Map of Earthquake Epicenters in North Carolina and Portions of Adjacent States (1698-2006)

By Randy Bechtel, Michael A. Medina, John G. Nickerson, Kenneth B. Taylor, Jeffrey C. Reid, Richard M. Wooten, Kathryn Snider and Timothy W. (Tyler) Clark

Introduction:

Earthquakes are a common occurrence, and literally thousands of earthquakes are recorded each year around the world. We do not hear about most of them because they are very small or occur in isolated areas where few people live.

North Carolina has experienced the effects of earthquakes throughout its history. The large map shows earthquakes that have been recorded in and around our state between 1698 and October 2006. Before seismic instruments were installed in the region in the 1920s, earthquake history could only be compiled through historical accounts. After 1962, technology improved so that seismograph networks could locate minor earthquakes (less than a magnitude 4). By the 1970s, micro earthquakes (less than a magnitude 3) could be detected.

Circles on the map represent earthquake epicenters; bigger circles represent larger earthquakes. The effects of an earthquake cover a much larger area than the location of the dot or epicenter (see the isoseismal maps at the lower right of the poster). Most of the earthquakes in North Carolina are relatively small (most are in the micro earthquake range). Large damaging earthquakes rarely affect our state.

As you can see on the large map, there are several areas where there are clusters of epicenters. Geologists call these seismic zones. The long cluster of circles stretching from Tennessee through the edge of western North Carolina into northern Georgia and Alabama is known as the Eastern Tennessee Seismic Zone (ETSZ). Scientists are studying this region to determine why so many earthquakes happen here.

The 1886 Charleston earthquake occurred in the Charleston Seismic Zone (CSZ). There are also small groups of circles in other areas of the southeast. On December 9, 2003, a 4.5 magnitude earthquake occurred near Richmond, Virginia, and was felt as far south as Raleigh. This earthquake occurred in the Central Virginia Seismic Zone (CVSZ). There is a similar seismic zone in western Virginia called the Giles County Seismic Zone (GCSZ).

It is very important to realize that North Carolina and the east coast of the United States are not in an active fault zone like California and the West Coast. All of the known faults in North Carolina are inactive and ancient. Conversely, in California, there are many active faults where earthquakes occur regularly. Most of the earthquakes in North Carolina are just small, random, scattered movements of the earth's crust. The locations of earthquake epicenters in our state do not line up with known faults (as they do in California). This indicates that the inactive faults are not responsible for the earthquakes in our state. You can think of our earthquakes like the creaking and settling of an old house.

Information Sources on the Web:

North Carolina Department of Crime Control and Public Safety, Division of Emergency Management: Earthquake History, Response and Emergency Kit. http://www.nccrimecontrol.org/

United States Geological Survey (USGS) information about earthquakes and "Preparedness and Response" (includes links to American Red Cross and FEMA): http://earthquake.usgs.gov/learning/preparedness.php

USGS general information about earthquakes and educational resources: http://earthquake.usgs.gov/learning/index.php

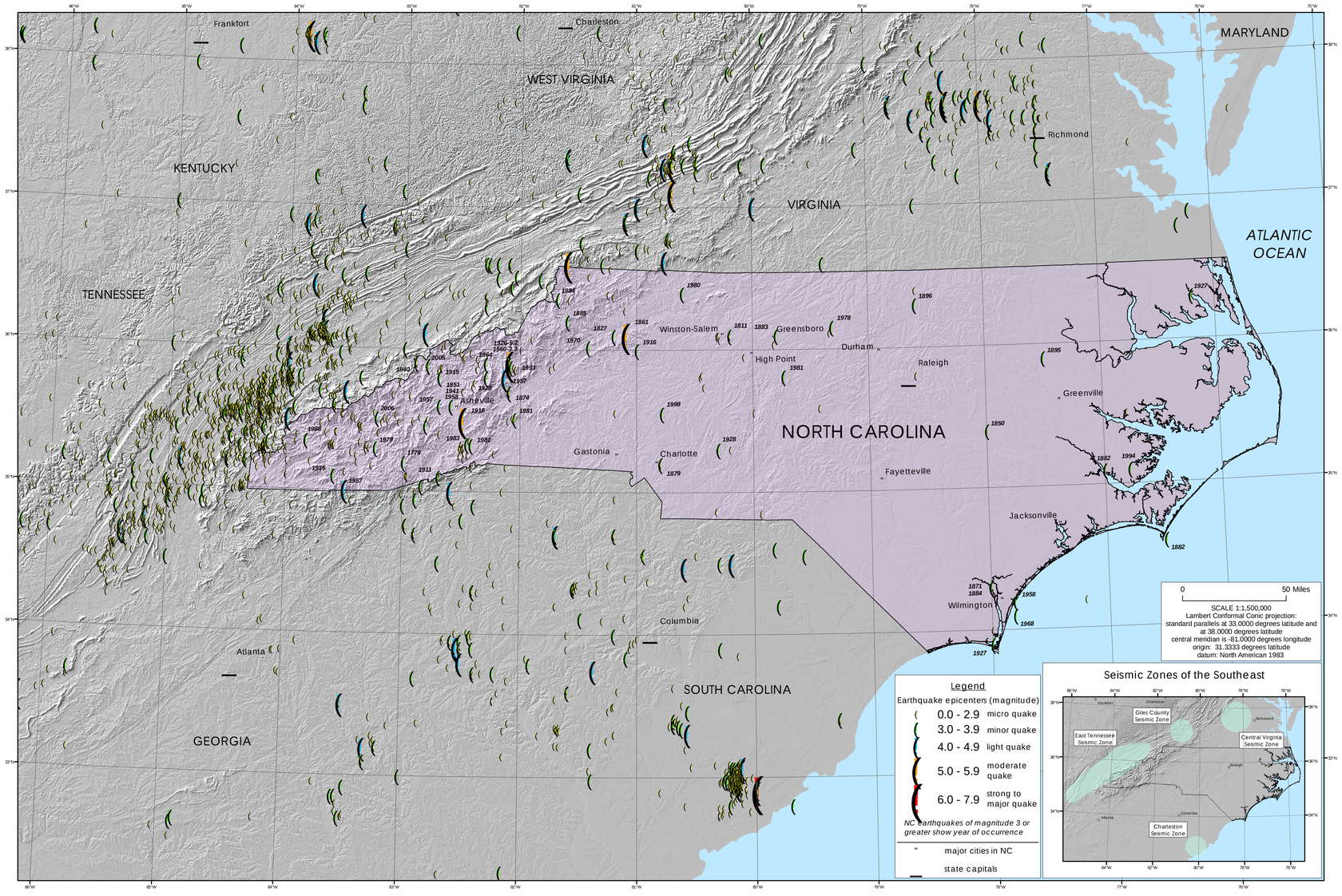
Data Sources:

United States Geological Survey (USGS) (Data source for earthquakes from 1993-2006) http://earthquake.usgs.gov/

Virginia Tech Seismological Observatory (VTSO) (Data source for earthquakes from 1698-1992) http://www.geol.vt.edu/outreach/vtso (includes a list of seismic networks that monitor earthquakes in the southeastern United States)

Base map from U.S. Geological Survey National Elevation Dataset, U.S. Census Bureau (2000) and the NC Center for Geographic Information and Analysis (1998).

Taylor, Kenneth B. (1996). Evaluation of the Mitchell County Public Schools for Potential Nonstructural Earthquake Hazards -- Final Report, N.C. Division of Emergency Management, Asheville, N.C., 18 pp.



Comparison of Earthquake Scales

MODIFIED MERCALLI SCALE		MAGNITUDE SCALE	
I.	Felt by almost no one.	2.5	Generally not felt, but recorded on seismometers.
II.	Felt by very few people.	3.5	Felt by many people.
III.	Tremor noticed by many, but they often do not realize it is an earthquake.		
IV.	Felt indoors by many. Feels like a truck has struck the building.		
V.	Felt by nearly everyone; many people awakened. Swaying trees and poles may be observed.		
VI.	Felt by all; many people run outdoors. Furniture moved, slight damage occurs.	4.5	Some local damage may occur.
VII.	Everyone runs outdoors. Poorly built structures considerably damaged; slight damage elsewhere. Small landslides.		
VIII.	Specially designed structures damaged slightly, others collapse.	6.0	A destructive earthquake.
IX.	All buildings considerably damaged, many shift off foundations. Noticeable cracks in ground.		
X.	Many structures destroyed. Ground is badly cracked. Large landslides.	7.0	A major earthquake.
XI.	Almost all structures fall. Very wide cracks in ground.	8.0 and up	Great earthquakes.
XII.	Total destruction. Waves seen on ground surfaces, objects are tumbled and tossed.		

Measuring Earthquakes

Scientists use various scales to determine the strength of an earthquake. Two of those scales are the Modified Mercalli Scale and the Richter Scale. The Modified Mercalli Scale describes how earthquakes "feel" and how much destruction was caused by the earthquake. The Richter Scale is one of many scales that attempts to measure how much energy was released by the earthquake. The Richter Scale is the number that most people are familiar with, for example "magnitude 3". Many factors determine the intensity of an earthquake at the surface of the earth, such as how deep the earthquake originates and what kind of rock and soil are at the surface. This chart was modified from http://www.fcs-net.com/biddled/scalesof.htm

References:

Bechtel, R., 2005, When the Ground Moves! A Citizen's Guide to Geologic Hazards in North Carolina, North Carolina Geological Survey Information Circular 32, 23p. http://nc-maps.stores.yahoo.net/ic32wheamo.html

Stover, C.W. and Coffman, J.L., 1993, Seismicity of the United States, 1568-1989 (Revised), United States Geological Survey Professional Paper 1527, 418p.

Damaging Earthquakes affecting North Carolina

Year	Date and Month	Location	Mag	MM in NC
1811	16-Dec	N.E. Arkansas	8.5	VI
1811	16-Dec	N.E. Arkansas	8	VI
1811	16-Dec	N.E. Arkansas	8	VI
1812	23-Jan	New Madrid, MO	8.4	VI
1812	7-Feb	New Madrid, MO	8.7	VI
1852	29-Apr	Wytheville, VA	5	VI
1861	31-Aug	Wilkesboro, NC	5.1	VII
1875	23-Dec	Central Virginia	5	VI
1886	31-Aug	Charleston, SC	6.7	VII
1897	31-May	Giles County, VA	5.8	VI
1913	1-Jan	Union County, SC	4.8	VI
1916	21-Feb	Skyland, NC	5.5	VII
1926	8-Jul	Mitchell County, NC	5.2	VII
1928	3-Nov	Newport, Tennessee	4.5	VI
1957	13-May	McDowell County, NC	4.1	VI
1957	2-Jul	Buncombe County, NC	3.7	VI
1957	24-Nov	Jackson County, NC	4	VI
1959	27-Oct	Chesterfield, SC	4	VI
1971	13-Jul	Newry, SC	3.8	VI
1973	30-Nov	Alcoa, Tennessee	4.6	VI
1976	13-Sep	Southwest Virginia	4.1	VI
1981	5-May	Henderson County, NC	3.5	VI

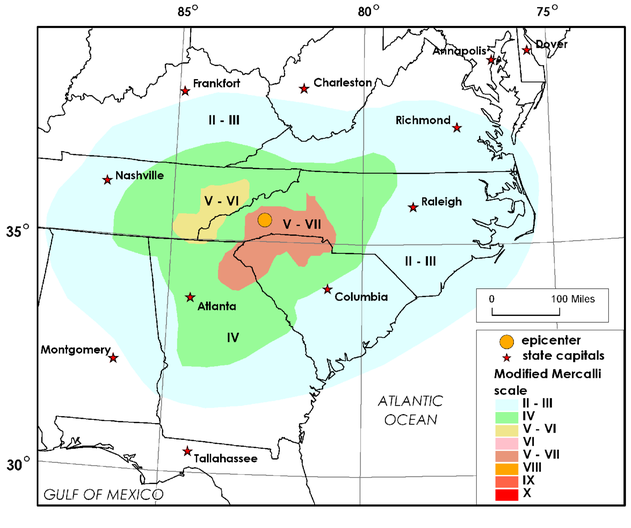
Mag = Earthquake Magnitude
MM in NC = Highest Modified Mercalli Intensity in North Carolina from quake
* Conflicting reports on this event; Intensity in North Carolina at V not VI

Earthquake Factoids

- The earliest reported earthquake in North Carolina occurred near Bath on March 8, 1735.
- The largest quake centered in North Carolina was a magnitude 5.5 on February 21, 1916 near Skyland, NC.
- The last damaging earthquake centered in North Carolina was a magnitude 3.5 in Henderson County on May 5, 1981.
- The largest recorded earthquake in the U.S. was a magnitude 9.2 that struck Prince William Sound, Alaska on Good Friday, March 28, 1964 (USGS).
- Alaska and California have the most earthquakes in the U.S. while Florida and North Dakota have the fewest (USGS).
- It is estimated that there are 500,000 detectable earthquakes worldwide each year. 100,000 of those can be felt, and 100 of them cause damage (USGS).

Isoseismal map for the Skyland, North Carolina, earthquake of February 21, 1916

(An isoseismal map indicates areas of equal shaking.)

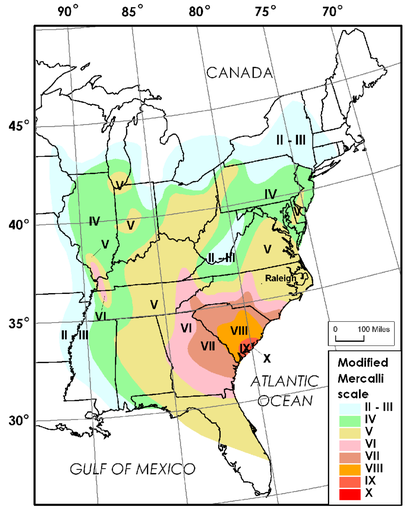


Skyland, North Carolina

There have been a few strong earthquakes in our mountain region in the last 100 years. In 1916, there was a magnitude 5.5 earthquake, with an intensity of VII on the Modified Mercalli Scale, near Skyland in Buncombe County, North Carolina. Chimneys were thrown to the ground, window panes cracked and people rushed into the streets. In certain areas, water flow in springs increased and became muddy. The map of the earthquake intensity shows how far the effects of the 1916 earthquake were felt.

Isoseismal map for the Charleston, South Carolina, earthquake of September 1, 1886

(An isoseismal map indicates areas of equal shaking.)



Charleston, South Carolina

In 1886 there was a large earthquake centered in Charleston, South Carolina, it was estimated to be a magnitude 6.7, with an intensity of X on the Modified Mercalli Scale. This earthquake was felt up and down the East Coast and throughout the Midwest of the United States. It was the most damaging earthquake in the Southeast and is one of the largest earthquakes ever in the eastern U.S.