 11%. However, when an earthquake of MLg >= 2.7 takes place, there is a 22% chance of another such event during the subsequent 7 days. Should the first event be MLg >= 3.5, the probability of an MLg >= 2.7 during the next 7 days is 35%. There is a link called "Weekly Probability ! of Felt Earthquakes in New England" on the Weston Observatory web page that shows the probability of a felt earthquake in New England for each upcoming 7-day period. Also shown on this web page is a map of those areas in New England that have about a 67% probability of being the epicenter of an earthquake of MLg >= 2.7 during the 7-day period. This map is based on the work of Kafka and Levin (2000).

Fig. 1. Stations of the Weston Observatory New England Seismic Network and other seismic stations in the northeastern U.S.and southeastern Canada in September 2001. (Return to text).

Fig. 2. Seismicity of the northeastern U.S. and southeastern Canada detected by the Weston Observatory New England Seismic Network from October 1, 2000 to September 30, 2001. (Return to text).

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Non-Technical Summary

The New England Seismic Network is cooperatively operated by Weston Observatory of Boston College and by the Earth Resources Laboratory of MIT. From October, 1, 2000 through September, 30, 2001 this seismic network detected and located 23 local earthquakes in the region with magnitudes from 1.3 to 3.6, along with a number of afterhshocks and microearthquakes too small to be felt. This was time period was unusual in that no earthquake of magnitude 3.0 or greater was detected from anywhere in New England, the first time since 1975 when they has

occurred. The accumulation of earthquake data by the regional seismic network is helping to define the seismically active parts of the region and to better quantify the earthquake hazard in New England.

Published Articles

None during the reporting period.

Published Abstracts

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