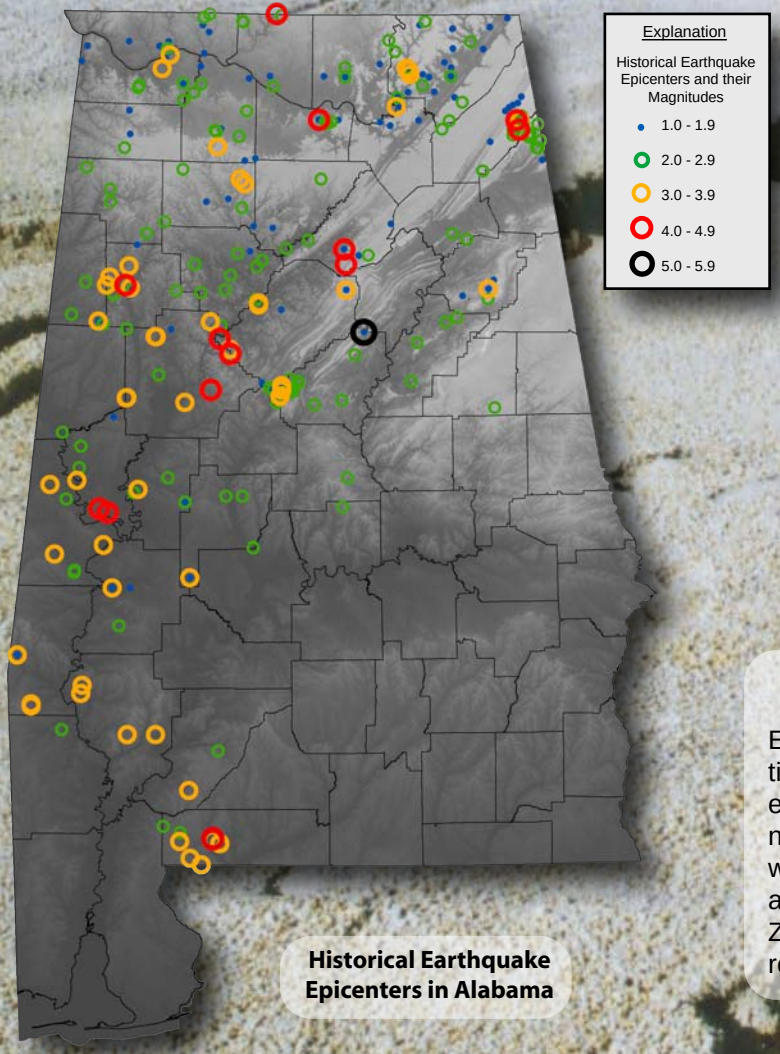
EARTHQUAKES IN ALABAMA



Historical Earthquake Epicenters in Alabama

EARTHQUAKES

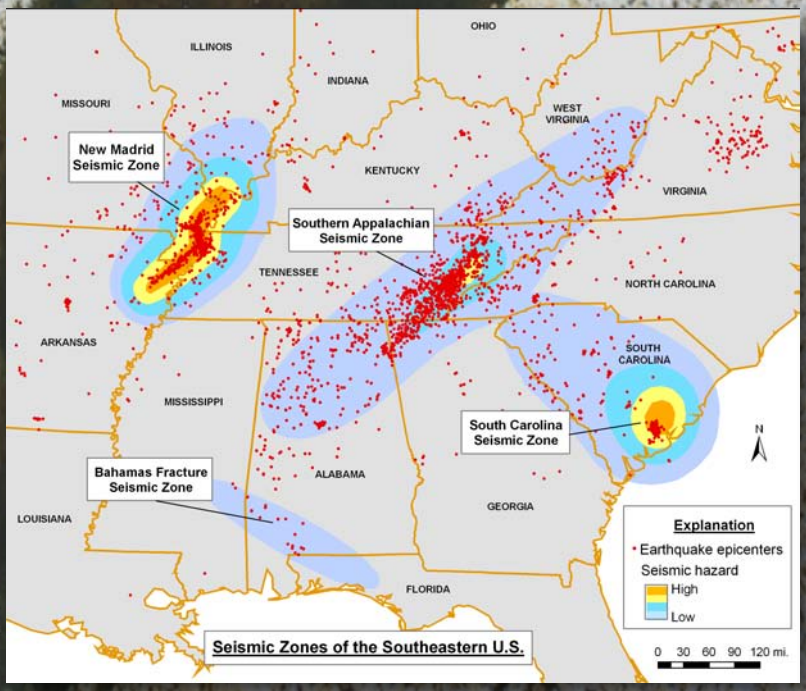
An earthquake is the sudden, sometimes violent, movement on the earth's surface from the release of energy in the earth's crust. The focus, the point at which the earthquake rupture begins, is usually deep within the earth on a fault – a fracture in the earth's crust along which displacement has occurred. The point on the earth's surface directly above the focus is called the epicenter.

Alabama Earthquakes

Earthquakes are not uncommon in Alabama. The illustration to the left shows epicenters of historical Alabama earthquakes from 1886 to 2007 and their respective magnitudes. The majority of the earthquakes are associated with the Southern Appalachian Seismic Zone (northern and central Alabama) and the Bahamas Fracture Seismic Zone (southern Alabama). The largest earthquake on record (black circle) occurred in 1916 near Birmingham.

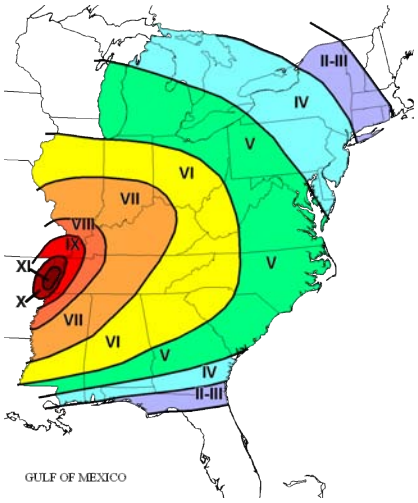
Seismic Zones Affecting Alabama

Earthquakes are fairly common in the eastern half of the United States. Four zones of frequent earthquake activity affecting Alabama (right) are the New Madrid Seismic Zone (NMSZ), the Southern Appalachian Seismic Zone (SASZ), the South Carolina Seismic Zone (SCSZ), and the Bahamas Fracture Seismic Zone (BFSZ).



Seismic Zones of the Southeastern U.S.

Earthquake History of Alabama and the Southeast



New Madrid, 1812

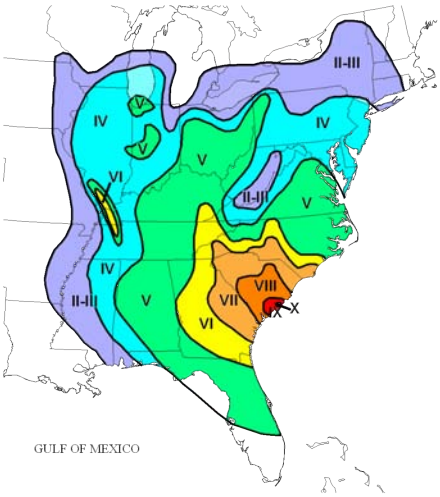
The New Madrid Seismic Zone lies within the central Mississippi Valley and extends through northeast Arkansas, southeast Missouri, and western Tennessee. Historically, this area has been the site of some of the largest earthquakes in North America. The last major earthquake in this area was on February 7, 1812, and had an estimated magnitude > 7.0. Shaking during the 1812 event was felt over 2,000,000 square miles (left), ringing bells in Boston, rattling furniture in the White House, and causing the Mississippi River to run backwards. There is a 40 percent chance of an earthquake of magnitude 6.0 or greater in this area within the next 50 years. The occurrence today of a large-magnitude event such as the one in 1812 in this region would result in numerous casualties and significant economic impact, including property damage in the billions of dollars. Damage would be widespread and would affect many states, including Alabama.

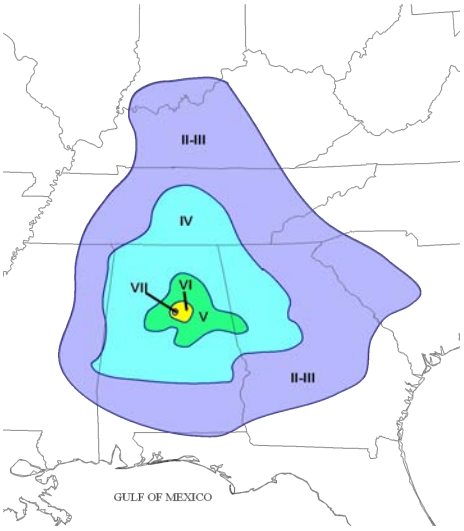
Isoseismic Maps

The colorful maps displayed on this page are isoseismic maps. Isoseismic maps show the area affected by an earthquake. Shaking intensities decrease with increasing distance from the epicenter. Roman numerals describe the shaking intensities on the Modified Mercalli Intensity Scale (see last page for more information).

Charleston, 1886

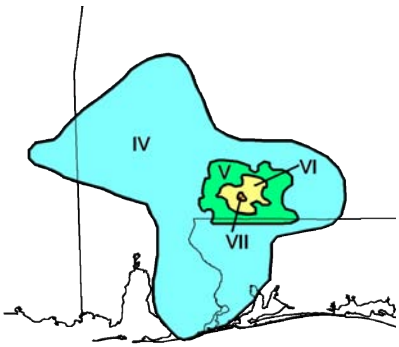
On August 13, 1886, the southeastern United States was shaken strongly by a magnitude 7.3 earthquake centered at Charleston, South Carolina (right), in the SCSZ. The earthquake leveled almost every building in the Charleston area and caused 60 deaths. The quake was felt 750 miles from the epicenter, and several areas in Alabama recorded damage. This is the most damaging earthquake to occur in the southeastern United States and is one of the largest historical quakes in eastern North America.





Irondale, 1916

The largest known earthquake in Alabama occurred in the SASZ, near Birmingham, in 1916. Although no seismographs existed in the state at that time, the magnitude of the earthquake (estimated from the reported shaking intensities) was calculated to be approximately 5.1, and the epicenter was located in the Irondale area.

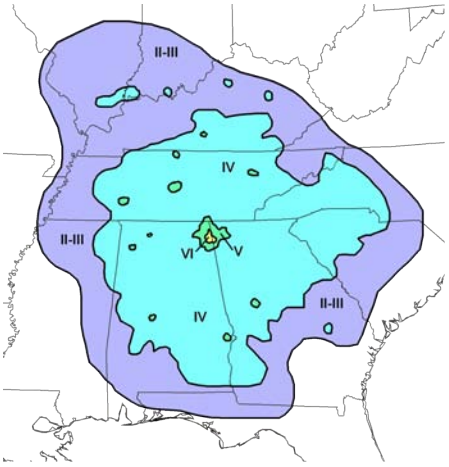


Escambia County, 1997

Recently, there has been an increasing number of recorded earthquakes in southwest Alabama, one of which was a 4.9 magnitude event on October 24, 1997, in Escambia County (left). This was the largest quake at that time recorded by seismographs in Alabama and the largest in the Southeast in the last 30 years. Historically, the southwestern part of Alabama has had minimal seismic activity, but this quake indicates activity on the BFSZ, an ancient basement fault zone that underlies the area.

Fort Payne, 2003

On Tuesday morning, April 29, 2003, a 4.9 magnitude earthquake occurred in DeKalb County, Alabama, 10 miles northeast of Fort Payne, Alabama. The quake was felt in 13 states (right). The earthquake was deep enough to suppress significant damage in Fort Payne, the closest city, although the event did damage weaker chimneys and formed cracks in some structures.



Earthquake-Triggered Phenomena

Damage Caused by Earthquakes

An earthquake can disrupt the land surface and can cause considerable structural damage. Steep slopes may become unstable, aquifers can be disrupted, cracks and fissures can develop in the ground, water-saturated sediments and soils can amplify shaking, and bridges and houses can be damaged during an earthquake.

Damage to Structures

Structural damage caused by the Fort Payne 2003 and Irondale 1916 earthquakes included broken windows, minor cracks in masonry walls (below), and chimneys that collapsed or broke at the top (left).

Natural Hazards

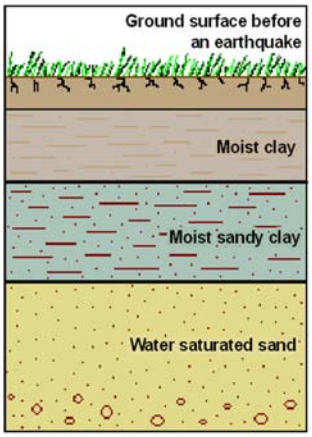
The Fort Payne magnitude 4.9 quake caused the development of sinkholes (below right) and minor landslides (left), and muddied the underground water supply for the town of Valley Head, causing the pumps to shut down. Effects from the shaking were seen as far away as Lawrence County where a berm on a pond failed, spilling water and fish across a road. In the Escambia County quake (also magnitude 4.9), large cracks developed in sand along a creek (below left).

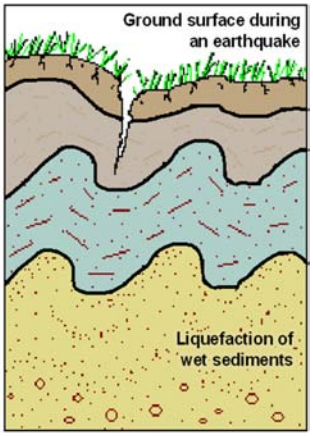
Fires

Another significant problem that can be triggered in moderate to large earthquakes is pipeline leaks and breakage. Breaks and leaks in gas lines can cause fires in urban areas, while disruption of water lines can inhibit efforts to extinguish the fires.

Seismic Wave Amplification

Different geologic materials (soils, sediments, and rocks) react differently to seismic waves generated by earthquakes. When shaking intensities are very strong, soft sediments can actually undergo liquefaction (below), a phenomenon that occurs when wet sediments amplify seismic waves, causing the sediment to shake intensely.

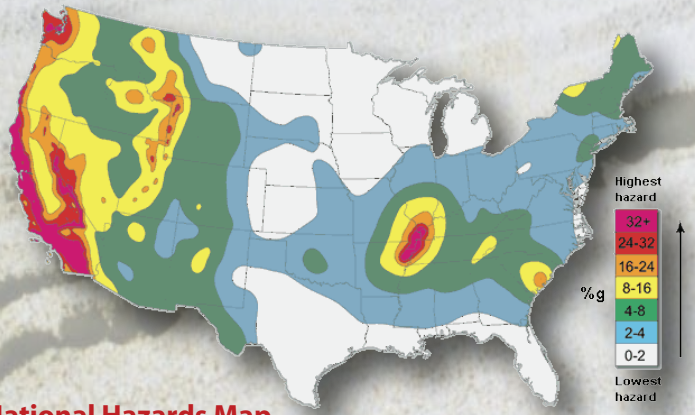




Liquefaction can occur in areas underlain by unconsolidated material or in water-saturated soils such as those that are found on river floodplains where recent (Quaternary) soft sediments are saturated by the high water table. The geologic map (right) shows some of these areas in yellow.

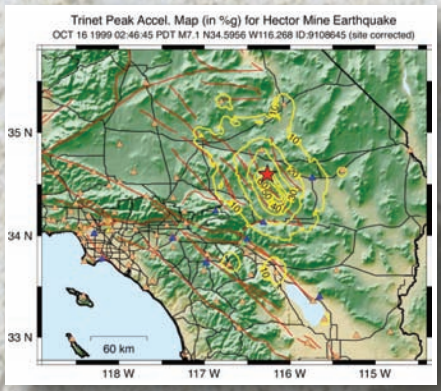
Geologic Map of Alabama

EARTHQUAKE ANALYSIS



National Hazards Map

Earthquake hazards maps provide information essential to creating and updating the seismic design provisions of building codes used in the United States. The 2002 U.S. Geological Survey shaking-hazard map for the United States (above) is based on earthquake occurrence in different areas and on shaking extent relative to the epicenter. Colors show levels of horizontal shaking that have a 1-in-10 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of g (g is the gravitational acceleration of a falling object).

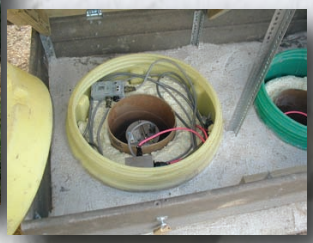


Computer Analyses

Multiple computer software programs exist to model earthquake dynamics. The Federal Emergency Management Agency's HAZUS (above left) software estimates losses from a potential earthquake. ShakeMap is a product of the U.S. Geological Survey that provides maps (above right) of ground motion and shaking intensities during significant earthquakes. These maps are used for post-earthquake response and recovery, public and scientific information, and preparedness exercises and disaster planning.

Modified Mercalli Intensity Scale

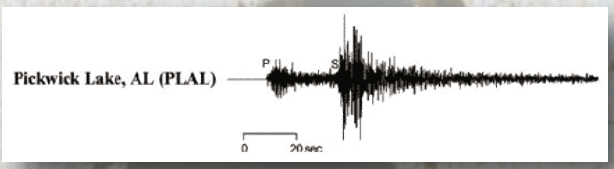
- **I.** Not felt.
- **II.** Felt by persons at rest, on upper floors, or favorably placed.
- **III.** Felt indoors. Vibration like passing of light trucks.
- **IV.** Vibration like passing of heavy trucks.
- **V.** Felt outdoors. Small unstable objects displaced or upset.
- **VI.** Felt by all. Furniture moved. Weak plaster/masonry cracks.
- **VII.** Difficult to stand. Damage to masonry and chimneys.
- **VIII.** Partial collapse of masonry. Frame houses moved.
- **IX.** Masonry seriously damaged or destroyed.
- **X.** Many buildings and bridges destroyed.
- **XI.** Rails bent greatly. Pipelines severely damaged.
- **XII.** Damage nearly total.



Seismic station in Bibb County, AL.

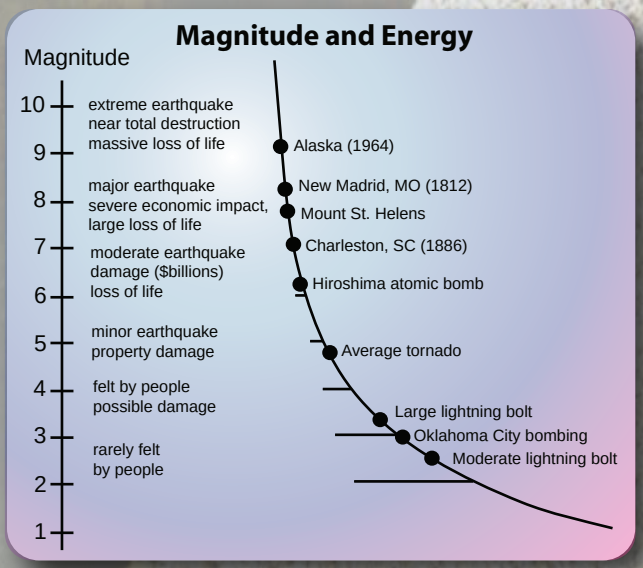
Seismographs

When an earthquake occurs, the energy released is measured at seismic stations (above) by seismographs. From seismograph records (such as the one from the Ft. Payne event shown below as measured by the Pickwick Lake seismograph), the magnitude of the event can be determined.



Magnitude and Energy

Amplitude recorded on a seismogram is related to the amount of energy released during the earthquake at the epicenter (below). The magnitude is often recorded as a number on a scale ranging from 1 to 10. Each unit represents a tenfold increase in earthquake amplitude.



Shaking Intensity

Intensity is a description of the severity of shaking at a particular location, whether at the epicenter or beyond. Intensity describes how people and objects were affected by the shaking based on reports and observations from people in the area. Values range from I to XII on the Modified Mercalli Intensity Scale (left), increasing from barely detectable to catastrophic.

Geological Survey of Alabama and Alabama Emergency Management Agency.
Brochure design by Sandy Ebersole, Geological Survey of Alabama, 2007.