# A R K A N S A S   S E I S M I C   N E T W O R K

GH-EQ-SPP-LCAR-003

## Overview

Public awareness of the occurrence of earthquakes in the United States has primarily been focused on California, Alaska, or the western United States in general. However, Arkansas has had its share of significant earthquakes, most of which originate from an area of northeast Arkansas known as the New Madrid seismic zone (NMSZ). The NMSZ is the most seismically active area in the United States east of the Rocky Mountains. The presence of the NMSZ puts Arkansas and surrounding states at a significant risk for future, major 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 northward 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 (Figure 2). On average, there is an earthquake in 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 where the seismic hazard is the greatest. However, earthquakes can occur at any time or location across the 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 in 2010 within selected state parks across Arkansas. Three pre-existing broadband stations were added to the ASN in 2016. Installation of the initial six stations was funded through the Arkansas Governor’s General Improvement Fund in 2008. The goal of the ASN is to establish better and more uniform earthquake detection outside of the NMSZ. The network is seamlessly integrated with other regional and national seismic networks and 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. It was assigned the code of **AG** within the Advanced National Seismic System (ANSS). Since its establishment, the ASN has recorded seismicity such as the May 2013 earthquake cluster near Strawberry in extreme southwest Lawrence County.

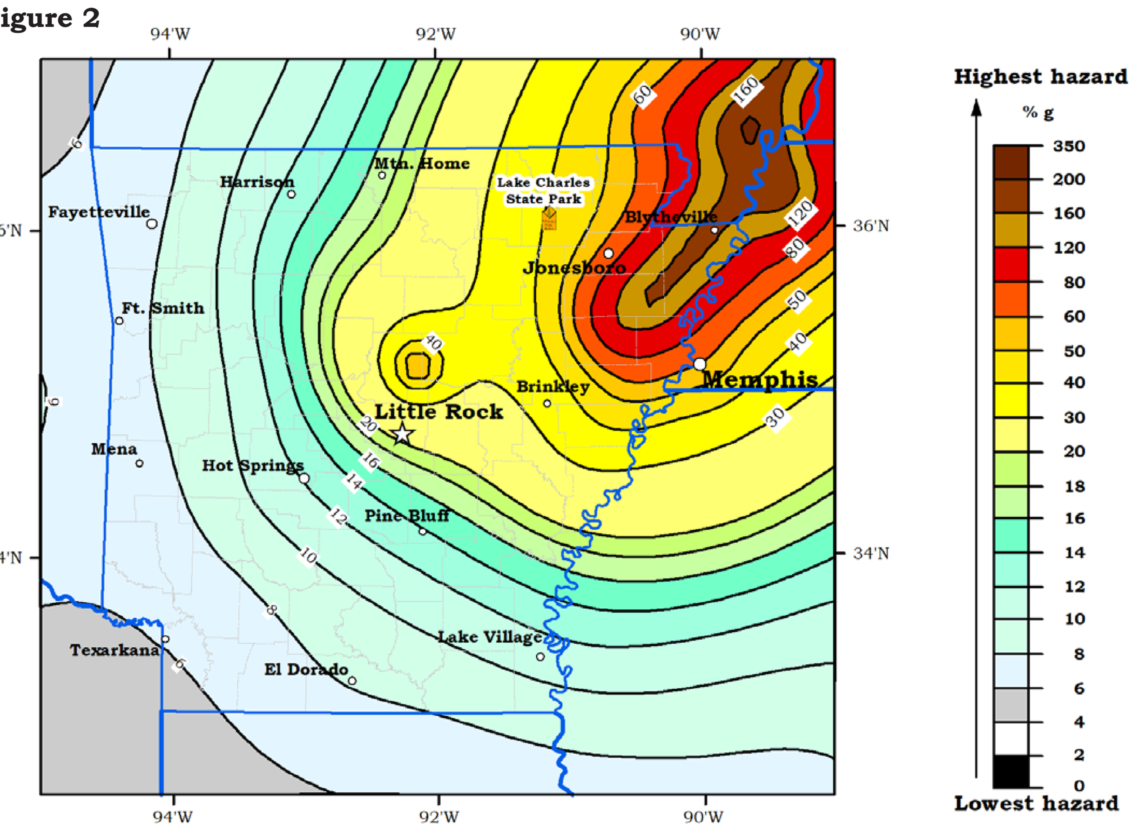
The six original ASN stations were located within state parks because these properties are owned by the State of Arkansas and the visitor centers have internet access. Internet access allows the seismic data generated at the station to be efficiently transmitted to CERI and the National Earthquake Information 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 allow wireless transmission of the continuous stream of seismic data to a receiving antenna mounted at each of the visitor centers. The Lake Charles seismic station is located approximately 1,480 feet north-northwest of the park visitor center. Its ASN network acronym is **LCAR**. The ASN can be accessed via the AGS or CERI websites.

Each ASN station consists of a fiberglass, 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 geologic conditions present at the site. Seismic instrumentation installed in the fiberglass vault includes two types of instruments: a broadband seismometer and a strong-motion seismometer or accelerometer. The broadband 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 engineer’s 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). This information is crucial to engineers when designing seismic resistant structures.

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 diameter polyvinyl chloride (PVC) conduit with a burial depth of approximately six inches. A removable lid is bolted down on top of the vault after placement of the instrumentation. Like the above-ground equipment enclosure, the fiberglass vault is weather-tight to protect the instrument(s) from moisture.

## Arkansas Seismic Hazard Map

Figure 2

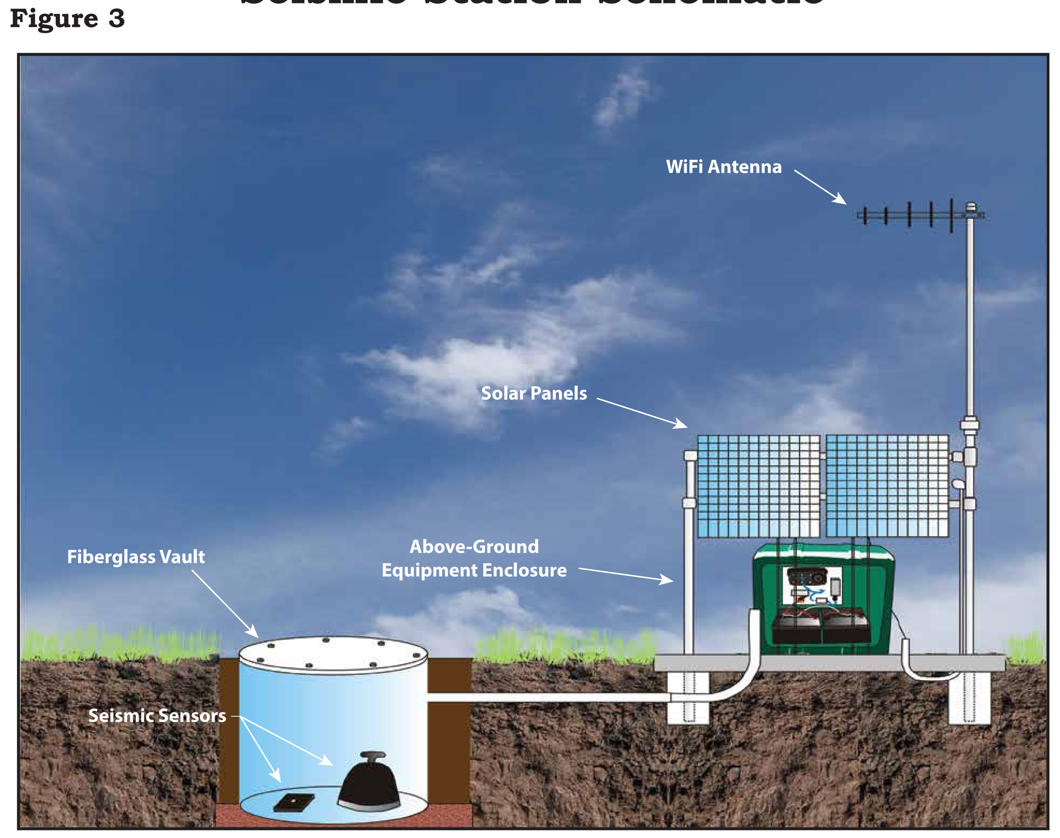



**Seismic Hazard is expressed as Peak Ground Acceleration (PGA) on firm rock, in percent g, expected to be exceeded in a 50 year interval with a probability of two percent**
**Source: National Seismic Hazard Mapping Project (2016)**

**NOTE: g** denotes acceleration of gravity

## Seismic Station Schematic

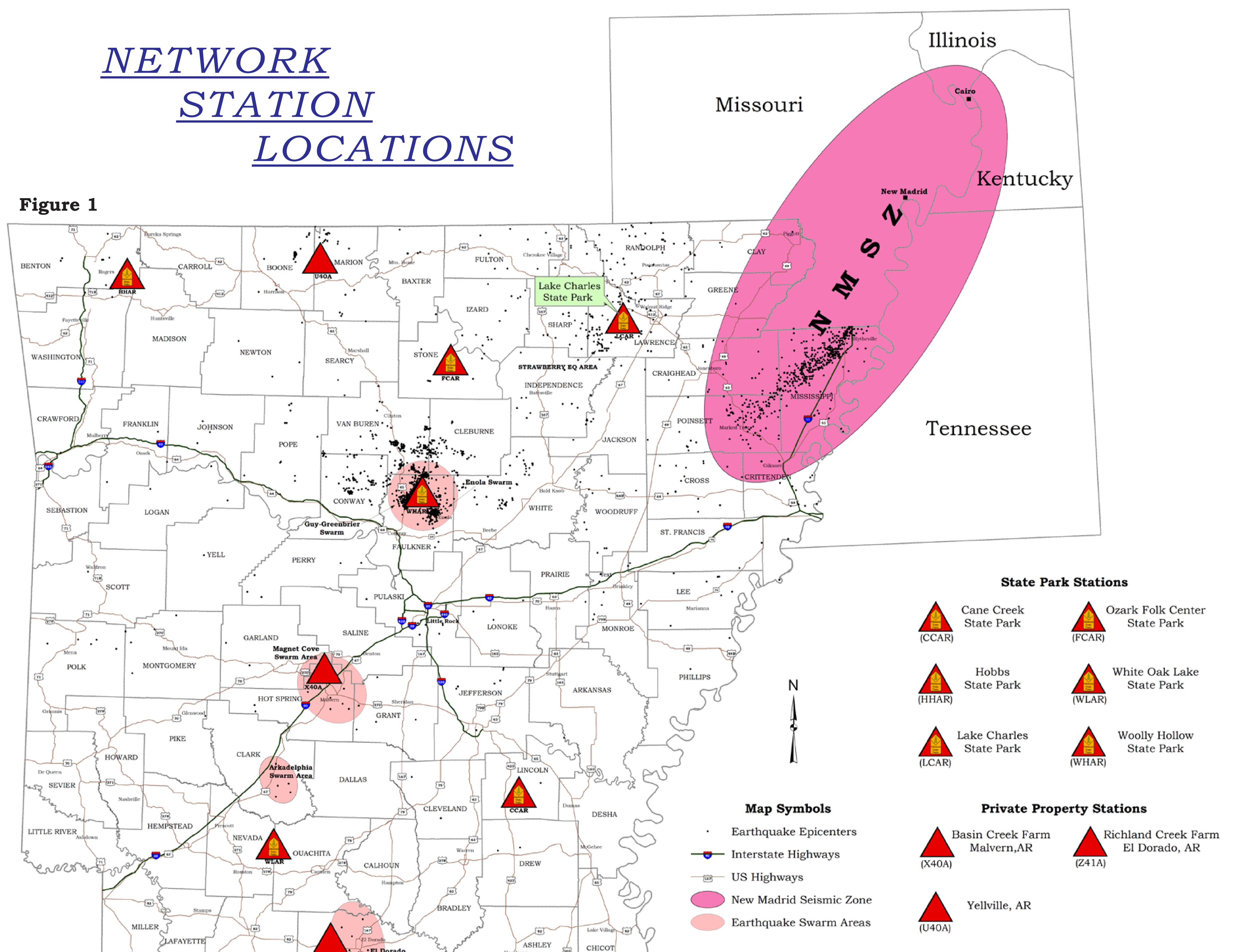
Figure 3




# LAKE CHARLES STATE PARK HAS AN EARTHQUAKE MONITORING STATION!

## NETWORK STATION LOCATIONS

Figure 1





**REFERENCES**

Advanced National Seismic System (ANSS) earthquake database web page: http://earthquake.usgs.gov/monitoring/anss

Center for Earthquake Research and Information (CERI) - New Madrid Earthquake Catalog: http://folkworm.ceri.memphis.edu/catalogs/html/cat_nm.html

Feature Class Data used in the making of the maps in this poster was acquired at online at http://www.gis.arkansas. gov

National Earthquake Information Center (NEIC) – Preliminary Determination of Epicenters (PDE) earthquake catalog for M2.5 and greater U.S. earthquakes and M4.5 and greater Worldwide earthquakes http://earthquake.usgs.gov/earthquakes/eqarchives/epic/

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


## Station Installation


Clearing out hole for placement of 3x3.5 ft. cylindrical fiberglass vault


Placing fiberglass vault below-ground


Backfilling around fiberglass vault


Preparing form for above-ground equipment enclosure concrete pad


Pouring concrete pad for above-ground equipment enclosure


Placing seismometer in fiberglass vault


Interior of above-ground equipment enclosure


WiFi receiving antenna at Visitor Center


CERI Installation team

## Completed Seismic Station Installation Lake Charles State Park


## Helicorder Displays: Digital seismograms, LCAR 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.ar.gov**

Figure 4

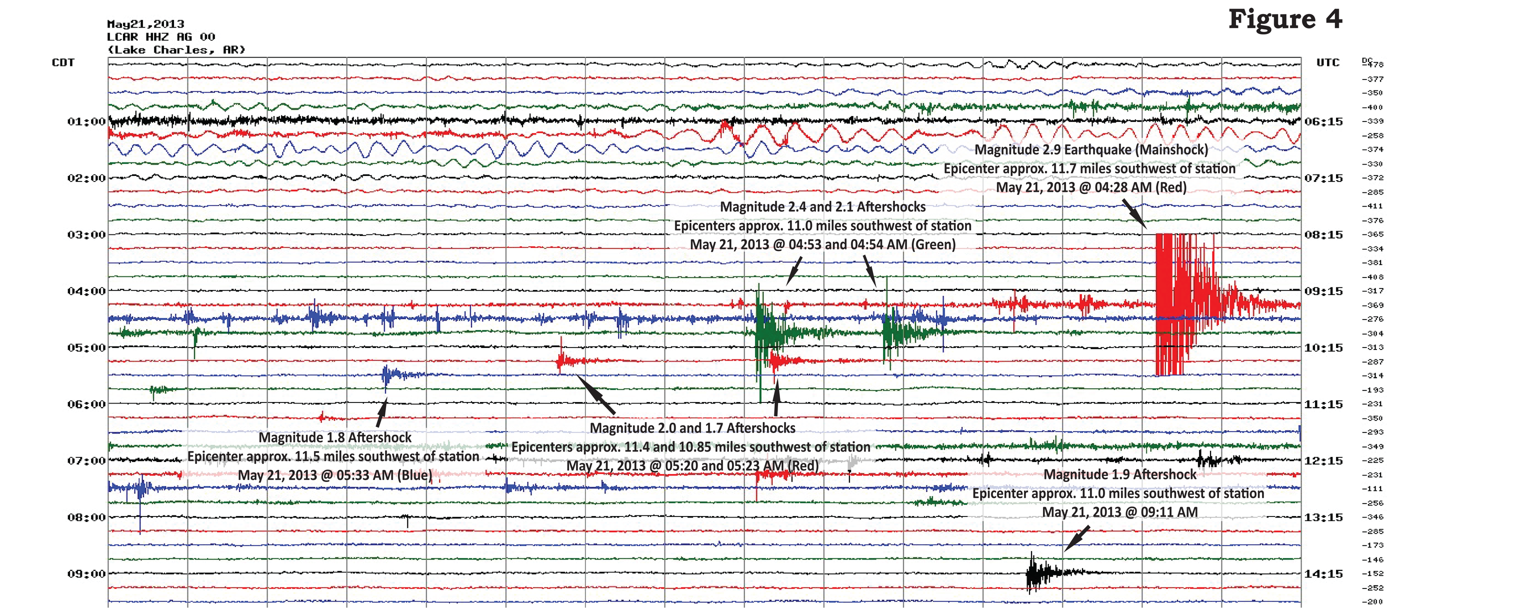
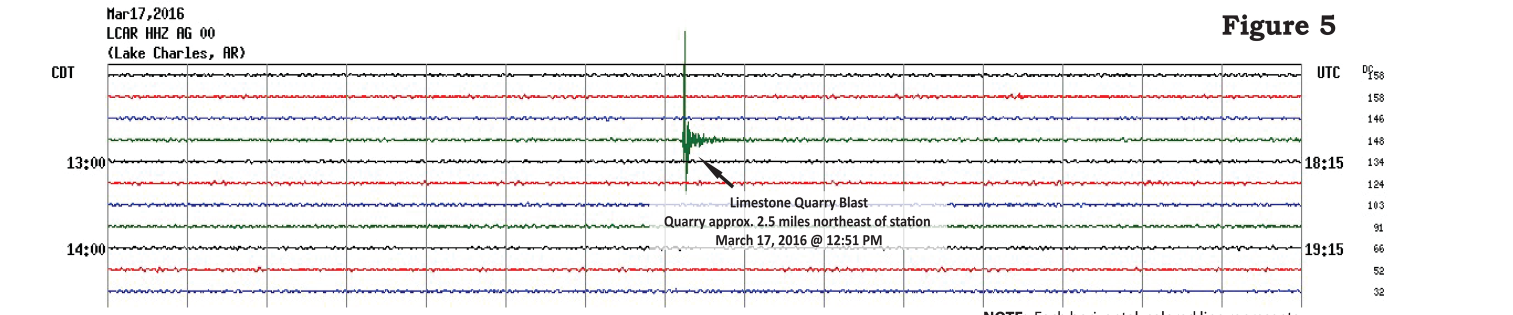



Figure 5



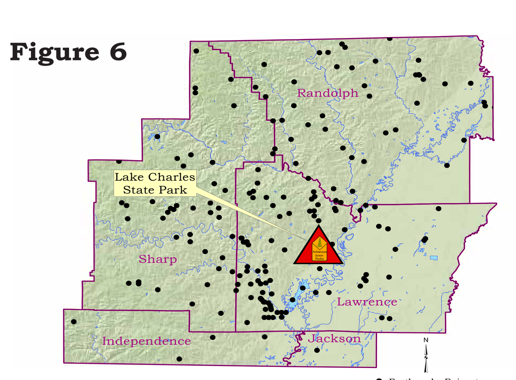

**NOTE:** Each horizontal, colored line represents 15 minutes

## Area Seismicity

As depicted on the seismic hazard map at the far left (Figure 2), due to its proximity to the New Madrid seismic zone (NMSZ), the Lake Charles State Park is located in a part of the State with a moderate to high seismic risk. Although not located in the NMSZ itself, it is situated in an area with seismicity that is slightly elevated above normal, “background” levels. However, it would be significantly impacted by a large event in the NMSZ.

Since 1918, over 200 earthquakes have been recorded by the United States Geological Survey (USGS) in the area defined by the counties of Fulton, Independence, Izard, Lawrence, Randolph, and Sharp. This area of seismicity is located along and on the west side of a sub-surface structural feature known as the Commerce Geophysical Lineament (CGL). The CGL is thought to be associated with a southwest-northeast oriented, linear zone of sub-surface faulting that extends from southern Missouri into northern Arkansas, trending roughly toward Little Rock. Many of these earthquakes were recorded at the Lake Charles station after it went online in mid-February, 2010 (Figure 6). Among these events are seven small earthquakes that occurred on May 21, 2013 near the town of Strawberry, approximately 11.5 miles southwest of the Lake Charles station (Figure 4). The first and largest of the seven earthquakes was a magnitude 2.9 event with its epicenter located approximately two miles southeast of Strawberry. This earthquake was followed on the same day by six smaller events whose epicenters are within two miles of the magnitude 2.9 epicenter. There were four Arkansas felt reports for the 2.9 event. The closest felt report was in Strawberry and the farthest approximately 40 miles to the southwest in the Stone County community of Marcella. The remaining six events ranged from 1.7 to 2.4 in magnitude and were likely too small to be felt. These smaller events are referred to as “aftershocks.”

Figure 6




Aftershocks are smaller earthquakes that happen in the same general area during the days to years following a larger event or “mainshock.” They occur during the period of time before the normal, or background seismicity level has resumed. Aftershocks have been interpreted as representing minor readjustments along the portion of a fault that slipped during the mainshock. Aftershocks tend to decrease in size and frequency with time. Typically, the larger the mainshock, the larger and more numerous the aftershocks, and the longer they will continue. Historically, deep earthquakes (> 30 kilometers) are much less likely to be followed by aftershocks than shallow earthquakes. It is worth noting that all of the Strawberry events originated at less than 30 kilometers in depth. Foreshocks are earthquakes that precede larger earthquakes in the same general location. An earthquake cannot be identified as a foreshock until after the occurrence of a larger event in the same area. There were no detectable foreshocks associated with the Strawberry mainshock.

The Strawberry events are believed to have occurred naturally rather than having been associated with human activity such as the deep well disposal of gas exploration or production wastewater by what are referred to as injection wells. Researchers have linked this subsurface disposal practice to the occurrence of over 1,300 earthquakes in the area of Guy and Greenbrier in Faulkner County, primarily from 2010 through 2011. Unlike the short-lived burst of activity near Strawberry, the Guy-Greenbrier events are referred to as a “swarm” since there was no initial mainshock.

In addition to natural and human-induced sub-surface seismicity, many of the northern Arkansas seismic stations routinely detect ground surface vibrations associated with blasting at local quarry operations. Nearby construction projects or other activities that require the use of explosives can also register on the station seismometers. Figure 5 above shows a portion of the morning helicorder display recorded at the LCAR station on March 17, 2016. It can be concluded that the signature shown at 12:51 PM on the referenced display represents vibrations induced by a blast since the representative of a nearby quarry confirmed that a charge had been detonated at the same time.

**WHEN THE EARTH SHAKES, KNOW WHAT TO DO:**



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