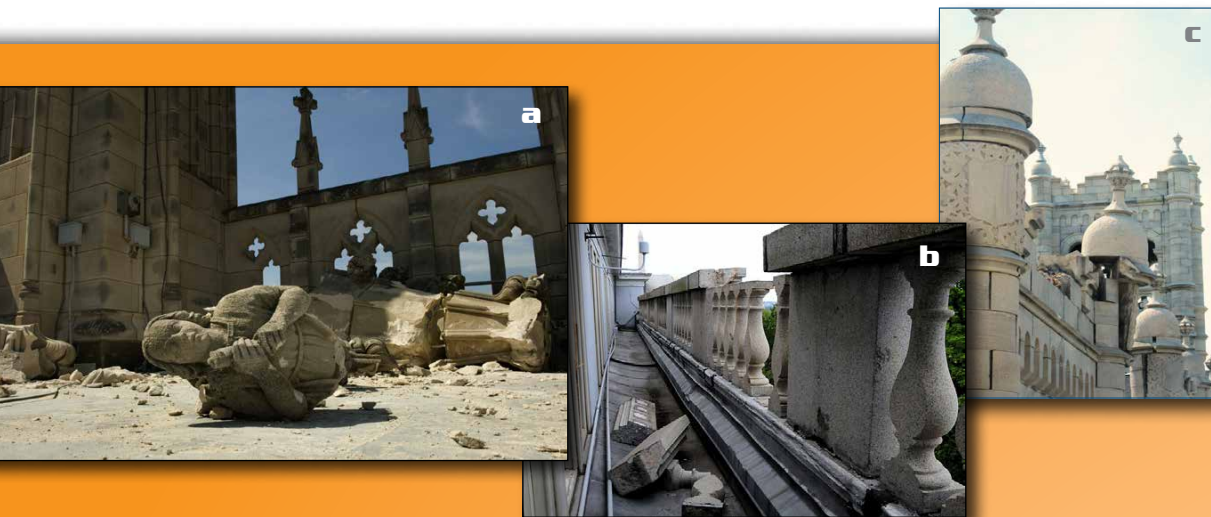


Large earthquakes in the central and eastern United States are relatively rare, but could have devastating consequences because many buildings and much of the infrastructure are not built with earthquakes in mind. In the past, large earthquakes occurred in New Madrid, Missouri, in the winter of 1811–1812 and near Charleston, South Carolina, in 1886. Even the moderate 2011 M5.8 Mineral, Virginia, earthquake damaged the Washington Monument, the National Cathedral, and other buildings as much as 130 km (80 miles) from the epicenter. Human industrial activity, primarily through subsurface fluid injection of wastewater, is causing the so-called “induced earthquakes” that have increased seismic hazard in some parts of the central and eastern United States.

Currently, the 158 stations of the Central and Eastern US Seismic Network (CEUSN), installed as part of the National Science Foundation (NSF) supported EarthScope project, is advancing our understanding of natural earthquakes and human-induced events in the central and eastern United States and improving the US Geological Survey (USGS) National Seismic Hazard Maps on which building codes are based. The CEUSN supplements the sparser array of the USGS and other seismic stations in the region, and almost doubles the number of seismic stations operating in the United States, east of the Rocky Mountains.

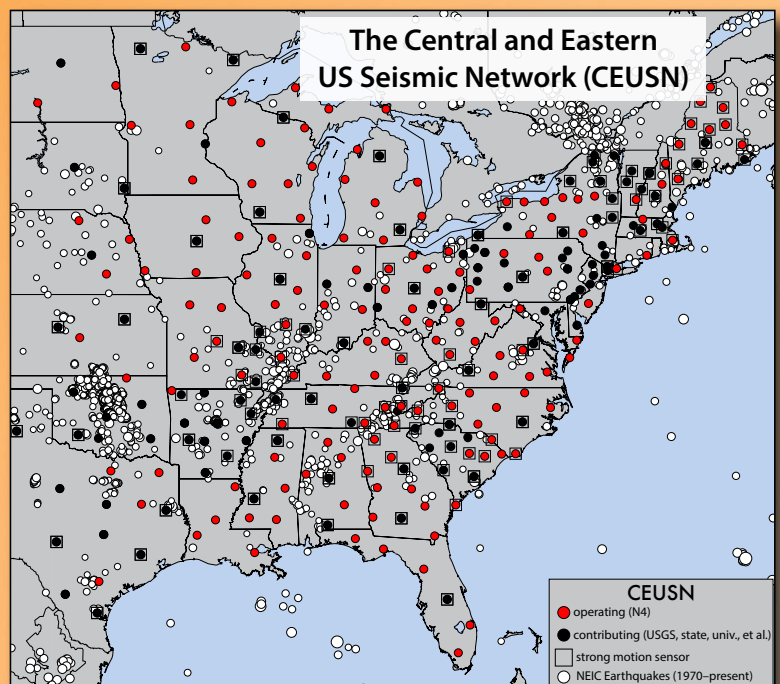


Damage in Washington, DC, caused by the 2011 Mineral, Virginia, earthquake included the (a) National Cathedral (photo credit: Nikki Kahn/ The Washington Post), (b) US Treasury building (photo credit: US Department of the Treasury, and (c) historic Sherman Building (photo credit: Armed Forces Retirement Home and PRESERVE/scapes).

2011 Mineral, Virginia Earthquake

More people felt the August 23, 2011, M5.8 Mineral, Virginia, earthquake, which struck within the Central Virginia Seismic Zone, than any other earthquake in US history.

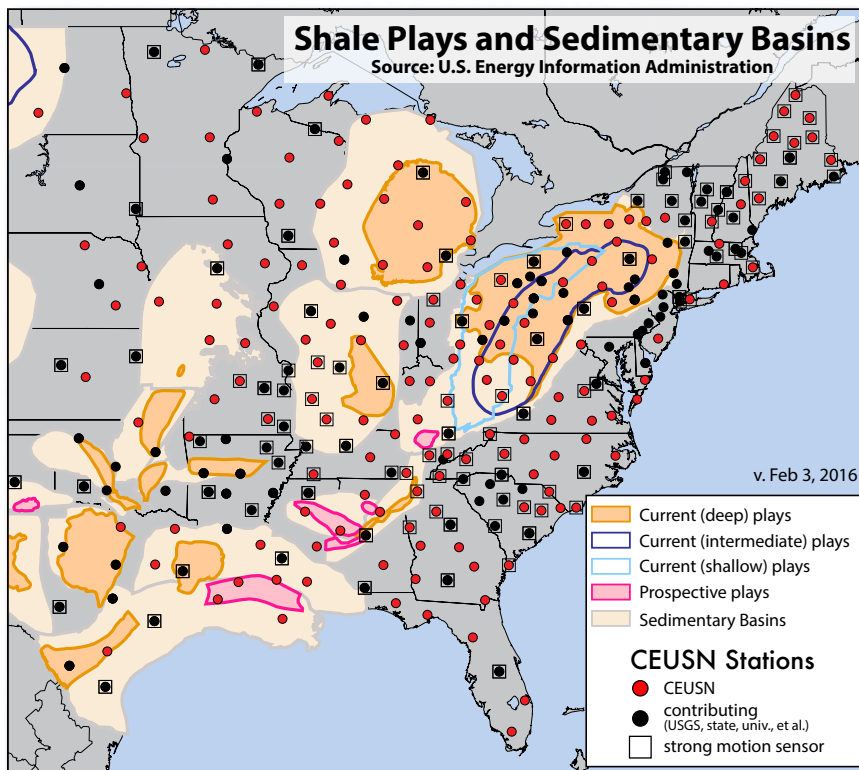
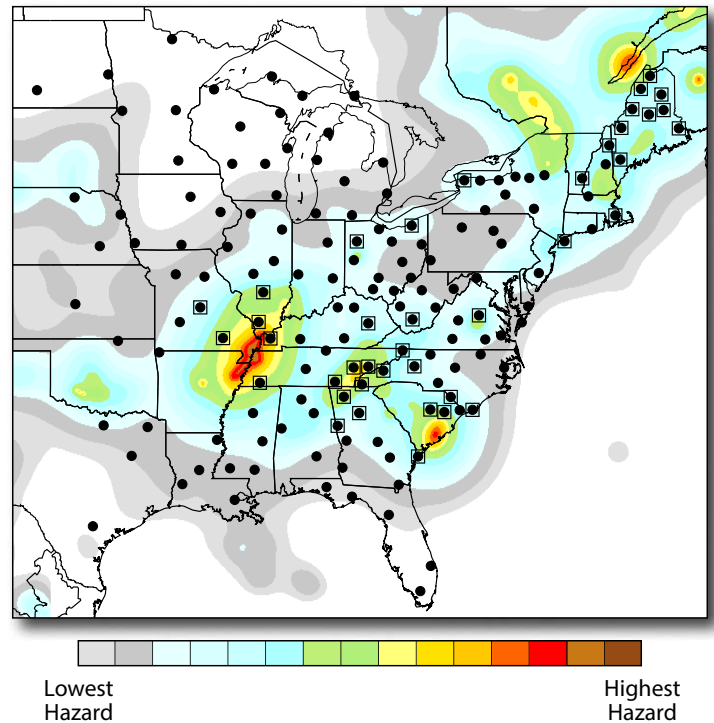
- The USGS received 148,638 felt reports from 31 states and four Canadian provinces.
- The Mineral, Virginia, earthquake occurred near the North Anna nuclear power plant.
- In 2011, the USGS finalized a report for the US Nuclear Regulatory Commission, and determined that at least 25 additional broadband and strong motion stations are needed to support Nuclear Regulatory Commission goals and support the agency's oversight responsibilities.
- Additional priorities for continued station coverage include regions of elevated seismic hazard to understand ground motion and characterize faults, especially near critical facilities.



CEUSN: Improving National Seismic Hazard Maps and Building Codes

Communities in the central and eastern United States are not as prepared as communities in the West to respond to low-probability, high-consequence earthquakes, like the 2011 M5.8 Virginia earthquake. The primary assessments of earthquake hazards throughout the United States are the National Seismic Hazard Maps, which show the intensity of ground shaking that a building or other structure may have to withstand. The denser seismic network provided by the CEUSN will better characterize the ongoing seismicity by detecting smaller earthquakes, providing better locations for all earthquakes, and providing more accurate measurements of how seismic energy is transmitted across the region.

- Building codes are determined based on National Seismic Hazard Maps, which rely on accurate accounts of background seismicity and seismic energy transmission across the states.
- Measuring seismic energy transmission has been particularly difficult in the central and eastern United States because the seismic networks were relatively sparse and there are relatively few earthquakes. The CEUSN is providing a significant improvement in coverage.



CEUSN: Detecting and Monitoring the Growing Problem of Induced Seismicity

The number of earthquakes in the central and eastern United States has risen dramatically in the past decade because of seismicity caused by human activity.

Earthquakes induced by injection of waste fluids into deep wells, and less often, by hydraulic fracturing (hydrofracking) that has rapidly increased hydrocarbon production, are growing problems in the central and eastern United States. A challenge to understanding induced earthquakes is the difficulty in detecting small magnitude earthquakes that can mark the onset of human-induced seismicity, and characterizing the changes in the numbers of small earthquakes. The density of CEUSN stations will permit earlier detection and better monitoring of induced earthquakes, which can help operators control the fluid injection to mitigate potential damage from these earthquakes.

CEUSN: Monitoring Non-Earthquake Seismic Events

Quarry blasts, mine collapses, severe weather, and other natural and human events can be monitored by seismic arrays. The arrays can help pinpoint the locations of the events, provide additional information to aid in understanding the causes of accidents such as mine collapses, and measure the energy from quarry blasts and other explosions.

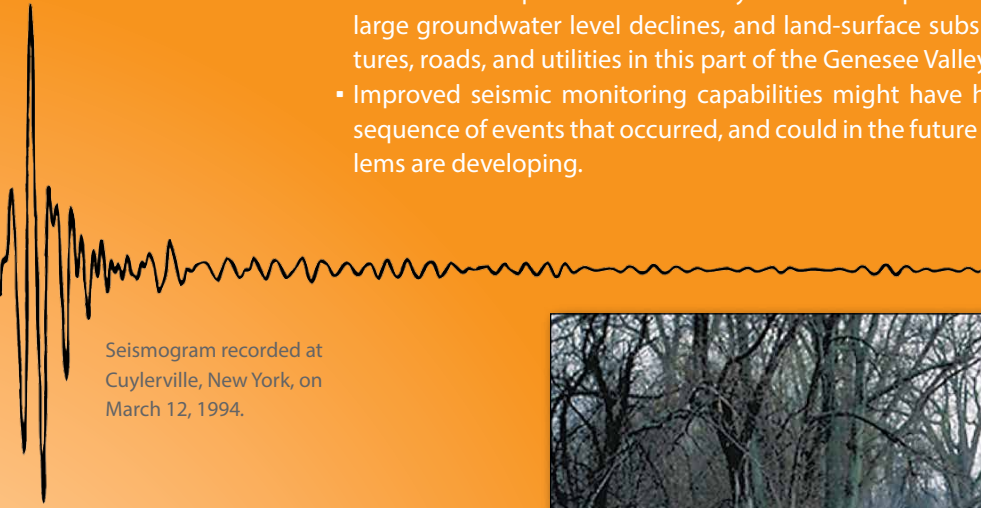
CEUSN: Helping Understand the Causes of Earthquakes

Even a moderate earthquake beneath a major city in the central and eastern United States may have a severe impact on surface structures, yet the causes of seismicity in this region are poorly understood compared to earthquakes in the tectonically active western United States. In the central and eastern United States, we know less about which faults are active, what processes cause the seismic activity, or how frequently large earthquakes may occur. The CEUSN will provide a wealth of new data to detect more earthquakes of smaller magnitude throughout the region, and more accurately locate and characterize these earthquakes to reveal active faults. Data from the CEUSN will provide our best opportunity to understand the causes of earthquakes in the region.

1994 Retsof Salt Mine Collapse

An apparent earthquake of M3.6 near Cuylerville, New York, woke residents on March 12, 1994. Seismometers as far as 300 km away recorded the earthquake.

- The earthquake was the result of shale ceiling rock collapse in the Retsof Salt Mine.
- Methane and hydrogen sulfide gases escaped, and groundwater flowed from the collapsed ceiling into the mine. The mine had always been dry since it began operating in 1885.
- The initial collapse was followed by another collapse and complete flooding of the mine, large groundwater level declines, and land-surface subsidence that affected many structures, roads, and utilities in this part of the Genesee Valley.
- Improved seismic monitoring capabilities might have helped to better understand the sequence of events that occurred, and could in the future provide some warning that problems are developing.



Seismogram recorded at Cuylerville, New York, on March 12, 1994.

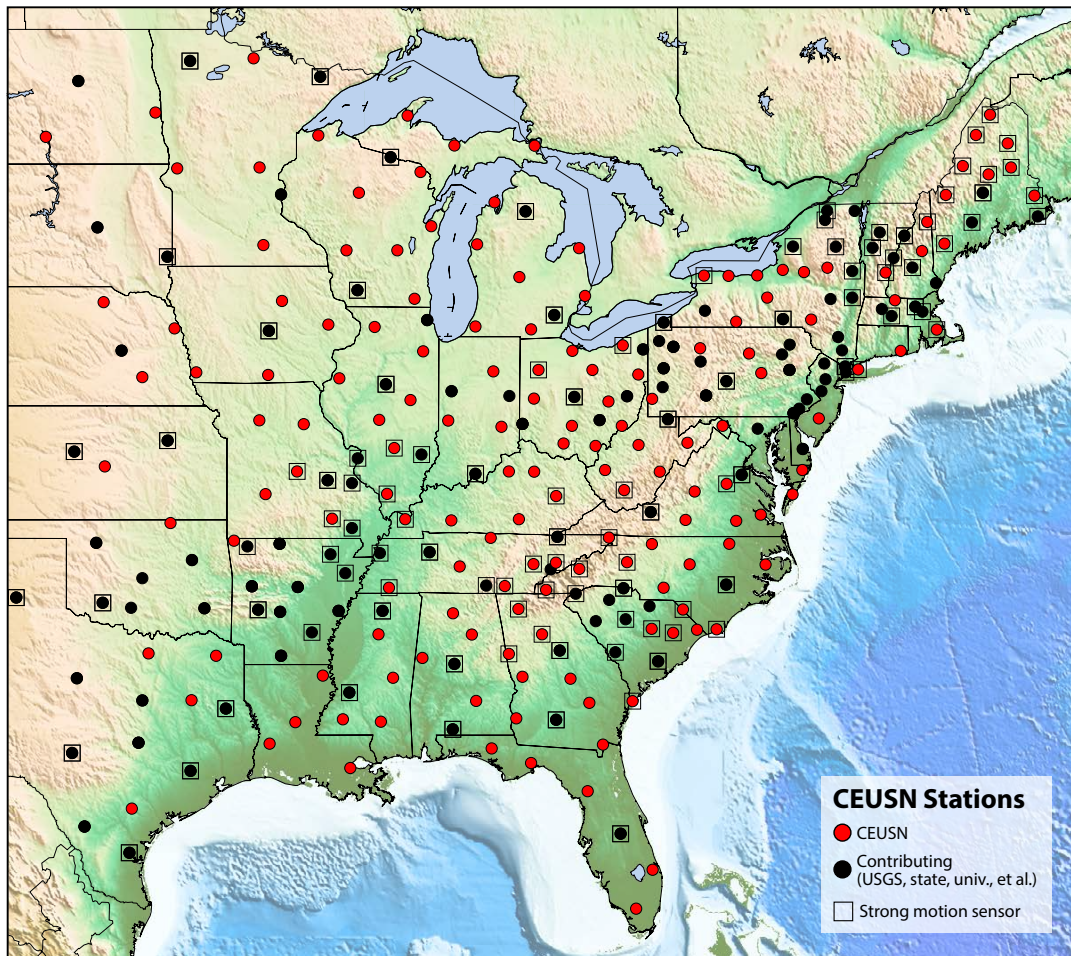
Damage caused by the Retsof Salt Mine Collapse.



CEUSN: Capitalization on Earlier Investments

Several Federal agencies recognized the unique opportunity to retain select EarthScope seismic stations in the central and eastern United States beyond their standard deployment period of two years per site, allowing creation of the CEUSN. In 2012, the USGS and NSF worked with the White House Office of Science and Technology Policy, the Nuclear Regulatory Commission, the Department of Energy, and the Office of Management and Budget to develop a plan for the CEUSN under which NSF would support the construction costs and the USGS would seek funding to assume the long-term operation after NSF support ends in October 2017. Stations were chosen for retention in order to maintain a relatively uniform distribution across the region while focusing on proximity to known regions of seismic hazard, nuclear power plants and other critical facilities, and potential scientific targets.

The Incorporated Research Institutions for Seismology (IRIS) expects to operate the CEUSN through FY17. The 158 stations retained from the EarthScope deployment, with operation and management funds provided by NSF and the USGS, are a valuable investment toward a better understanding of seismicity in the central and eastern United States. All data are recorded in real time and sent to the IRIS Data Management Center for permanent archival under network code N4.



<http://www.usarray.org/ceusn>

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