Magnitude 4.8 NEW JERSEY
Friday, April 5, 2024 at 14:23:20 UTC

Latitude 40.703°N
Longitude 74.758°W
Depth 4.7 km

A rare 4.8 magnitude earthquake rattled the Northeast on Friday, occurring at 10:23am EDT about 4 miles north of Whitehouse Station, New Jersey at a depth of 4.7 km (3 miles). The earthquake was widely felt.

There have been no reports of injuries and only minor damage.

Video of the earthquake as experienced by the Statue of Liberty recorded on her multiple Torch Cams (NPS / EarthCam)

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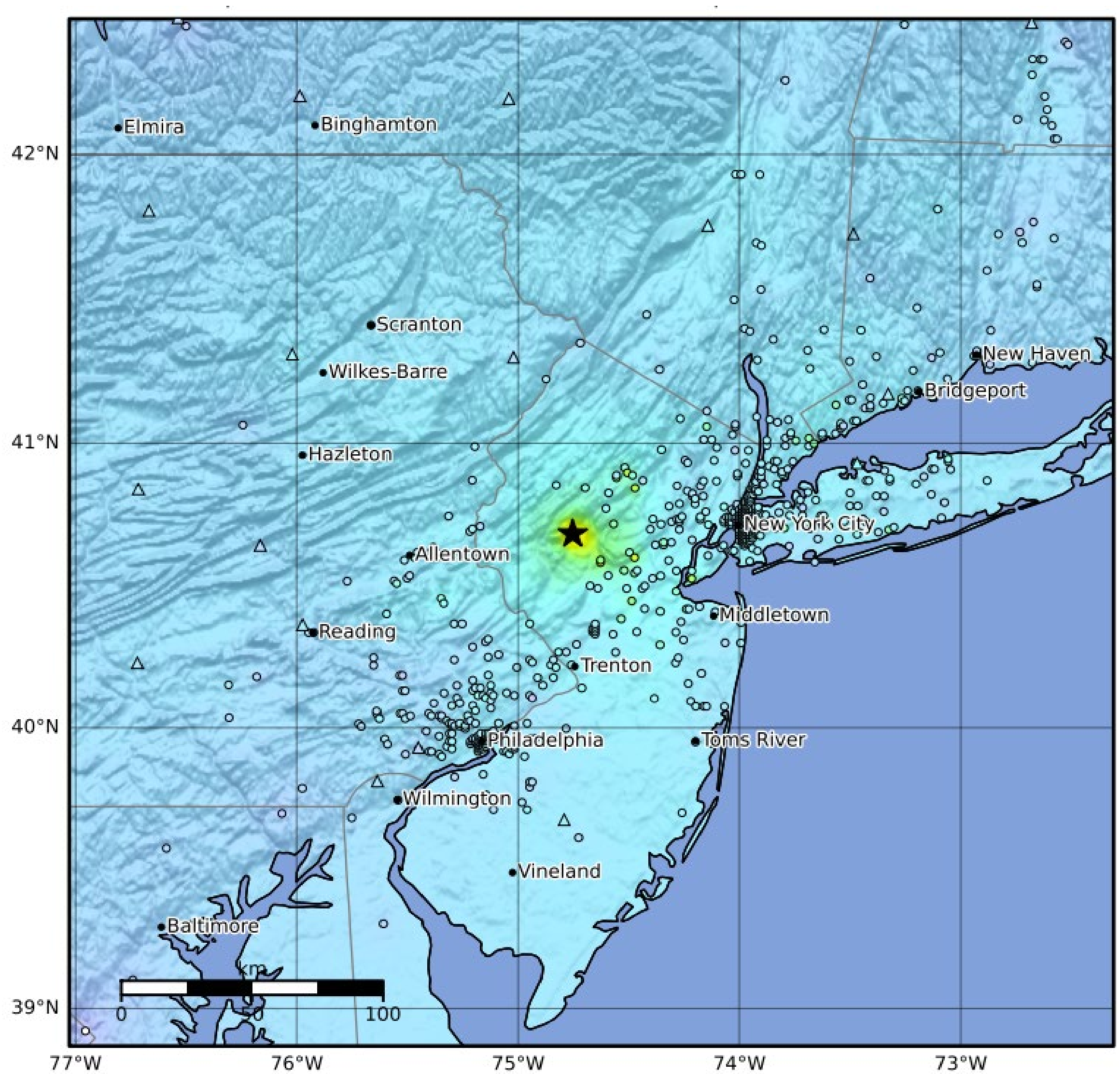
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking.

Intensity is based on observed effects and is variable over the area affected by the earthquake and is dependent on earthquake size, depth, distance, and local conditions.

MMI	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt



USGS estimated shaking intensity from M 4.8 Earthquake

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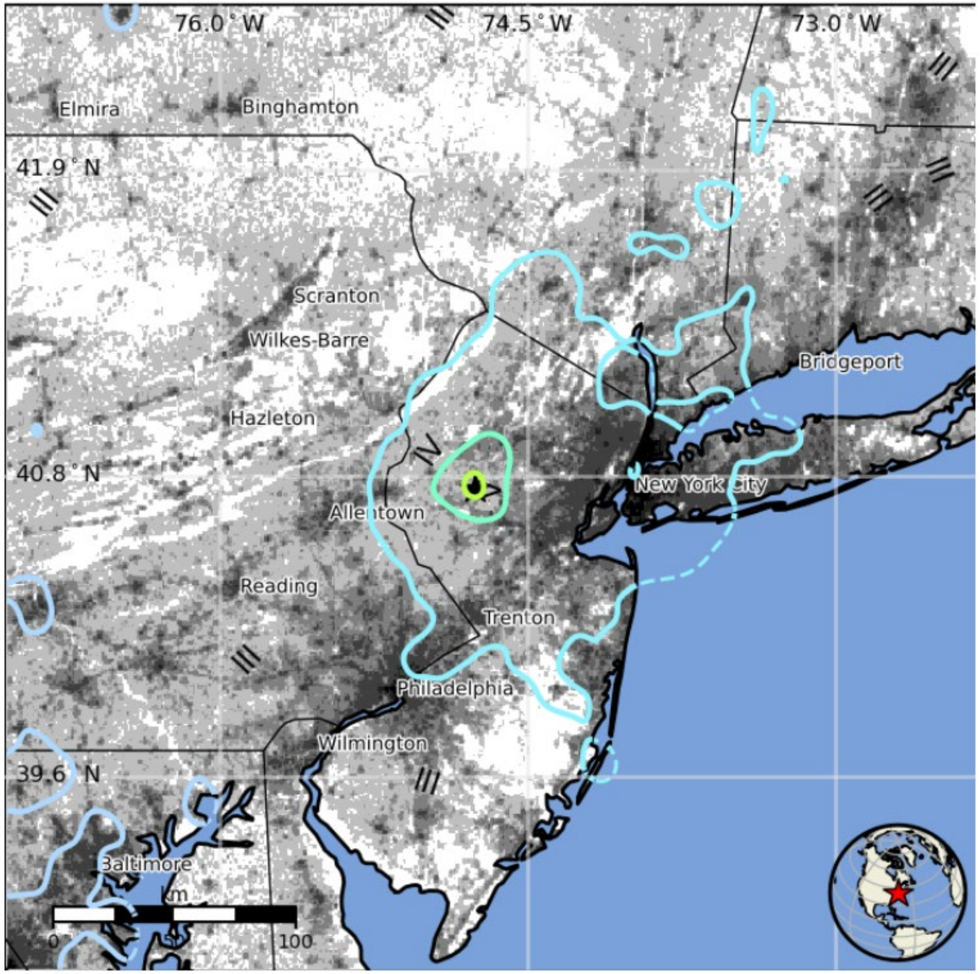
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that more than 42 million people felt shaking from this earthquake.

MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	25,293 k*
IV	Light	17,261 k
V	Moderate	211 k
VI	Strong	11 k
VII	Very Strong	0 k
VIII	Severe	0 k
IX	Violent	0 k
X	Extreme	0 k



The color-coded contour lines outline regions of MMI intensity. The total population exposure to a given MMI value is obtained by summing the population between the contour lines. The estimated population exposure to each MMI Intensity is shown in the table.

Image courtesy of the US Geological Survey

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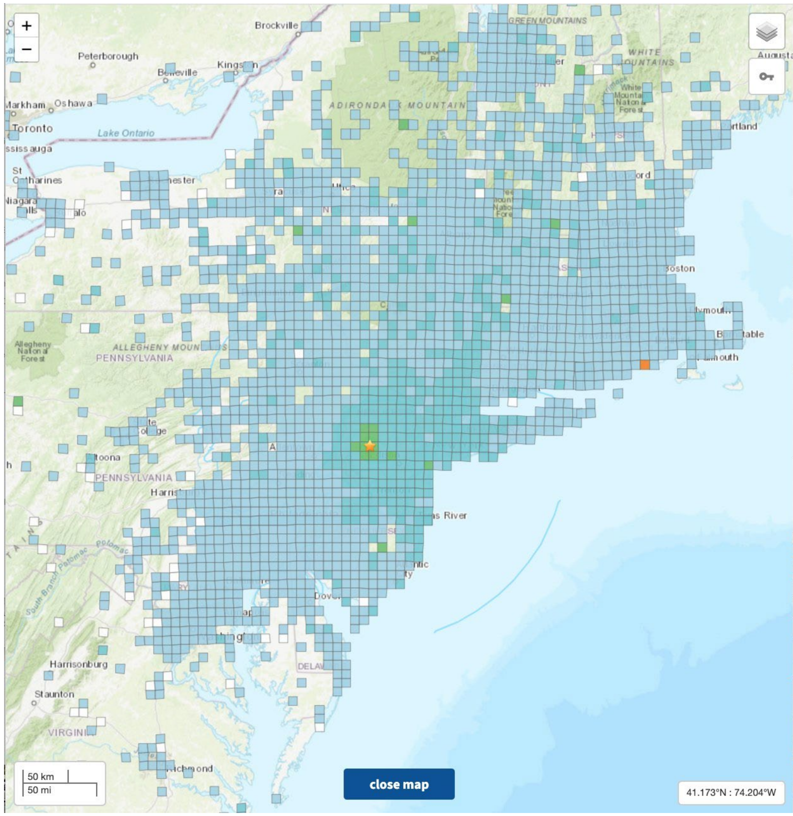
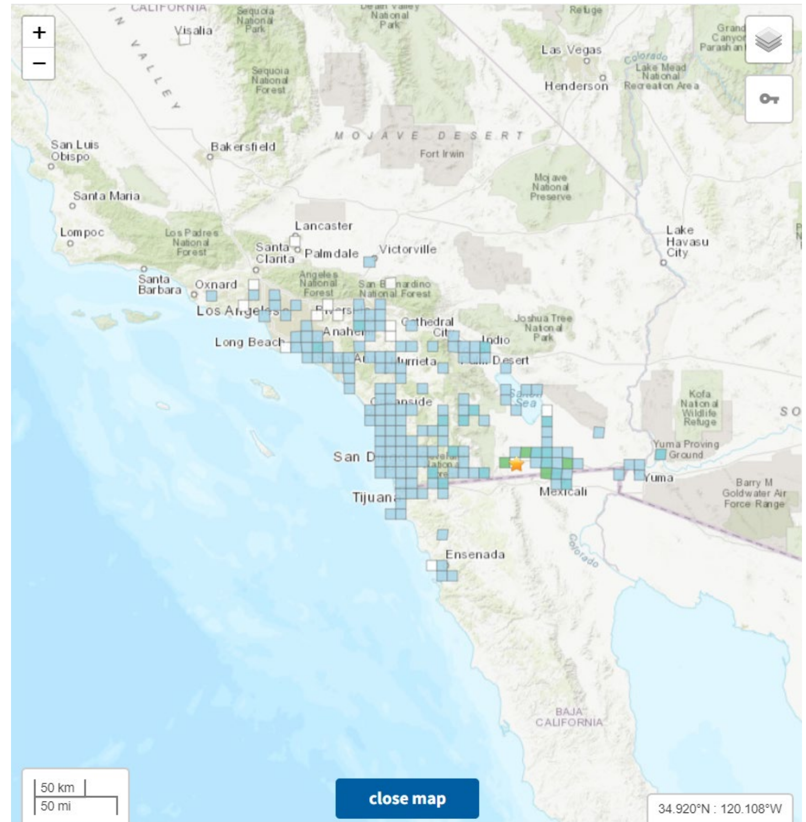
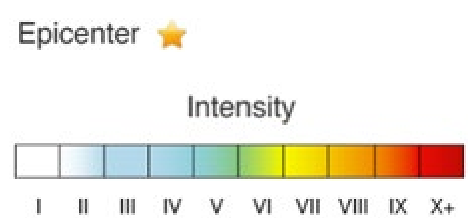


M 4.8 New Jersey



M 4.8 Ocotillo, California

A comparison of the USGS DYFI reports for this **M 4.8 New Jersey earthquake** with a **M 4.8 earthquake near Ocotillo, CA** that occurred in December 2023. Using the same map scale, while there is a difference in population density, there is a significant difference in felt area. (Edited from X @Harold_Tobin)



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The April 5 New Jersey earthquake was widely felt along the east coast from Florida to Quebec.

According to the US Geological Survey, “Earthquakes in the central and eastern U.S., although less frequent than in the western U.S., are typically felt over a much broader region. East of the Rockies, an earthquake can be felt over an area as much as ten times larger than a similar magnitude earthquake on the west coast.”

Seismic waves travel most efficiently through the North American Craton, the very old and stable part of the continental lithosphere.

Simply stated, older and colder rocks transmit seismic waves faster and more efficiently than younger and warmer rocks. So, the geologic history of a region affects how well it transmits seismic waves.

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There are many faults in the Appalachians and adjacent areas inherited from the formation of the supercontinent Pangea from 500-300 million years ago, raising the Appalachian Mountains. The supercontinent rifted apart about 200 million years ago to form what is now the northeastern United States. These old faults can be reactivated to produce occasional earthquakes in the Atlantic Coast region.

Scotese, C.R., 2019. Plate Tectonics, Paleogeography, and Ice Ages, YouTube video: • Scotese Plate Tectonics Paleogeography and Ice Ages

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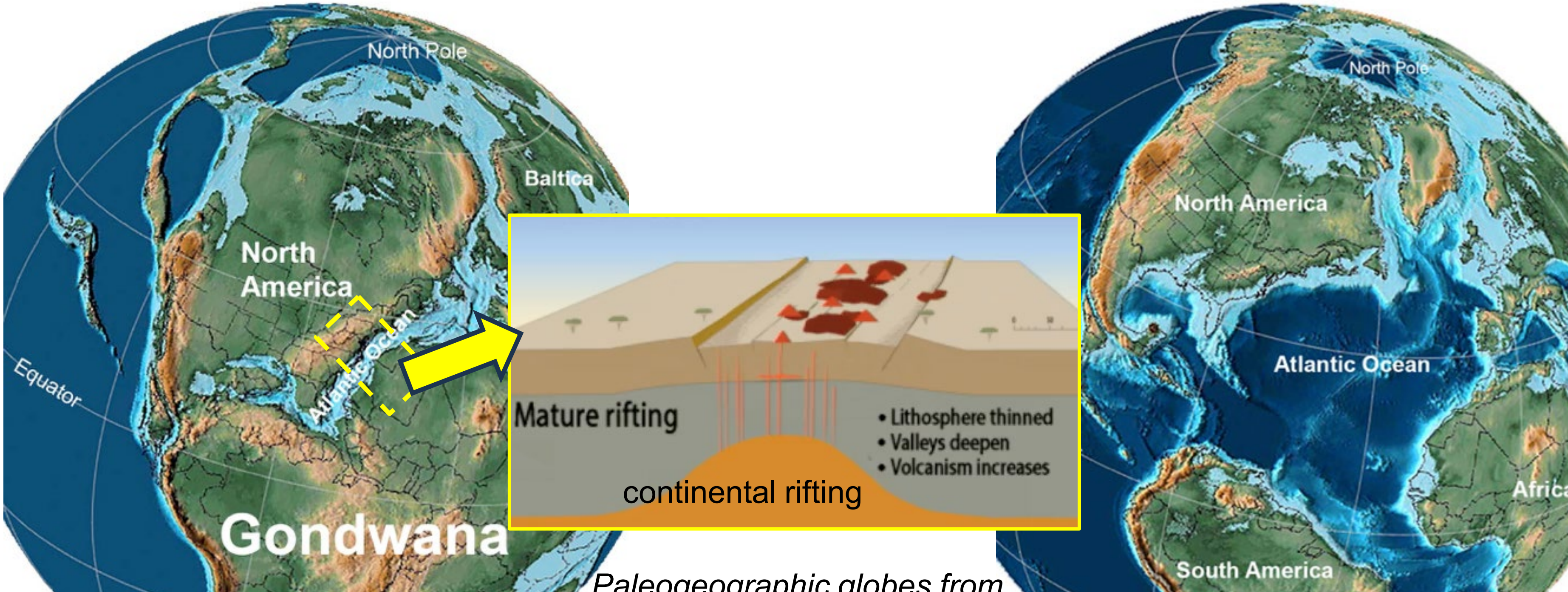

Paleogeographic globes from Chris Scotese Paleomap Project.

175 million years ago

65 million years ago

From about 200 to 170 million years ago, eastern North America rifted away from northwest Africa during the breakup of Pangea. That rifting process was similar to what is happening today along the East Africa Rift Zone. During continental rifting, normal faults form at the margins of down-dropped rift basins within which volcanic rocks erupt and below which igneous intrusive rocks solidify. The Newark Basin is a rift basin formed along the North American continental margin during the breakup of Pangea and the Palisades Sill is an igneous intrusive rock formed during continental rifting. No major tectonic or igneous activity has occurred along the eastern margin of North America since about 170 million years ago. So, the eastern margin of North America is now cold continental crust that “rings like a bell” when struck by an earthquake.

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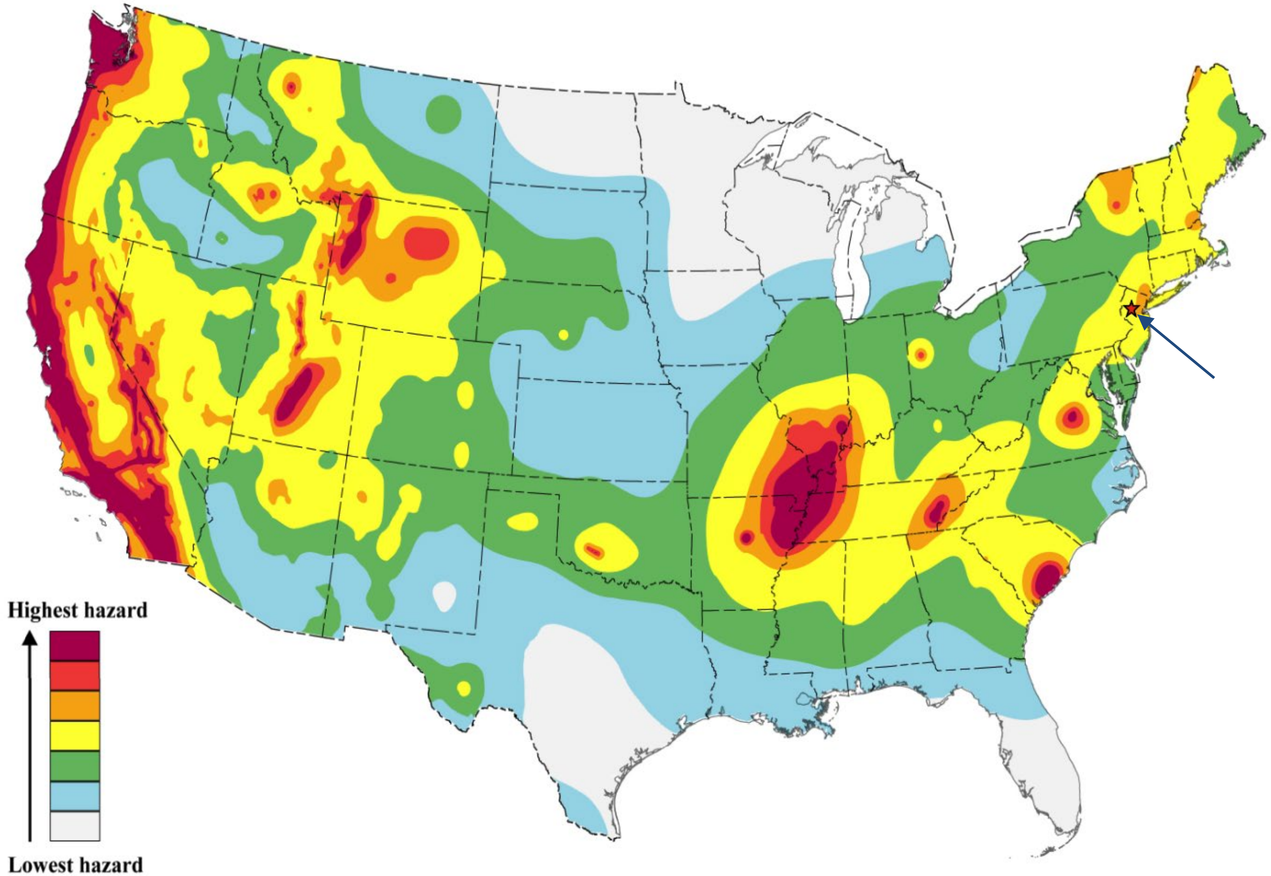

The updated 2023 USGS map of earthquake risk for the mainland United States. This map shows a simplified probability of an area to get a large or damaging earthquake within the next 50 years. While the east coast has a lower risk of experiencing a large earthquake than the west coast there are still locations with higher risk. This M 4.8 earthquake occurred in an area of medium risk.

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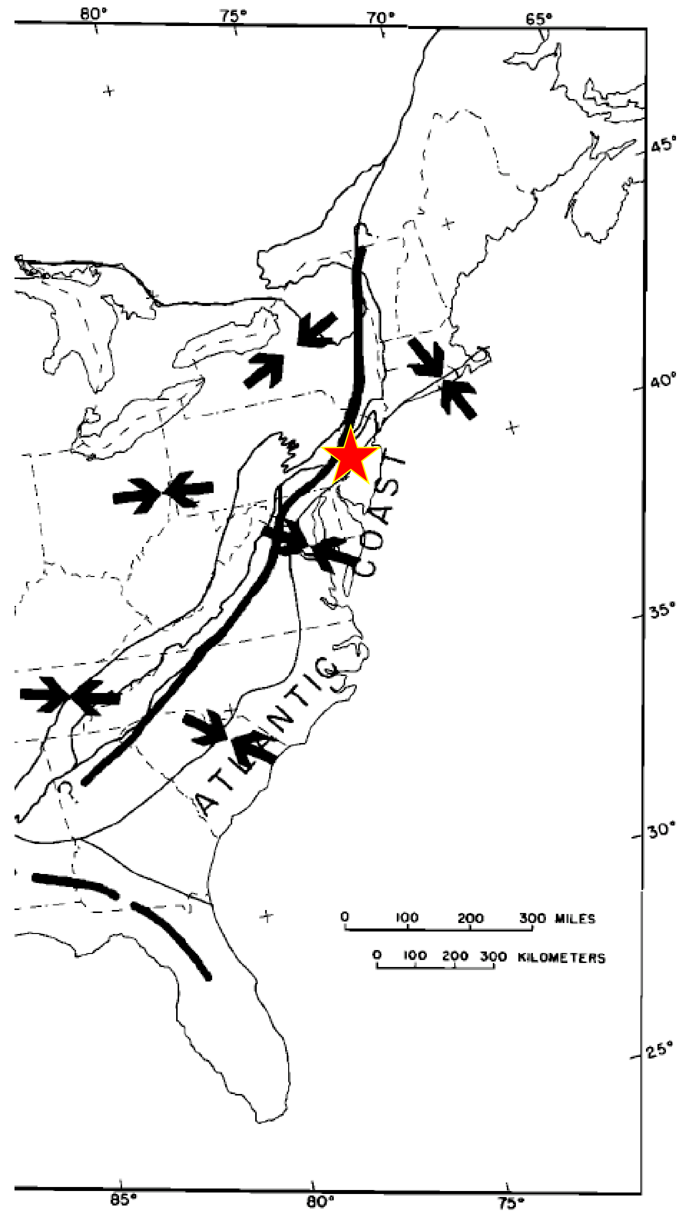
What stresses might have reactivated the fault that produced the April 5 New Jersey earthquake? Using hundreds of stress measurements across the North American Plate, US Geological Survey geophysicist Mary Lou Zoback and coworkers compiled a map of stress provinces in the coterminous Unites States. The Atlantic Coast and adjacent areas of that map are shown here.

- Notice that the direction of compression along the Atlantic Coast region is oriented northwest–southeast.
- Farther west, the direction of compression is northeast - southwest in some areas and east–west in other areas.

The April 5 earthquake (shown by star) occurred near the boundary between areas with northwest–southeast oriented compression and areas with northeast–southwest oriented compression.

Interestingly, the April 5 earthquake was produced by thrust faulting with a northeast–southwest oriented axis of maximum compression.



M. L. Zoback and M. Zoback, State of Stress in the Coterminous United States, J. Geophys. Res., v. 85, p. 6113-6156, 1980.

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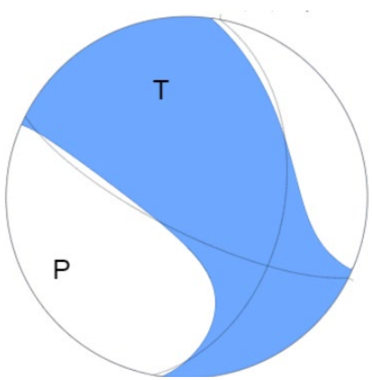
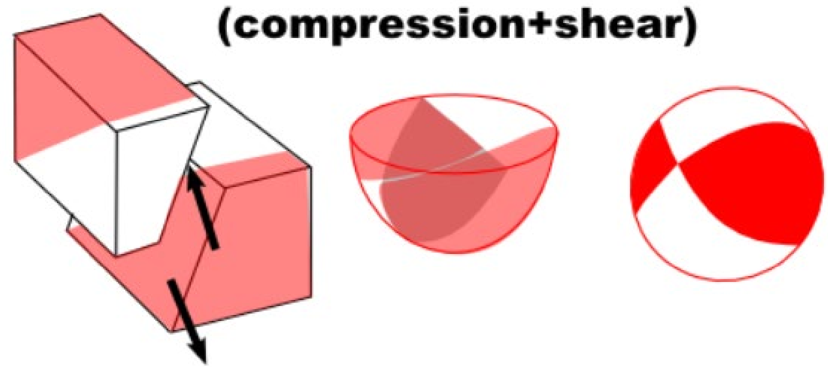
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation of these quadrants determined from recorded seismic waves determines the type of fault that produced the earthquake.



USGS W-phase Moment Tensor Solution

The tension axis (T) reflects the minimum compressive stress direction. The pressure axis (P) reflects the maximum compressive stress direction.

Transpression (compression+shear)



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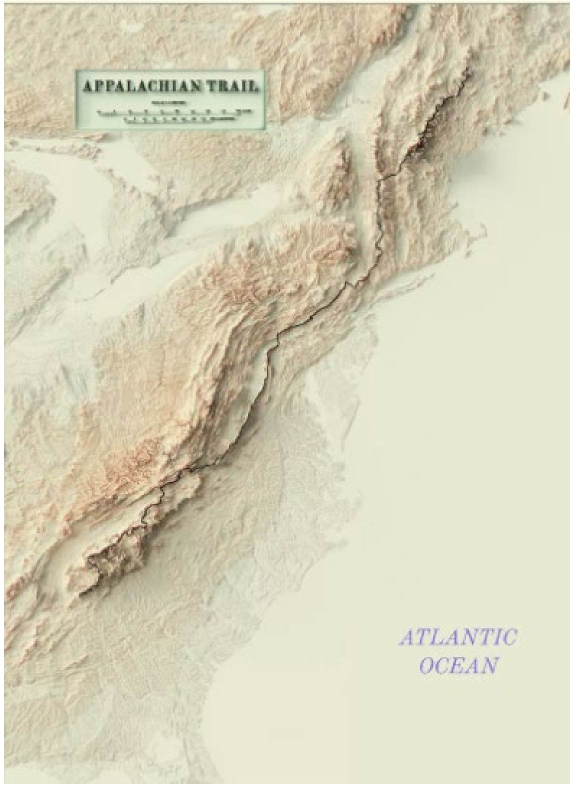
What accounts for compressive stress within the Atlantic Coast and Appalachian region?

Several ideas have been proposed including "rebound" or flexure of the crust as the Appalachian Mountains erode. The figure to the right shows the 3D topography of the Appalachian Mountains.



Another possibility for the origin of compressive stress within the eastern margin of North America is ridge push from the Mid-Atlantic Ridge that is pushing the North and South American plates away from the Eurasian and African plates as the Atlantic Ocean gets wider. In the figure below, ridge push develops because the region of a rift is elevated. Like a wedge of honey with a sloping surface, the mass of the ridge pushes sideways.

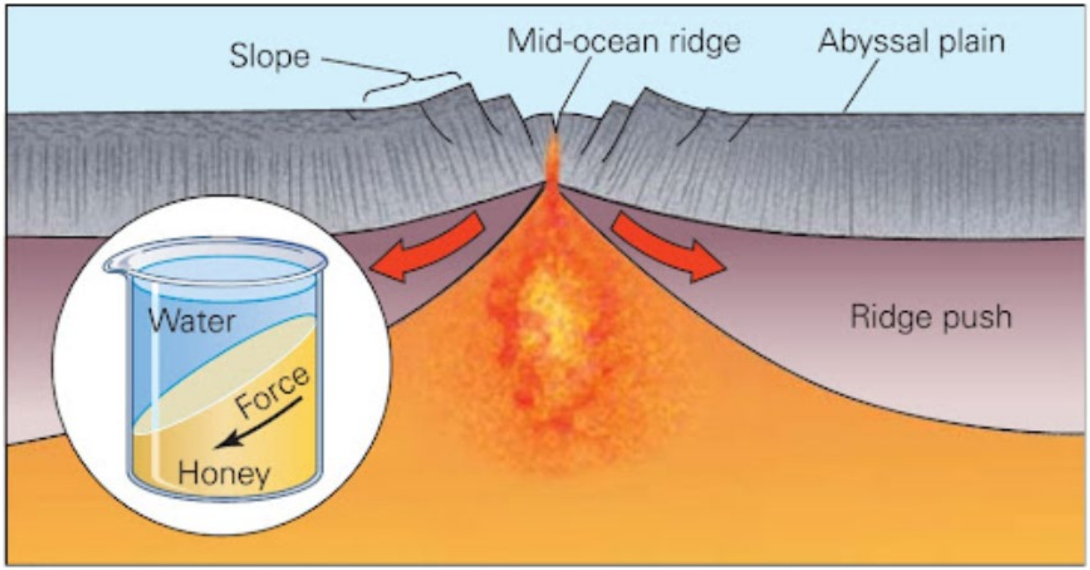


Image courtesy Stephen Marshak (Essentials of Geology)

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This map shows M 3.0 or larger events since 1990. This includes 98 earthquakes (circles) and larger quarry blasts (diamond) in the eastern United States within 500 km (310 miles) of the epicenter (orange circle).

The largest event is the 2002 M 5.8 Au Sable Forks, New York earthquake.

Closer, within ~115 km (71.5 miles), are the 1994 M 4.2 and M 4.6 Reading, Pennsylvania earthquakes.

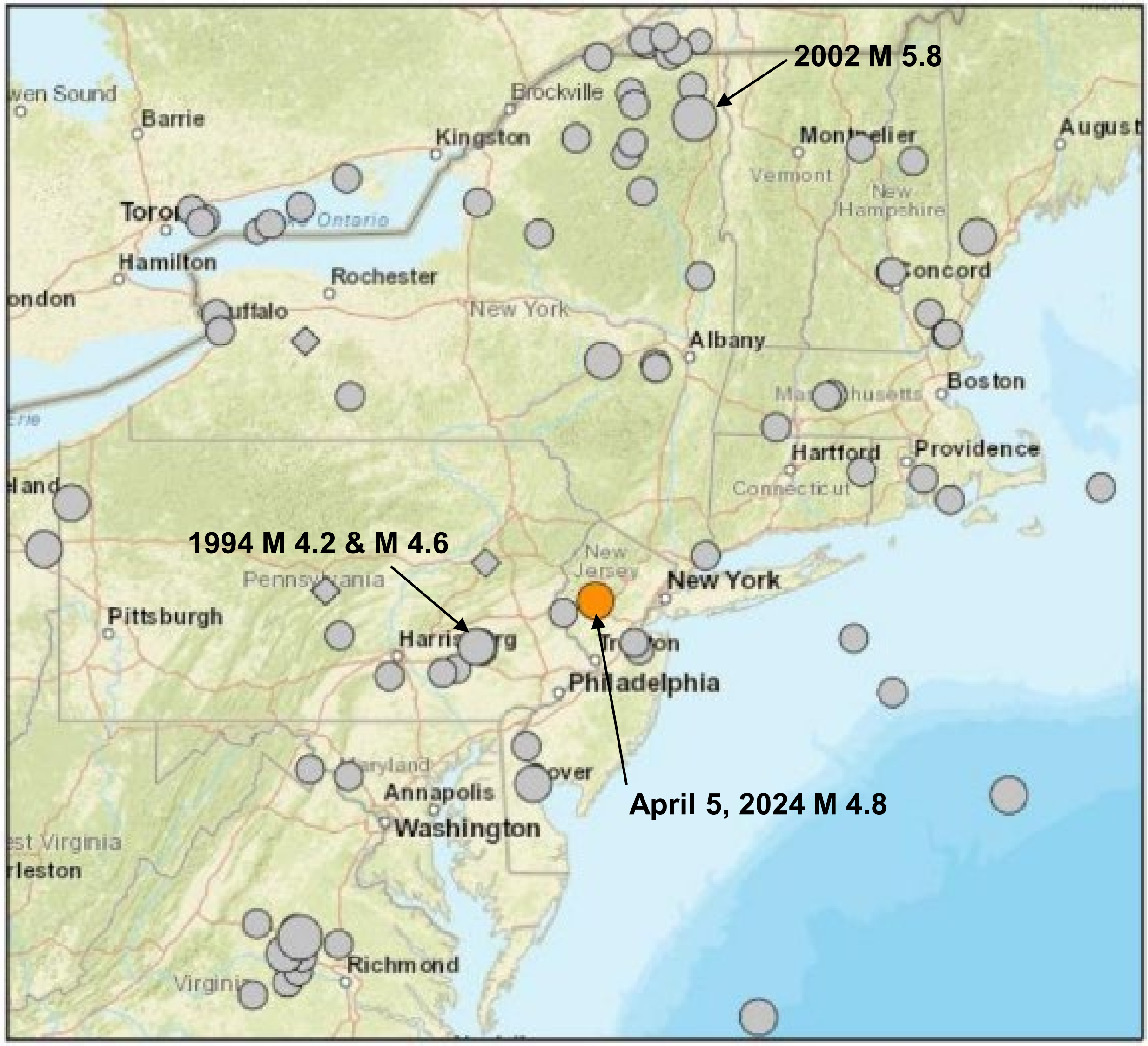

Image courtesy of the US Geological Survey

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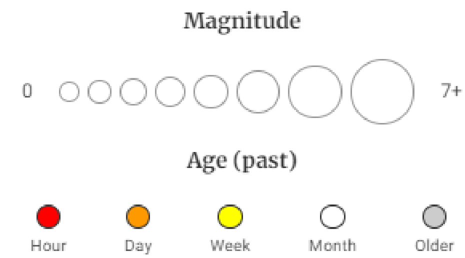

Following the M 4.8 earthquake, there have been at least 40 aftershocks, ranging from M 1.5 to a M 3.8 that struck nearly 8 hours after the initial earthquake (mainshock). The orange dots represent the most recent aftershocks.

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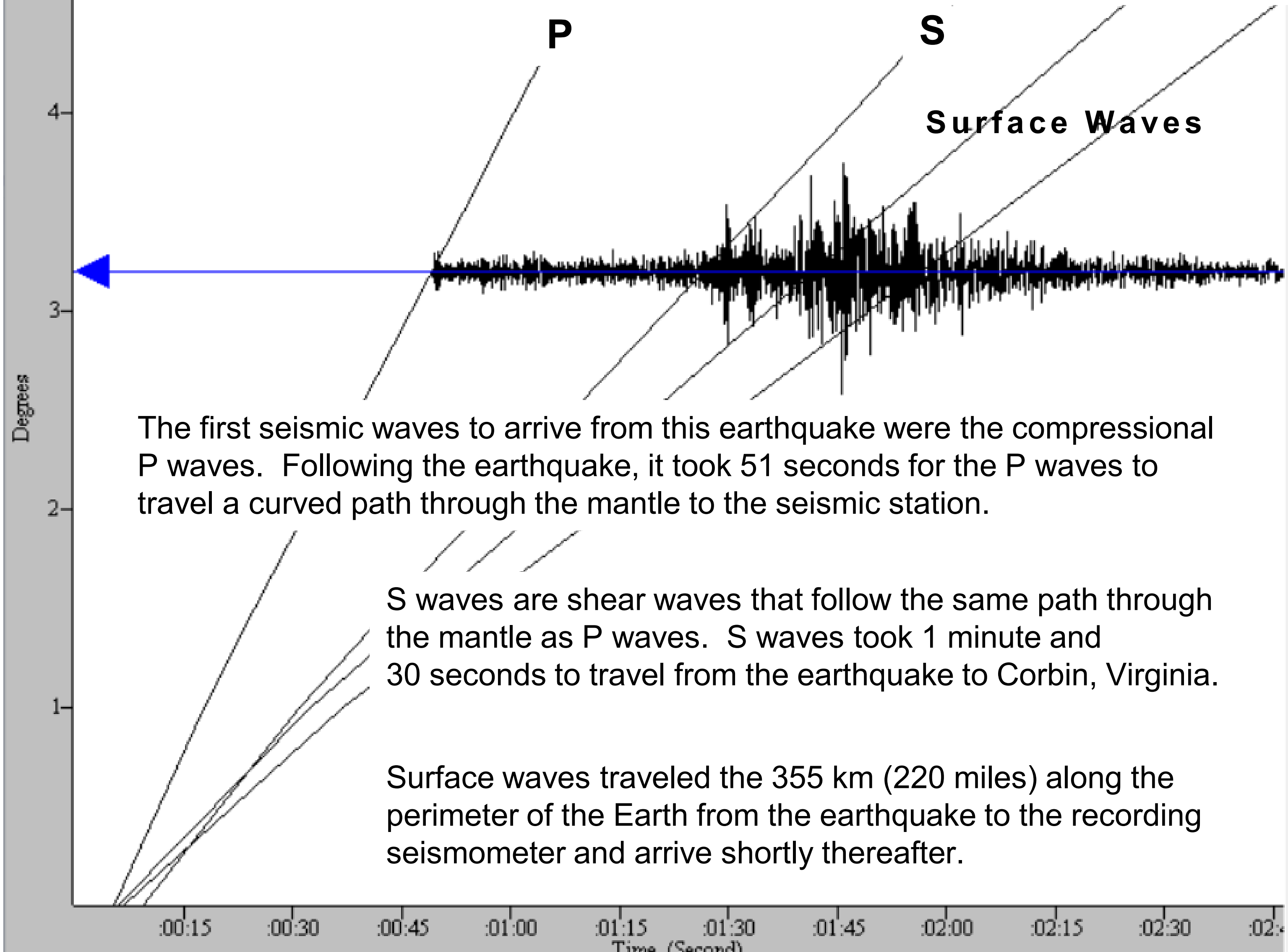
The record of the earthquake in Corbin (Fredericksburg Observatory), Virginia (CBN) is illustrated below, 355 km (220 miles, 3.2°) from the location of this earthquake.



The first seismic waves to arrive from this earthquake were the compressional P waves. Following the earthquake, it took 51 seconds for the P waves to travel a curved path through the mantle to the seismic station.

S waves are shear waves that follow the same path through the mantle as P waves. S waves took 1 minute and 30 seconds to travel from the earthquake to Corbin, Virginia.

Surface waves traveled the 355 km (220 miles) along the perimeter of the Earth from the earthquake to the recording seismometer and arrive shortly thereafter.

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