Environmental Issues
of the Northeastern US

Geology affects where we live, how we live, and how we use the land. In the Northeast, earthquakes, landslides, land subsidence, and radon are important issues tied to the type of rocks found at the surface and underlying the region. They are 'issues' only because they disrupt human lives and constructs. Whether directly caused by human activity (such as landslides and land subsidence in some cases) or simply a natural process (such as earthquakes or the production of radon gas), the significance is magnified because of the presence of people. Ideally, growing knowledge of environmental issues and an understanding of their foundation in geology, will help us to make wiser and more informed decisions on land use and planning. In this chapter we will discuss the Northeast region as a whole.

Earthquakes

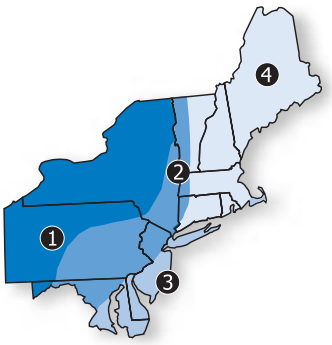
Ninety-eight percent of earthquakes occur at tectonic plate boundaries. As the plates collide, pull apart, or move past each other, their grinding and shifting build up stress. When these stresses are released suddenly at the plate boundary or at faults near the boundary, the crust shifts and ***seismic waves*** are released, causing an earthquake. In the US, most earthquakes occur west of the Rocky Mountains, where there is currently an active plate boundary between the North American and Pacific Plates. During the break up of Pangea and the preceding mountain-building events, there was an ***active plate boundary*** at the margin of the east coast of North America. The eastern margin of the continent no longer is at an active plate boundary. Now the active plate boundary lies thousands of kilometers to the east at the Mid-Atlantic Ridge, where the North American and Eurasian plates are pulling apart and new crust is forming.

Though large quakes are not a common event in the Northeast, earthquakes *do occur*, most likely caused by old faults formed when the eastern margin of North America was an active plate boundary. Stress upon the old faults may force them to shift suddenly, causing an earthquake. Geologists have not had much luck, though, relating earthquake events in the Northeast to known faults. Unlike the west coast, where there is a clear relationship between earth-

Seismic waves *are the shock waves or vibrations radiating in all directions from the center of an earthquake.*

see Geologic History, p. 16

An active plate boundary *exists where two plates of the Earth's crust are colliding, pulling apart, or moving past each other.*



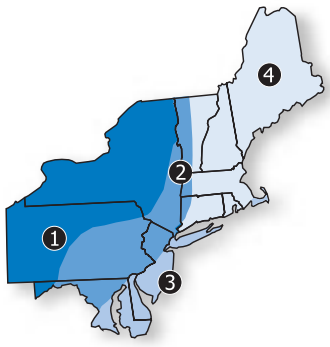
Largest earthquakes in each state

data from the United States Geological Survey

State	Date	Magnitude	Intensity
Connecticut	1791	-	VII
Delaware	1871	-	VII
Maine	1904	5.1	VII
Maryland	1990	2.5	V
Massachusetts	1755	-	VIII
New Hampshire	1940	5.5	VII
New Jersey	1783	5.3	VI
New York	1944	5.8	VIII
Pennsylvania	1998	5.2	VI
Rhode Island	1976	3.5	VI
Vermont	1962	4.2	V

Measuring Quakes

Earthquakes are measured using the descriptive Mercalli Intensity Scale and the more quantitative Richter Scale. The Mercalli Intensity Scale (Figure 8.1) measures the intensity of an earthquake by describing the effects of the earthquake on people, man-made structures and natural features. The Richter Scale is a measurement of the amount of energy released at the center of an earthquake. Because the scale is logarithmic, an earthquake with a magnitude of 5 is 10 times greater than a magnitude 4 earthquake. Likewise, an earthquake with a magnitude of 6 is 100 times greater than a magnitude 4 earthquake. Very few earthquakes in the Northeast have a magnitude greater than 5 on the Richter Scale; most have a magnitude less than 2.



quakes, faults and the active plate boundary, there is no clear relationship in the Northeast between earthquakes and known faults.

Most earthquakes in the Northeast are minor, rarely causing any damage. Minor earthquakes occur in every state throughout the Northeast, though relatively few have been located in the Inland Basin region, where the crust experienced little deformation relative to the rest of the Northeast *(Figure 8.2)*. Occasionally, large earthquakes actually do occur in the region. One of the largest was on November 18, 1755 off Cape Anne, Massachusetts. The vibrations from the quake were felt over 450,000 square kilometers.

Due to the vague relationship between earthquakes and faults in the Northeast, it is difficult to assess the risk of earthquakes in the region. Using historical records of the Northeast dating back to the 1500's, geologists predict

Figure 8.1: The Modified Mercalli Intensity Scale.

Modified Mercalli Scale
(1931 Abridged Version)

Corresponding Richter Scale Intensity		
<3.0	I.	Not felt except by a very few under especially favorable circumstances.
<3.0	II.	Felt only by a few persons at rest, especially on the upper floors of buildings. Delicately suspended objects may swing.
3.0	III.	Felt quite noticeably indoors, especially on the upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is like a passing truck. Duration is estimated.
3.7	IV.	During the day felt indoors by many, outdoors by few. At night some are awakened. Dishes, windows, and doors are disturbed. Walls make a creaking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
4.3	V.	Felt by nearly everyone; many are awakened. Some dishes, windows, etc. are broken; a few instances of cracked plaster occur. Unstable objects are overturned. Disturbance of trees, poles, and other tall objects is sometimes noticed. Pendulum clocks may stop.
5.0	VI.	Felt by all; many are frightened and run outdoors. Some heavy furniture is moved; a few instances of fallen plaster or damaged chimneys occur. Damage is slight.
5.6	VII.	Everybody runs outdoors. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys are broken. Noticed by persons driving motor cars.
6.3	VIII.	Damage is slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls are thrown out of frame structures. Chimmneys, factory stacks, columns, walls, and monuments fall; heavy furniture is overturned. Sand and mud are ejected from the ground in small amounts. Changes occur in well water. Persons driving motor cars are disturbed.
7.0	IX.	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plumb; damage is great in substantial buildings with partial collapse. Buildings are shifted off their foundations. Ground is cracked conspicuously. Underground pipes are broken.
7.7	X.	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with their foundations. Ground is badly cracked. Rails are bent. Considerable landslides occur on river banks and steep slopes. Sand and mud are shifted. Water is splashed (slopped) over banks.
8.4	XI.	Few, if any, masonry structures remain standing. Bridges are destroyed. Broad fissures occur in the ground. Underground pipelines are completely out of service. Earth slumps and land slips occur in soft ground. Rails are bent greatly.
9.0	XII.	Damage is total. Waves are seen on the ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.

that future earthquakes are most likely to occur in the same general areas as past earthquakes. Despite such attempts to assess the level of risk in the region, it is still not possible to predict the place and time of individual earthquakes on either the west coast or the east coast *(Figure 8.3)*.

The Northeast has a lower risk of earthquakes than California or other states west of the Rocky Mountains. However, the more densely populated east coast makes the infrequent large quake possibly more damaging than similar earthquakes in the West. Many buildings in the Northeast were not built with earthquakes in mind and could potentially be damaged by stronger tremors. Additionally, seismic waves travel further in the eastern US. The active plate boundary on the west coast makes near-surface rocks west of the Rocky Mountains warmer than rocks east of the Rocky Mountains. Heat absorbs seismic waves and they are unable to travel as far. Cooler rocks, like those of the Northeast, are less of an impediment to seismic waves, allowing them to travel further and potentially cause more damage.

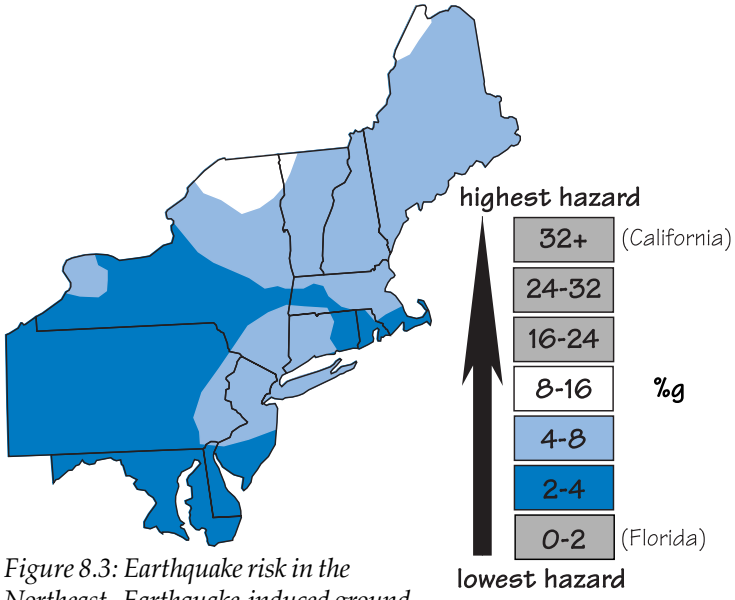


Figure 8.3: Earthquake risk in the Northeast. Earthquake-induced ground movement is expressed as a percentage of the force of gravity (%g). The map illustrates the amount of ground shaking that is predicted in a given period of time. After the National Seismic Hazard Maps, United States Geological Survey.

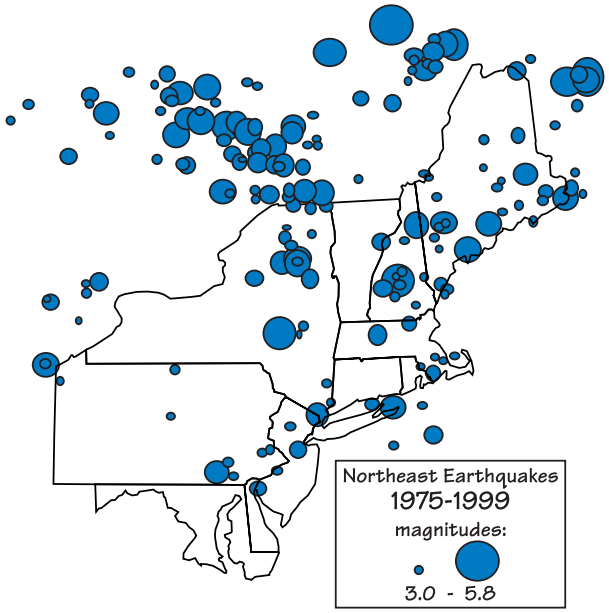


Figure 8.2: Earthquakes with a magnitude greater than 3.0 in the Northeastern US from 1975 to 1999. *Image courtesy of Alan Kafka, Weston Observatory,* ***http://www2.bc.edu/~kafka/Why_Quakes/why_quakes.html.***