ARKANSAS SEISMIC NETWORK

Overview

Public awareness on the occurrence of earthquakes in the United States has tended to be focused on California, Alaska, or the western United States in general. HOWEVER, Arkansas has had its share of earthquake activity and an area known as the New Madrid seismic zone (NMSZ) puts Arkansas and surrounding states at a significant risk for future earthquakes. Named for a small town in Missouri on a bend of the Mississippi River (see Figure 1), the NMSZ is an active fault system that extends northeastward from around Marked Tree in northeastern Arkansas to near Cairo in southern Illinois. In the winter of 1811-1812, a series of at least three catastrophic earthquakes with estimated magnitudes greater than 7.0 rattled the region. Cabins collapsed, people were frightened, and there was widespread land deformation. The NMSZ remains active and scientists believe it is still capable of producing large and damaging earthquakes (see Figure 2). On average, there is an earthquake on the NMSZ every other day, though most are too small to be felt. The felt threshold for earthquakes is generally above a magnitude 2.5, though locally there can be exceptions.

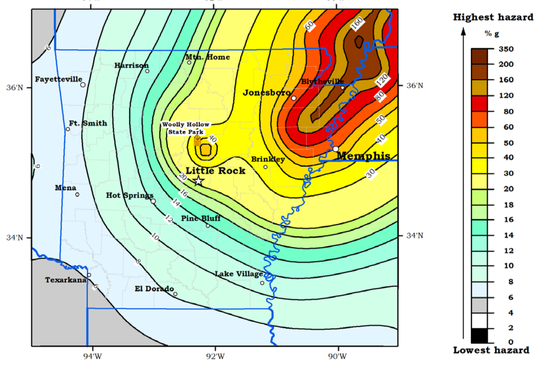
Prior to 2010, most of the seismic stations in Arkansas were concentrated around the NMSZ in northeast Arkansas. However, earthquakes can occur at any time across the entire state. In 2008, a series or "swarm" of small earthquakes struck near Magnet Cove in Hot Spring County. An earthquake swarm is a series of earthquakes in a localized area that occur over a relatively short period of time. The Magnet Cove Swarm, coupled with the seismic risk that continues to be posed by the NMSZ, served as the impetus for the establishment of the Arkansas Seismic Network (ASN). The ASN initially consisted of six state-of-the-art permanent broadband seismic stations strategically placed within selected state parks across Arkansas. Installation of the initial six stations in 2010 was funded through the Arkansas Governor's General Improvement Fund in 2008. Three pre-existing broadband stations were added to the ASN in 2016. The goal of the ASN is to establish better and more uniform earthquake detection outside of the NMSZ. The network was installed and seamlessly integrated with the regional and national seismic networks. The ASN was assigned the code of **AG** within the Advanced National Seismic System (ANSS). The ASN is operated and maintained in cooperation with the Arkansas Geological Survey (AGS), Center for Earthquake Research and Information (CERI) at the University of Memphis, and Arkansas State Parks. Since its installation, the ASN has recorded area seismicity such as the Guy-Greenbrier swarm.

The ASN stations are located within state parks because these properties are owned by the State of Arkansas and because visitor centers have internet access. Internet access allows the seismic data generated at the station to be efficiently transmitted to CERI and the National Earthquake Information Center (NEIC) in Denver, Colorado for processing. Because of vehicular traffic and other human causes of vibrations or "noise" common in the immediate area of the park visitor centers, the stations were installed in remote or relatively quiet areas of the parks away from the visitor centers. The remoteness of the sites requires the seismic stations to be equipped with a radio transmitter and directional antenna which allows wireless transmission of the continuous stream of seismic data to a receiving antenna mounted at each of the visitor centers. The Woolly Hollow seismic station is located approximately 1,175 feet northwest of the park visitor center. Its ASN network acronym is **WHAR**. The AG network can be accessed via the AGS or CERI websites.

Each ASN station consists of an above-ground equipment enclosure with a partially buried fiberglass vault located no more than twenty feet away. The above-ground equipment enclosure is weather-tight and contains a digitizer, radio transmitter, and four 12-volt batteries. Two south-facing solar panels mounted directly above the enclosure keep the batteries charged, ensuring that the seismic instrumentation will operate on a continuous basis (Figure 3). Ideally, the hole for the vault is excavated to the top of bedrock, however, this is not always possible due to the local geologic conditions at the site. Seismic instrumentation installed in the fiberglass vault includes a broadband seismometer and accelerometer. The seismometer is a digital version of the traditional seismograph which senses vibrations over a large range of seismic wave frequencies or bands. An accelerometer is a special type of seismometer which is also known as a "strong motion" sensor. Strong ground motion is the engineers' measure of an earthquake's size. Accelerometers measure the movement of the ground at a particular site in terms of a percentage of gravity (g). Wiring that supplies power to the vault and cables that convey seismic data from the vault to the above-ground equipment enclosure are run through a two-inch PVC conduit with a burial depth of approximately six inches. A removable lid is bolted down on top of the vault after instruments are installed. Like the above-ground equipment enclosure, the fiberglass vault is weather-tight to protect the instruments from moisture intrusion.

Arkansas Seismic Hazard Map

Figure 2

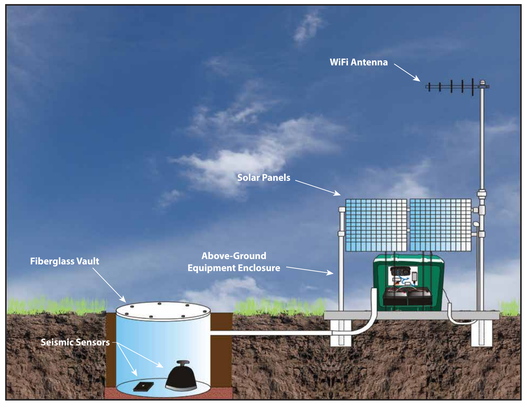


Seismic Hazard is expressed as Peak Ground Acceleration (PGA) on firm rock, in percent g, expected to be exceeded in a 50 year interval with a probability of two percent Source: National Seismic Hazard Mapping Project (2016)

NOTE: **g** denotes acceleration of gravity

Seismic Station Schematic

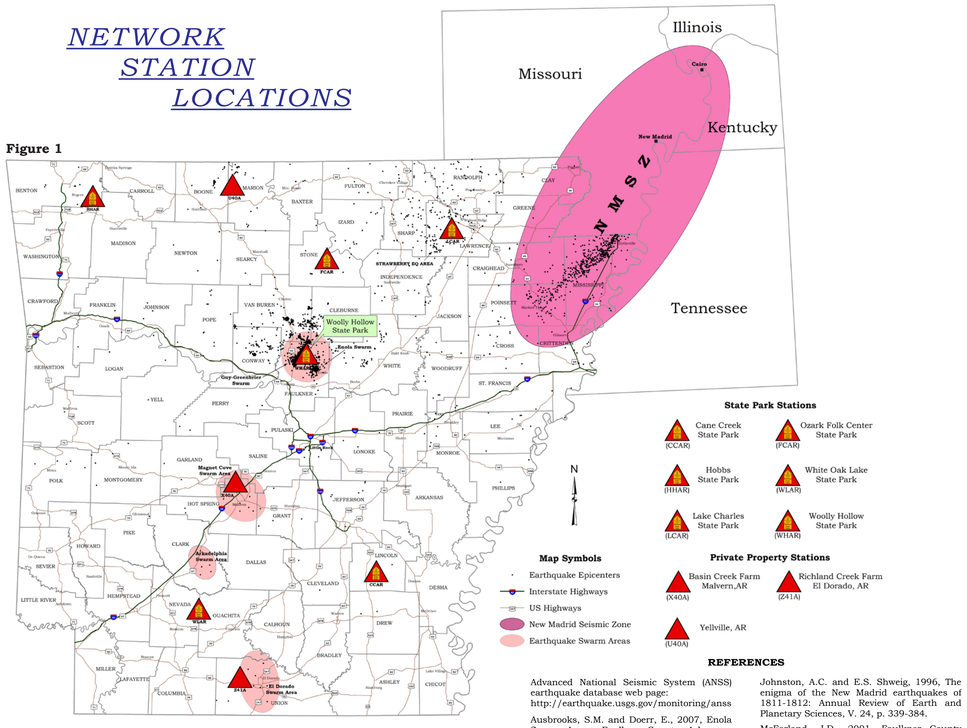
Figure 3

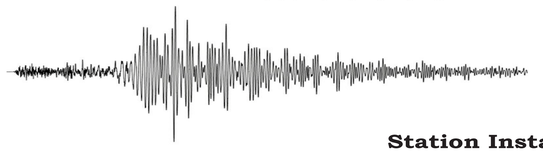


WOOLLY HOLLOW STATE PARK HAS AN EARTHQUAKE MONITORING STATION!

NETWORK STATION LOCATIONS

Figure 1





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United States Geological Survey (USGS) Earthquake Hazards Program and National Earthquake Information Center https://earthquake.usgs.gov

Station Installation


PLATE 1

Placing a 3x3.5 ft. cylindrical, fiberglass vault 3 ft. below-ground


PLATE 4

Backfilling around fiberglass vault


PLATE 7

Placing seismometer in fiberglass vault

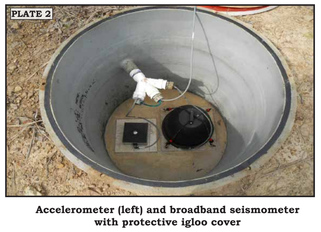


PLATE 2

Accelerometer (left) and broadband seismometer with protective igloo cover


PLATE 5

Pouring a 3 inch concrete pad for above-ground equipment enclosure


PLATE 8

Placing above-ground equipment enclosure

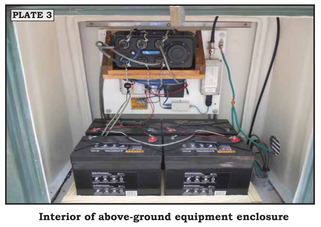


PLATE 3

Interior of above-ground equipment enclosure


PLATE 6

Installing WIFI antenna at snack bar


PLATE 9

Installation team

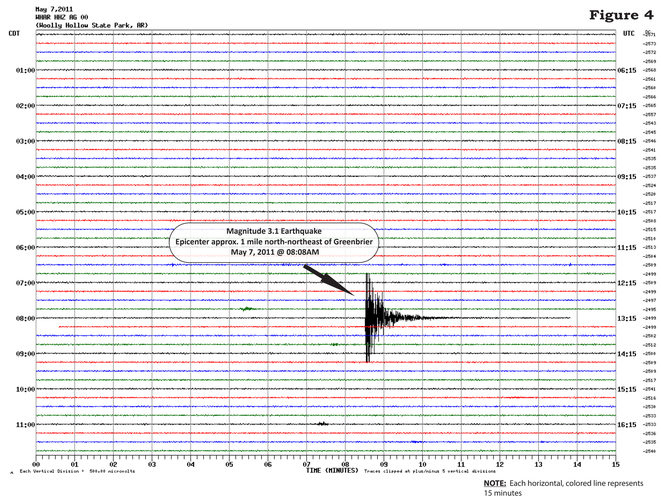
Completed Seismic Monitoring Station
White Oak Lake State Park


PLATE 10

Helicorder Display: Digital seismogram, WHAR seismic station
Two displays are generated each day (AM and PM)

Go to AGS website to view or download near real-time displays: http://www.geology.arkansas.gov

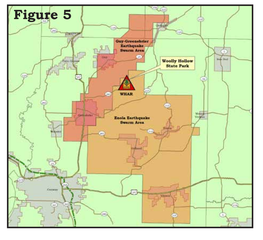
Figure 4



NOTE: Each horizontal, colored line represents 15 minutes

Notable Area Seismicity

Figure 5



Guy-Greenbrier Earthquake Swarm

The Guy-Greenbrier Earthquake Swarm began in August 2010 and continued through 2011. Over 1,300 earthquakes were reported by the USGS during this time in the Guy and Greenbrier area of Faulkner County. It is likely that the number of reported events would be lower and/or the location uncertainty greater if it were not for the presence and close proximity of the Woolly Hollow seismic station. Most of the events recorded were too small to be felt, however, there were hundreds of earthquakes greater than magnitude 2.0 with many of these events felt locally and some with magnitudes of around 3.0 or greater strong enough to be felt regionally. The largest earthquake in the swarm was a magnitude 4.7 event that originated approximately three miles northeast of Greenbrier at 11:00 PM on February 27, 2011. Felt reports were widespread across Arkansas, and it was also felt in portions of surrounding states. It is reported that at least one residence very close to the epicenter had some structural damage, and there were reports of cracked windows, items knocked off shelves, and cracks in plaster walls. Over time, the earthquakes migrated southwestward from near Guy to the Greenbrier area with the epicenters forming a distinct 13 kilometer long linear trend highlighting a previously unknown, sub-surface fault, now named the Guy-Greenbrier Fault. Unlike the Enola Swarm, the Guy-Greenbrier Swarm does not appear to have occurred naturally. Instead, research points to a potential link to nearby injection wells (now defunct) that were used to dispose of wastewater generated during the completion of regional natural gas production wells.

Enola Earthquake Swarm

Earthquake swarms with measurable events have occurred periodically in Arkansas over the last forty years. One of the most notable is the Enola Earthquake Swarm that occurred in central Faulkner County during the early 1980s and again in 2001 (see Figure 5). It is named for the small town of Enola because the individual event epicenters are mapped in close proximity to this community. On January 12, 1982, an earthquake with a magnitude of 1.2 was recorded near Enola. This earthquake is considered to mark the beginning of the Enola Swarm. More than 40,000 seismic events have been instrumentally recorded in the vicinity of Enola since 1982. The vast majority of the earthquakes were less than 2.5 in magnitude and most of the events went unnoticed by area residents. Felt events that have been reported include a 4.5 magnitude earthquake on January 21, 1982 which was the largest recorded seismic event in the Enola Swarm area. On May 4, 2001, a magnitude 4.4 earthquake struck the Enola area and was followed by numerous aftershocks, some of which measured greater than 2.0 in magnitude. Approximately 2,500 earthquakes were recorded in the Enola area in 2001. It is reported that the Enola Swarm earthquakes did not result in structural damage, although there were reports of broken china near the epicenters of some of the larger events. The Enola Swarm seismicity is considered to be naturally occurring and unrelated to the New Madrid Seismic Zone.

Figure 4 above is a digital seismogram referred to as a helicorder display which shows the signature of a magnitude 3.0 earthquake that struck just north-northeast of Greenbrier on May 7, 2011.

WHEN THE EARTH SHAKES, KNOW WHAT TO DO:

DROP COVER HOLD ON

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2019