U.S. Department of the Interior
U.S. Geological Survey

Geologic Investigations Series I-2812
Version 1.0

Prepared in cooperation with the
Central United States Earthquake Consortium
and the Association of CUSEC State Geologists

Earthquakes in the Central United States—1699-2002

By Russell L. Wheeler, Eleanor M. Omdahl, Richard L. Dart,
Gerald D. Wilkerson, *and* Rick H. Bradford

2003

About This Map

The large map shows the distribution of earthquakes in the most seismically active region of the central United States. It was prepared for a general audience and should not be used to assess earthquake hazards for small areas or at individual locations.

The map shows earthquakes that were large enough to be felt, and a few of them were large enough to cause damage. Earthquakes too small to be felt are far more numerous, occur nearly everywhere, but are not shown on the map.

The well-known New Madrid seismic zone (NMSZ) is shown by the dense, northeast-elongated cluster of earthquakes in northeastern Arkansas, southeastern Missouri, and adjacent Tennessee and Kentucky. The seismic zone is the most seismically active part of North America east of the Rocky Mountains (see "*Notable Earthquakes*"). The southern and northern ends of the NMSZ are near the two large earthquakes that occurred in 1843 and 1895, respectively. North of the NMSZ, extending as far as St. Louis and Indianapolis, is an area of scattered earthquakes. The eastern part of this area straddles the Wabash River and is called the Wabash Valley seismic zone.

A tight cluster of small earthquakes north of Little Rock, Ark., is called the Enola earthquake swarm. During the 1980's, tens of thousands of small, mostly unfelt earthquakes occurred in the cluster, and the map shows the largest of them.

The oldest earthquake shown on the map occurred in 1795 northeast of St. Louis; however, almost a century earlier in 1699, missionaries traveling down the Mississippi River felt an earthquake. From their single written report we cannot determine that earthquake's location. They reported being camped, probably next to the river and probably between what are now Memphis, Tenn., and Helena, Ark. Seismologists interpreted the description of the earthquake shaking as consistent with a small earthquake, possibly within a few tens of kilometers of the camp. The map shows the approximate location of the camp (solid red diamond) along the river between present-day Memphis and Helena.

Earthquakes occur on geologic faults. However, east of the Rocky Mountains, with few exceptions we cannot tell which fault slipped to cause an individual earthquake because many faults are not exposed at the Earth's surface. Maps like this one show the locations of earthquakes, but there is no reliable map of all "earthquake faults" for the central United States.

The most common measure of the size of an earthquake is its magnitude: a measure of the amount of energy released within the Earth by an earthquake. An older measure of earthquake size is intensity: a summary of the effects of earthquake shaking at ground level. There are many different ways to measure magnitude. The frequently cited "Richter scale" was the first of these ways, although the name is too often applied indiscriminately. Use of different magnitude types can give slightly different values for the magnitude of the same earthquake. Differences of several tenths of a magnitude unit are common.

The location of an earthquake's focus within the Earth is uncertain, typically by several kilometers or more. Uncertainties are larger where seismographs (instruments that record earthquake waves) are far apart, and for earthquakes that occurred before the development of seismographs. Some earthquakes with uncertain locations appear to line up along east-west or north-south lines (for example, in and near St. Louis, Chicago, and Memphis) because their locations can only be estimated to the nearest degree or tenth of a degree. Despite the uncertain locations of some earthquakes, the map shows that people in most parts of the map area have felt earthquakes since European settlers arrived there.

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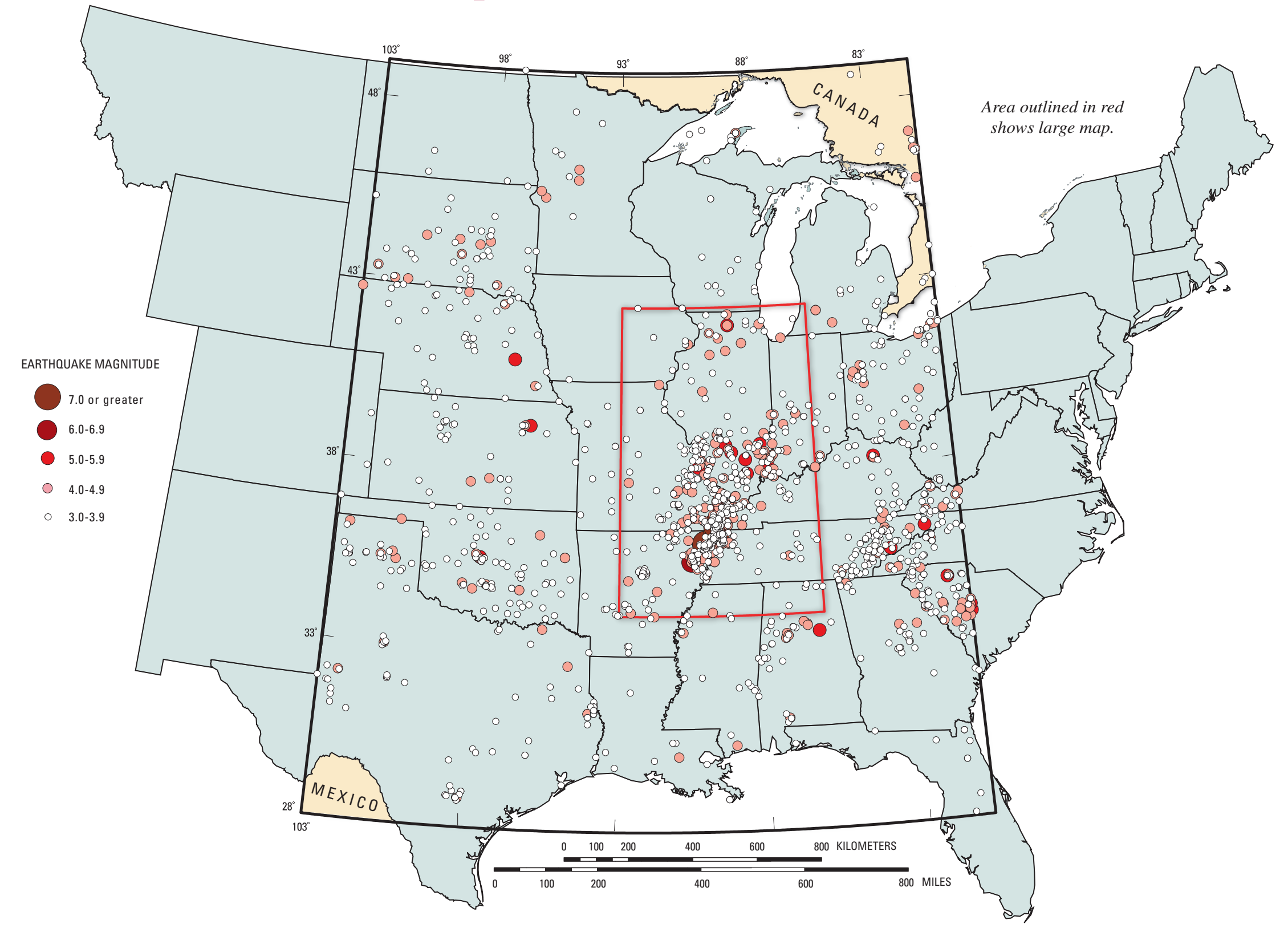
Earthquakes in the Central United States

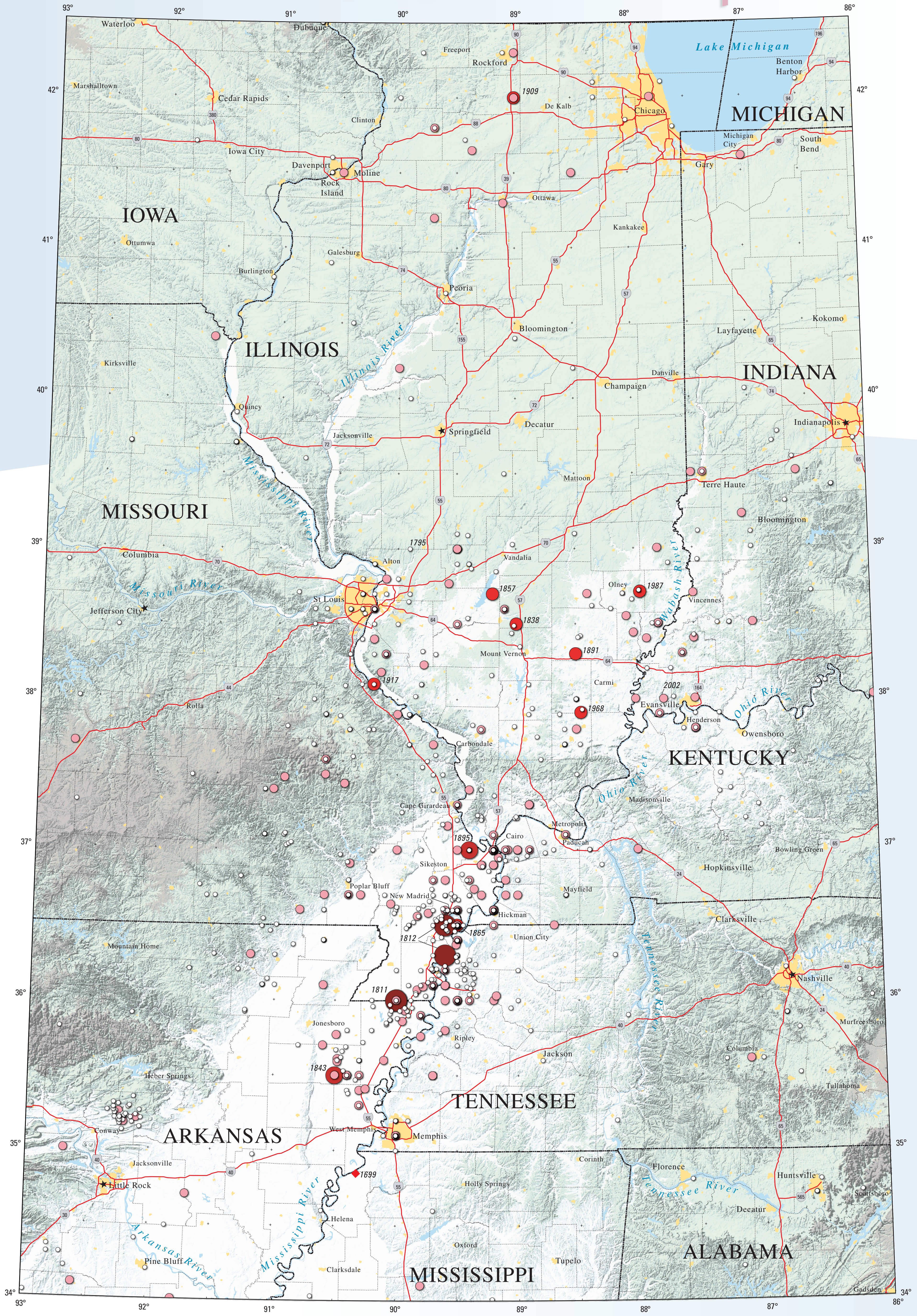


Area outlined in red shows large map.

Technical Note for Seismologists: Details of catalog assembly are in Wheeler, 2003, U.S. Geological Survey Open-File Report 03-232, 15 p. (*available for free downloading* at *URL http://pubs.usgs.gov/of /2003/ ofr-03-232)*. On the small map of earthquakes in the central United States, the area between the red and black outlines shows earthquakes whose records C.S. Mueller compiled through 2001 from several standard catalogs (written commun., 2002), plus records through 2002 that we added from the U.S. Geological Survey Preliminary Determinations of Epicenters (obtained from URL *http://www.neic.cr.usgs.gov*; see *"Sources of Information"*).

Contributors: The idea of making this poster originated with N.C. Hester and J. Wilkinson. The earthquake catalog and earthquake descriptions were improved by data, discussions, suggestions, and corrections from R.R. Anderson, M.B.E. Bograd, M.D. Bricker, M.C. Chapman, M.W. Hamburger, J.R. Hill, M.G. Hopper, A.C. Johnston, J.D. McFarland, A.G. Metzger, N.K. Moran, C.S. Mueller, D.E. Raymond, and M.M. Withers. The large map benefited from suggestions by A.J. Crone, P.S. Detra, J.T. Felkerson, R.B. Herrmann, D. Hoffman, W.-Y. Kim, T.H. Larson, E.S. Schweig, and A.C. Tarr. The poster as a whole was improved by reviews from J.D. Davis, J.S. Gomberg, J.C. Lahr, P.A. Lentz, P.J. Modreski, E.S. Schweig, and Lisa Wald. The poster resulted from collaboration between earthquake specialists in the U.S. Geological Survey Geology Discipline in Golden, Colo., and digital elevation specialists in the U.S. Geological Survey Geography Discipline in Rolla, Mo.

Three Centuries of Earthquakes



EARTHQUAKE MAGNITUDE

- ● 7.0 or greater
- ● 6.0-6.9
- ● 5.0-5.9
- ● 4.0-4.9
- ○ 3.0-3.9

SCALE 1:1,250,000

0 25 50 75 100 125 KILOMETERS

0 25 50 75 100 125 MILES

1 kilometer equals approximately 0.6 mile, and 1 mile equals approximately 1.6 kilometers

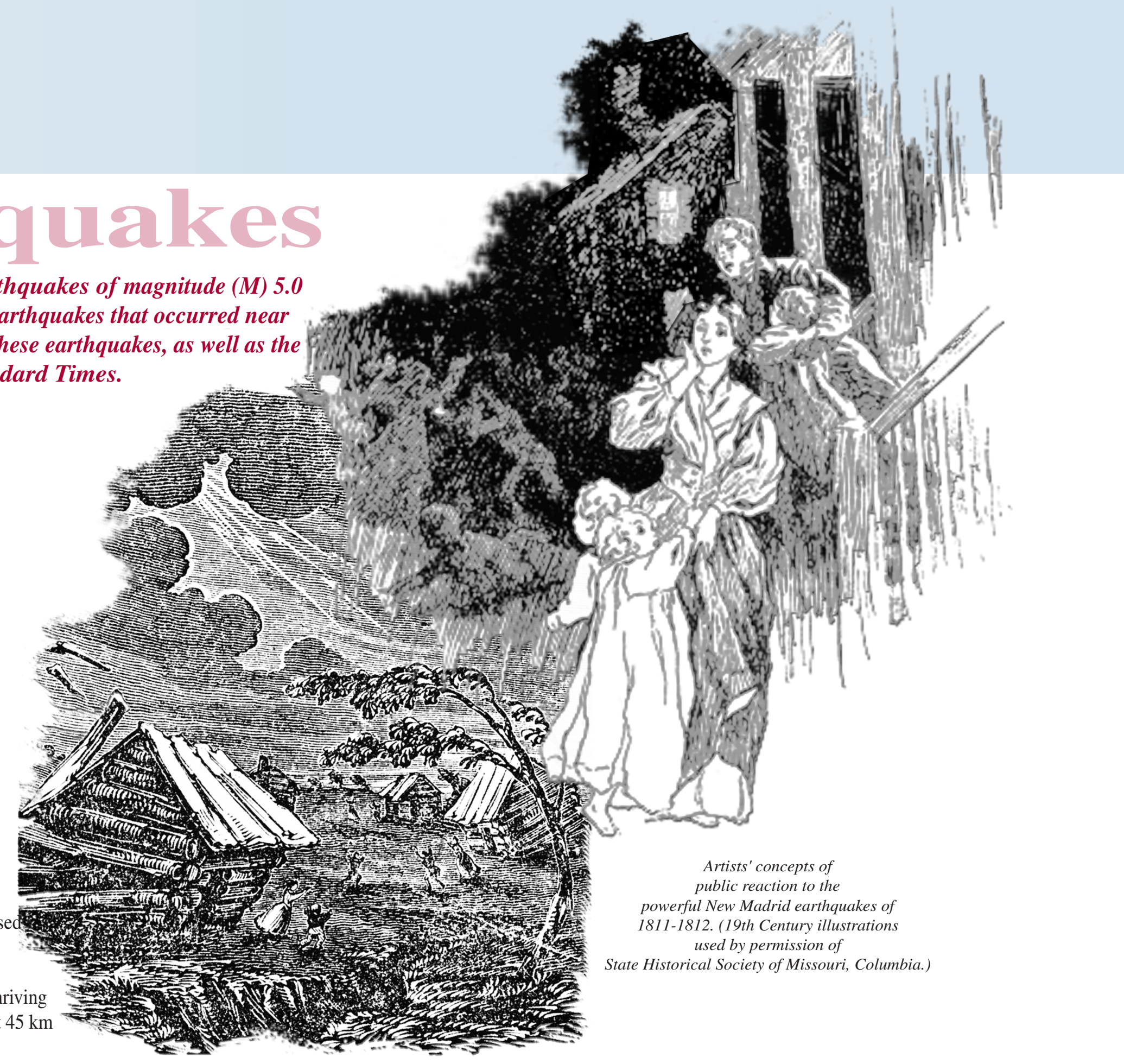
EXPLANATION

- County boundary
- State boundary
- Interstate highway
- Urban area
- ★ State capital
- ◆ Probable site at which 1699 earthquake was felt. See *"About This Map"*
- Elevation (in feet): High 2,157 — Low 150

Shaded-relief base produced by the United States Geological Survey from elevation data in *The National Map.* Base created with 8X vertical exaggeration from U.S. Geological Survey National Elevation dataset at 30-m resolution, resampled at 90 m. Albers equal-area projection, standard parallels 35°5'N. and 39°55'N., and central meridian 89°30'W. Latitude of projection's origin is 0°.

Notable Earthquakes

Numerous earthquakes have caused damage in the map area. All earthquakes of magnitude (M) 5.0 or larger are identified on the large map by their dates, as are two smaller earthquakes that occurred near St. Louis in 1795 and in southwestern Indiana in 2002. The five largest of these earthquakes, as well as the three most recent, are summarized below. Times shown are Central Standard Times.



Artists' concepts of public reaction to the powerful New Madrid earthquakes of 1811-1812. (19th Century illustrations used by permission of State Historical Society of Missouri, Columbia.)

December 16, 1811, 2:15 a.m.
January 23, 1812, 9:00 a.m.
February 7, 1812, 3:45 a.m.
● *M7.0 or greater*

1811-1812

Location: New Madrid seismic zone (NMSZ) of southeastern Missouri, northeastern Arkansas, and adjacent parts of Tennessee and Kentucky.

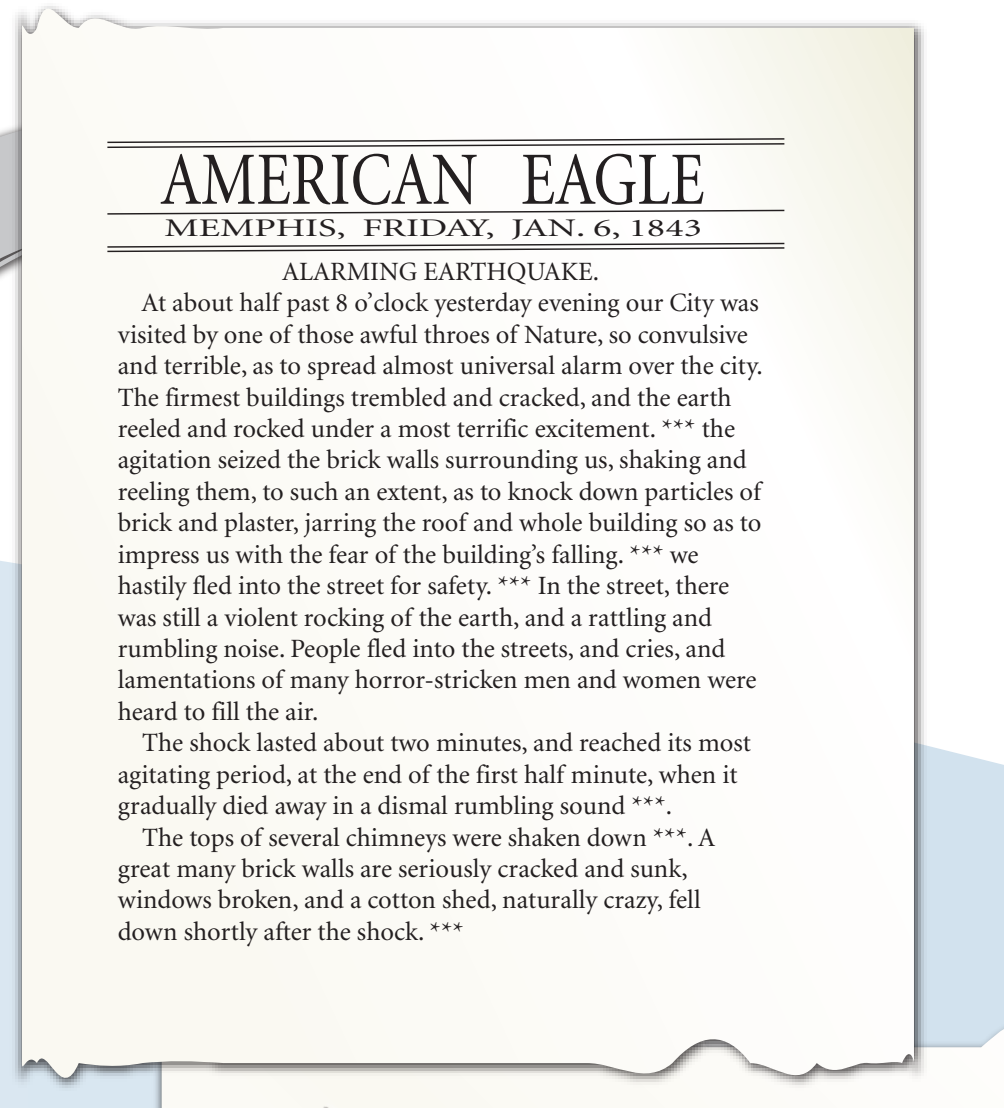
Effects: These three earthquakes were among the largest to strike North America since European settlement. They spanned 2 months and were followed by many hundreds of aftershocks that lasted for decades. Many of the aftershocks were major earthquakes themselves. The area that was strongly shaken by the three main shocks was 2-3 times as large as the strongly shaken area of the 1964 M9.2 Alaska earthquake, and 10 times as large as that of the 1906 M7.8 San Francisco earthquake.

The New Madrid earthquakes happened along the western frontier of the young U.S. They were felt in all settled parts of the central and eastern U.S. except Maine, as well as in Toronto, Canada. They caused general alarm from Detroit, Mich., to New Orleans, La.

Chimneys were knocked down as far off as Cincinnati, Ohio, 560 km (350 mi) away. Closer to the earthquakes, Memphis was not yet established. However, in St. Louis many homes were damaged; the thriving frontier trading town of New Madrid, Mo., was severely damaged and temporarily evacuated; and, about 45 km (30 mi) south of New Madrid, the town of Little Prairie, Mo., was destroyed.

The ground rose, fell, and cracked; trees snapped and were uprooted; large landslides were abundant on steep ground from the future site of Memphis, Tenn., to southernmost Illinois. Large areas rose permanently, and some of them dammed rivers to create or enlarge lakes that remain today. Other large areas sank and were flooded by streams and by enormous volumes of water and sand that erupted from thousands of fissures over a region about 240 km (150 mi) long and 80 km (50 mi) wide. Great waves on the Mississippi River and collapsing banks and sandbars along the river destroyed some boats and washed others ashore. A sudden uplift beneath the river caused it to overflow its banks, briefly flow upstream, and form two large rapids.

Eyewitness and other accounts make gripping reading at URL *http://www.ceri.memphis.edu/compendium/*. The U.S. Geological Survey and the Center for Earthquake Research and Information of the University of Memphis estimate that similar NMSZ earthquakes have a 7-10% chance of reoccurring within the next 50 years (U.S. Geological Survey Fact Sheet FS-131-02; see "*Sources of Information*").



AMERICAN EAGLE
MEMPHIS, FRIDAY, JAN. 6, 1843

ALARMING EARTHQUAKE.

At about half past 8 o'clock yesterday evening our City was visited by one of those awful throes of Nature, so convulsive and terrible, as to spread almost universal alarm over the city. The firmest buildings trembled and cracked, and the earth reeled and rocked under a most terrific excitement. *** the agitation seized the brick walls surrounding us, shaking and reeling them, to such an extent, as to knock down particles of brick and plaster, jarring the roof and whole building so as to impress us with the fear of the building's falling. *** we hastily fled into the street for safety. *** In the street, there was still a violent rocking of the earth, and a rattling and rumbling noise. People fled into the streets, and cries, and lamentations of many horror-stricken men and women were heard to fill the air.

The shock lasted about two minutes, and reached its most agitating period, at the end of the first half minute, when it gradually died away in a dismal rumbling sound ***.

The tops of several chimneys were shaken down ***. A great many brick walls are seriously cracked and sunk, windows broken, and a cotton shed, naturally crazy, fell down shortly after the shock. ***

M6.3 ● ***January 4, 1843, 8:45 p.m.***

1843

Location: Southern end of NMSZ, near Marked Tree, Poinsett County, northeastern Arkansas.

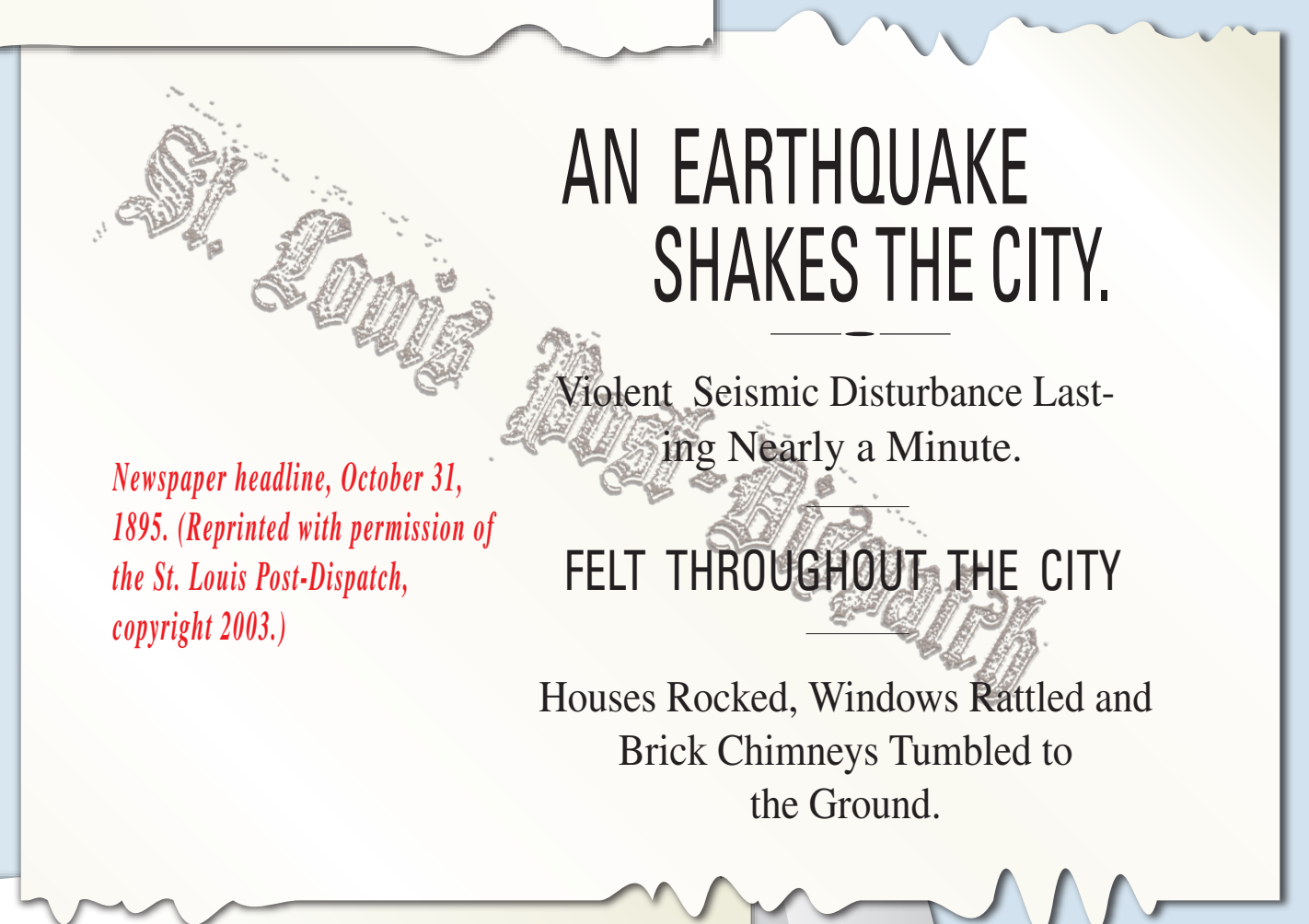
Effects: The strongest earthquake in the southern half of the seismic zone since 1811-1812 damaged Memphis, Tenn., 60-70 km (about 40 mi) from the epicenter—chimney tops fell, walls cracked, and windows broke. Chimneys fell at Helena, Ark., 110 km (70 mi) away, and at Hickman, Ky., 160 km (100 mi) distant. The earthquake was felt on the Atlantic Coast of Georgia and the Carolinas, in Providence, R.I., and beyond the westernmost frontier forts.

October 31, 1895, 5:08 a.m. ● *M6.6*

1895

Location: Northern part of NMSZ, at Charleston, Mississippi County, southeastern Missouri.

Effects: Strong shaking caused eruptions of slurries of sand and water at many places along a line roughly 30 km (20 mi) long. Damage occurred in six States, most severely at Charleston. Walls cracked, windows shattered, plaster broke, and chimneys fell extensively in Charleston and less so in Cairo, Ill. Shaking was felt in 23 States from Washington, D.C., to Kansas and from southernmost Canada to New Orleans, La.



St. Louis Post-Dispatch

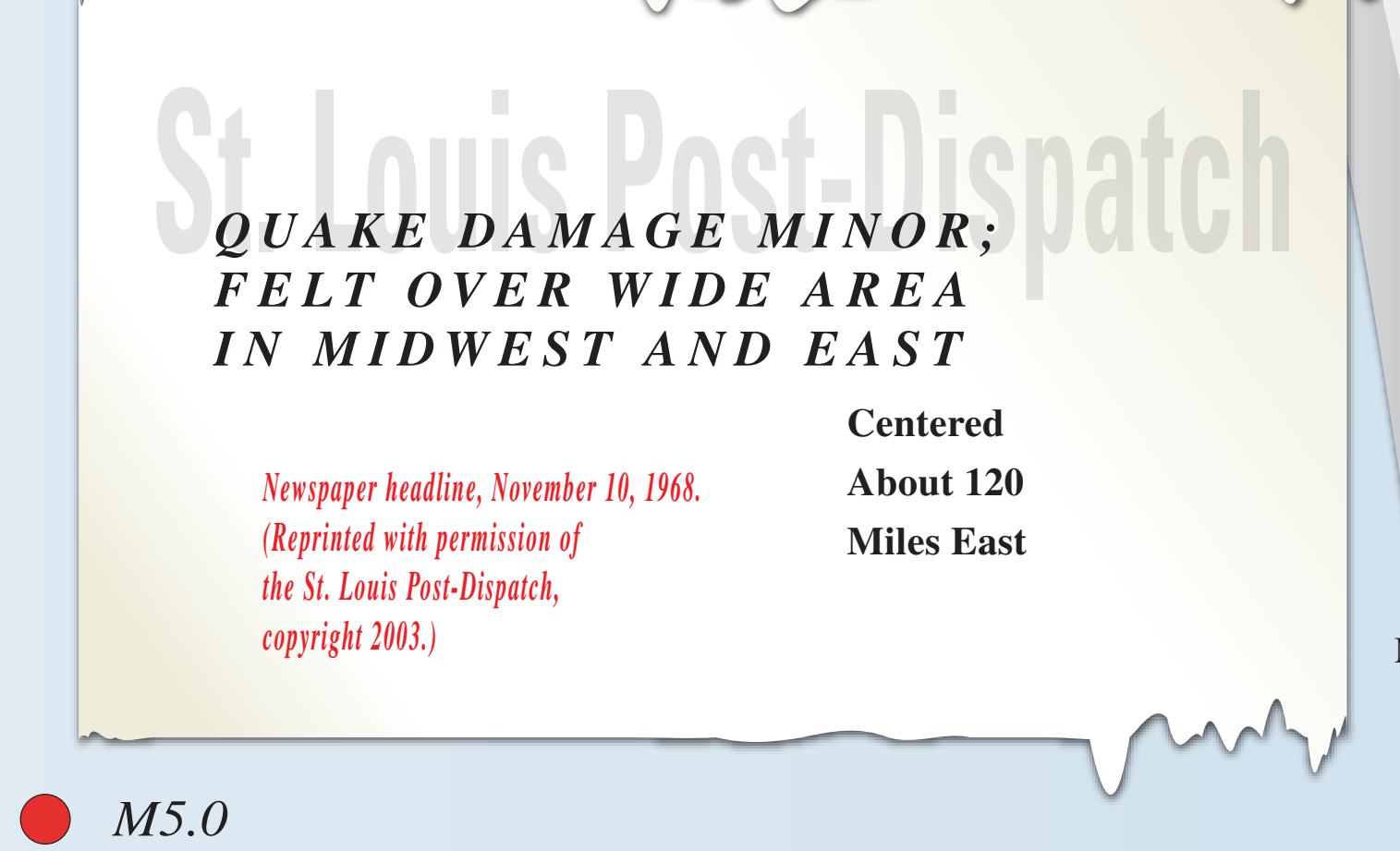
AN EARTHQUAKE SHAKES THE CITY.

Violent Seismic Disturbance Lasting Nearly a Minute.

FELT THROUGHOUT THE CITY

Houses Rocked, Windows Rattled and Brick Chimneys Tumbled to the Ground.

Newspaper headline, October 31, 1895. (Reprinted with permission of the St. Louis Post-Dispatch, copyright 2003.)



St. Louis Post-Dispatch

QUAKE DAMAGE MINOR; FELT OVER WIDE AREA IN MIDWEST AND EAST

Centered About 120 Miles East

Newspaper headline, November 10, 1968. (Reprinted with permission of the St. Louis Post-Dispatch, copyright 2003.)

M5.4 ● ***November 9, 1968, 11:02 a.m.***

1968

Location: Wabash Valley seismic zone (WVSZ), near Dale, Hamilton County, southeastern Illinois.

Effects: This was the largest earthquake in the map area since 1895. Chimneys and parapets fell, foundations cracked, and tombstones overturned. In a larger surrounding region, including St. Louis, Mo., 180 km (110 mi) away, bricks fell from chimneys, windows broke, television antennae fell, and plaster fell or cracked. Shaking was felt in 23 States from Minnesota to Georgia and from Pennsylvania to Kansas, and in multistory buildings in Boston, Mass., and southernmost Ontario, Canada.

June 10, 1987, 5:49 p.m. ● *M5.0*

1987

Location: WVSZ, near Olney, Richland County, southeastern Illinois.

Effects: Chimneys and chimney bricks fell, underground pipes were damaged, and sidewalks and streets cracked in at least four cities in Illinois, Indiana, and Kentucky. Several towns in Illinois and Indiana reported cracked chimneys, plaster, drywall, and foundations. Shaking was felt in 17 States and Canada, from Pennsylvania to Kansas and from Alabama to Minnesota and southernmost Ontario, Canada.

M4.6 ● ***June 18, 2002, 11:37 a.m.***

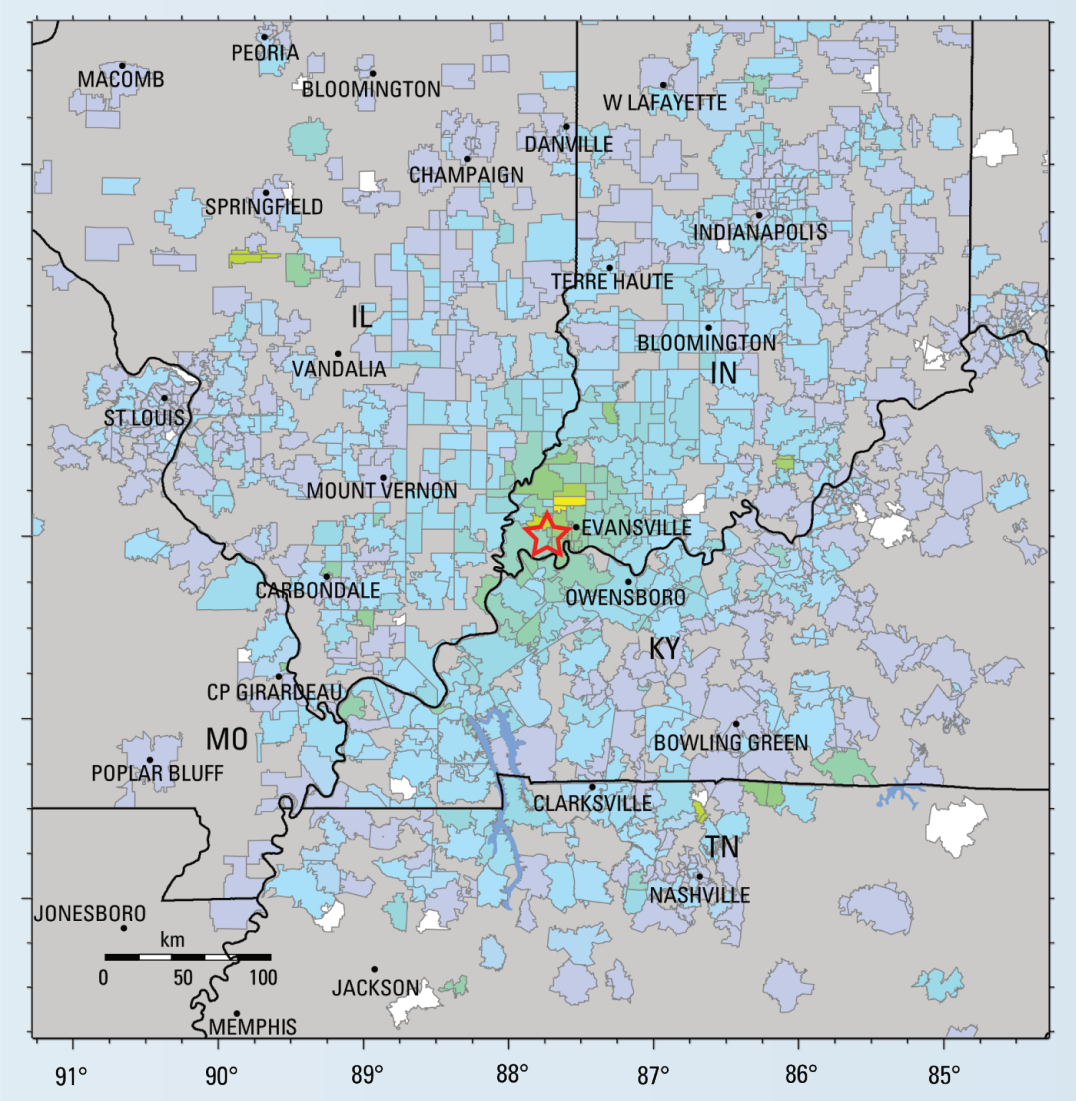
2002

Location: WVSZ, in Posey County, southwestern Indiana.

Effects: The moderate earthquake caused little damage. Chimneys cracked and windows broke in and near Evansville in adjacent Vanderburgh County. Items fell from shelves and walls over a larger area. Shaking was reported from seven States.

Did You Feel It?

Map showing intensities of the June 18, 2002, earthquake



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

This map was created from the public responses at URL *http://earthquake.usgs.gov ("Did You Feel It?") following the earthquake. Questionnaire answers for each ZIP Code were turned into ground-motion intensities, creating a map of the shaking distribution. This map is simplified from a graphic at* URL *http://pasadena.wr.usgs.gov/shake/ca/STORE/Xfnbk/ciim_display.html*

For sale by the U.S. Geological Survey Information Services, Box 25046, Federal Center, Denver, CO 80225

This map is also available as a PDF file at *http://pubs.usgs.gov*

Edited by ***F. Craig Brunstein***
Graphics, layout design, and digital layout by ***Eleanor M. Omdahl***
GIS by ***Richard L. Dart***

Manuscript approved for publication ***November 24, 2003***

Printed on recycled paper

ISBN 0-607-96013-2