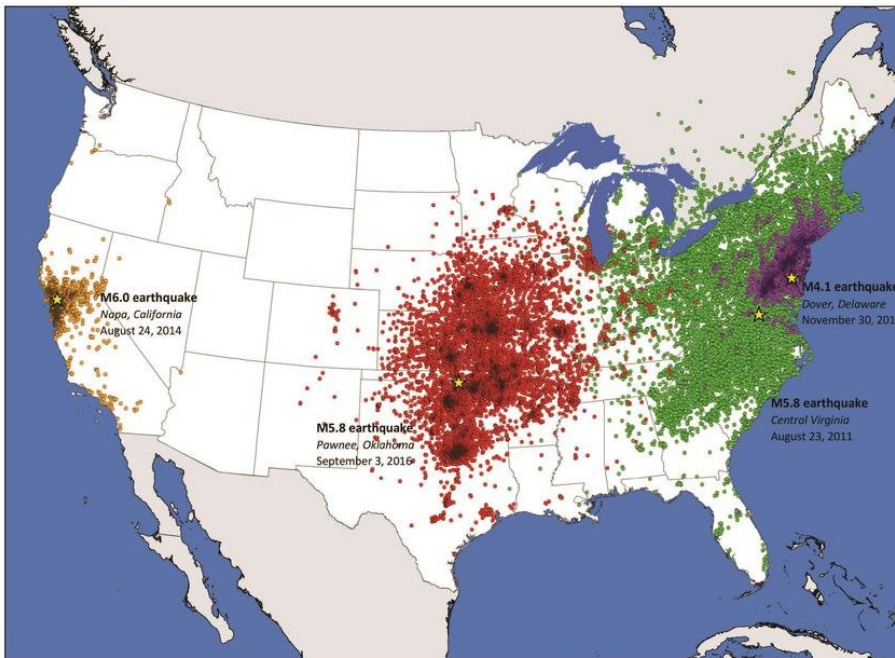


# East vs. West Coast earthquakes

April 25 2018



U.S. Department of the Interior  
U.S. Geological Survey

Map of USGS “Did You Feel It?” data shows that earthquakes east of the Rocky Mountains are felt over larger areas than earthquakes in the West. Credit: Eric Jones, USGS

Why was an earthquake in Virginia felt at more than twice the distance than a similar-sized earthquake in California? The answer is one that many people may not realize. Earthquakes east of the Rocky Mountains

can cause noticeable ground shaking at much farther distances than comparably-sized earthquakes in the West.

A magnitude 5.8 earthquake in 2011 in Mineral, Virginia, was felt up to 600 miles from the epicenter. Tens of millions of people in the eastern United States and southeastern Canada felt this earthquake.

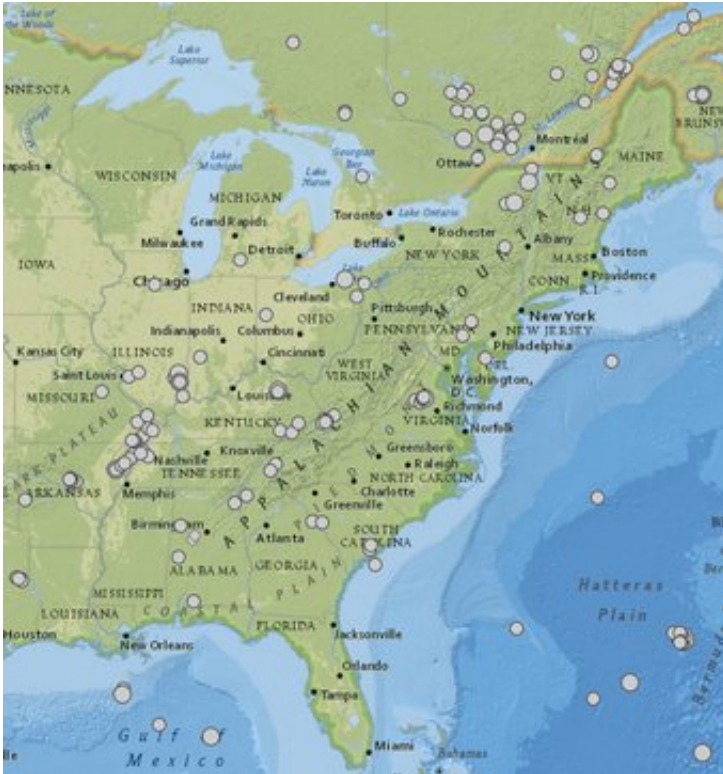
For comparison, a magnitude 6.0 earthquake in 2014 in Napa, California, was felt only as far as 250 miles from the epicenter. Despite the Napa earthquake releasing about twice as much energy as the Virginia earthquake and causing much more damage near the epicenter, it wasn't felt nearly as far away.

As another example, the magnitude 4.1 earthquake that occurred in December 2017 near Dover, Delaware, was felt approximately 200 miles from the epicenter. The region that felt this earthquake is about the same size as that of the much larger California event, which released about 700 times more energy.

Scientists are researching a variety of factors that influence regional differences in the intensity and effects of earthquakes. Some of the factors have to do with the nature of the underlying [tectonic plates](#) and their geologic history. Others are connected to the size and age of buildings.

## **Seismic Waves Can Travel Farther in the East**

Eastern North America has older rocks, some of which formed hundreds of millions of years before those in the West. These older formations have been exposed to extreme pressures and temperatures, making them harder and often denser. Faults in these older rocks have also had more time to heal, which allows seismic waves to cross them more effectively when an earthquake occurs.



This map shows earthquakes above magnitude 4.0 in the eastern United States since 1973, the first year with a complete catalog. There are 184 earthquakes recorded. An earthquake of magnitude 4.0 or greater can cause minor or more significant damage. The circle sizes correspond to earthquake magnitude, ranging from 4.0 to 5.9 (the largest was in the Gulf of Mexico). Credit: United States Geological Survey

In contrast, rocks in the West are younger and broken up by faults that are often younger and have had less time to heal. So when an earthquake occurs, more of the [seismic wave](#) energy is absorbed by the faults and the energy doesn't spread as efficiently.

## More Vulnerable Infrastructure in the East

Many of the older structures in the East, such as buildings and bridges

built before the 1970s, were not designed to endure earthquakes and therefore may not fare well. The recent earthquakes that struck near Christchurch, New Zealand showed the damage that infrequent earthquakes can do to a region with older structures. With that said, modern buildings are being constructed to newer design standards, and there has been progress in retrofitting many older buildings in the East. In the West, older structures are often retrofitted, and new structures are designed to withstand strong shaking.

Furthermore, smaller structures such as houses could experience stronger and more damaging shaking in the East. Earthquakes in the East tend to cause higher-frequency shaking—faster back and forth motion—compared to similar events in the West. Shorter structures are more susceptible to damage during fast shaking, whereas taller structures are more susceptible during slow shaking.

## **Surprising Level of Shaking in Washington, DC**

An example of the earthquake hazard in the eastern U.S. is provided by the surprising level of high-intensity ground shaking that occurred in Washington, DC, during the 2011 Virginia earthquake. This shaking caused well-publicized damage to some historic buildings, even though the earthquake was moderate in size and its epicenter was 80 miles from the city.

To learn more, USGS scientists [deployed 27 temporary seismometers](#) throughout DC to study variations in the strength of earthquake ground shaking. The instruments recorded ground motions from 30 earthquakes around the world during the 10 months they were in place.



Damage at the Sherman Building in Washington, DC, caused by the magnitude 5.8 earthquake in August 2011 in Mineral, Virginia. Credit: EHT Tracerics

Scientists confirmed that [shaking is amplified](#) in the parts of DC underlain by a thin layer of sediments compared to areas built on more solid, harder bedrock. This is because the energy in the seismic waves can move the lighter, weaker sediments more easily than the harder bedrock, and that energy gets "trapped" and echoes multiple times within the sediments.

While this amplification effect has been well documented in some western cities, including Seattle, Los Angeles and San Francisco, this is the first study that directly measures the effect in the nation's capital. It was previously suspected to occur in Washington, DC, and had been found in other cities such as Boston.

Other major cities in the central and eastern United States with similar geology that could lead to amplified ground shaking include Trenton, New Jersey; Wilmington, Delaware; Baltimore, Maryland; Richmond, Virginia; and Columbia, South Carolina. Similar deposits also underlie cities in the Mississippi Valley and Gulf Coast, notably Memphis,

Tennessee, near the New Madrid Seismic Zone.

The new results about amplification and the more efficient energy transmission in the East are part of an increased understanding and awareness of [earthquake hazards](#) in central and eastern U.S. cities. This information is especially useful to engineers and architects when designing buildings and retrofitting existing structures.

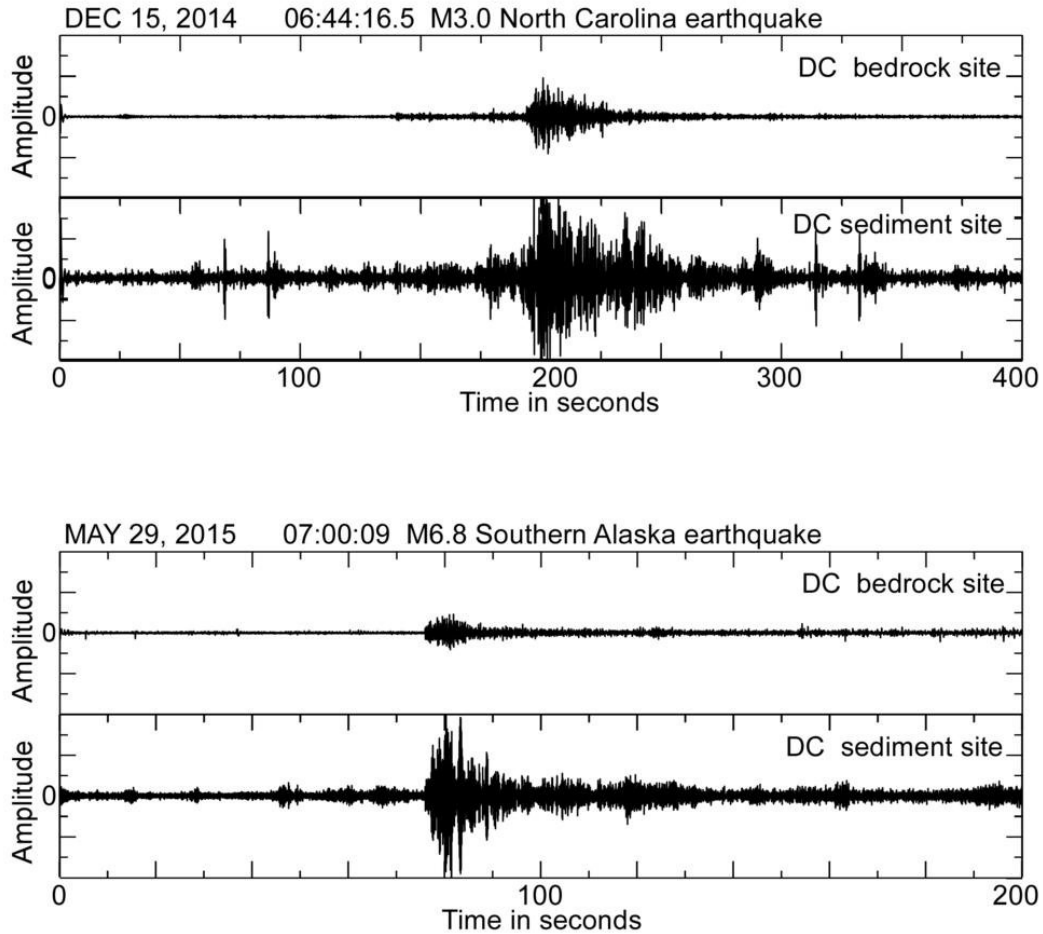
## **Challenges of Assessing Earthquake Hazards in the East**

The geology of the eastern United States and the relatively sparse history of earthquakes to study make it difficult for scientists to assess how frequently earthquakes will occur and how large they can be. Eastern earthquakes are more of a mystery because they do not take place at a plate boundary where most other earthquakes originate. Scientists do not fully understand the state of stress within tectonic plates, and they are studying how stresses accumulate and evolve and how earthquakes are triggered.

Scientists also do not know precisely where most active faults are located in the East. Most faults have not had major earthquakes or movement in the past few million years, and the faults that are active may only have earthquakes every few thousand or tens of thousands of years.

Furthermore, any evidence of past earthquakes on the land's surface in the eastern U.S. is often obscured by vegetation or is more subdued because of erosion.

## Amplitude of ground shaking in Washington, DC, from earthquakes in North Carolina and Alaska



This graphic demonstrates that ground shaking from earthquakes is amplified at sites with sediment compared to those with harder bedrock. The upper panel shows ground shaking at bedrock and sediment sites in Washington, DC, from an earthquake in North Carolina. The lower panel shows ground shaking in DC from an earthquake in Alaska. Credit: United States Geological Survey

Conversely, the West has more active faults and many areas with sparse

vegetation, meaning earthquakes can leave clear markings that inform research on earthquake history, size and effects.

## Ongoing Research

The National Science Foundation and the USGS recently added [new seismic stations](#) in the central and eastern United States, creating a more robust network that augments the monitoring by university partners. USGS scientists also are working with university collaborators on several research projects. For example, they are searching parts of Virginia and the Carolinas for evidence of strong earthquake shaking in the past, monitoring earthquakes and studying faults near the 2011 earthquake in Virginia and the 1886 earthquake in Charleston, South Carolina, and conducting detailed studies of the seismically active central Virginia region.

## Scientists Can't Predict Earthquakes

As far as predicting earthquakes, no reliable short-term earthquake prediction method has ever been developed. Nor do scientists expect to develop a method in the foreseeable future. However, using scientific data—such as fault locations and patterns of earthquakes over many years—[probabilities can be calculated](#) for future earthquakes, and that information is used in development of building codes. Furthermore, the USGS and its partners are working to develop a prototype Earthquake Early Warning System for the West Coast of the U.S. called ShakeAlert. The system does not predict earthquakes, but once an earthquake happens, it could provide a few seconds to tens of seconds of warning before seismic waves arrive and cause strong shaking.

## More Earthquakes in the West



The western United States lies along the boundaries of major tectonic plates that make up the Earth's crust—the North American Plate and the ocean plates to the west. These plates are moving against each other, breaking up the crust along many faults like the San Andreas Fault. Faults in the East are less active and lie entirely within the North American Plate.

One of the most important takeaway messages is that everyone should know how to protect themselves during an earthquake. Check out [FEMA's Ready campaign](#) for tips on [earthquake](#) preparedness.

Provided by United States Geological Survey

Citation: East vs. West Coast earthquakes (2018, April 25) retrieved 25 April 2024 from <https://phys.org/news/2018-04-east-west-coast-earthquakes.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.