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Quaternary Fault and Fold Database of the United States

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St. Louis-Cape Girardeau liquefaction features (Class A) No. 1030

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Synopsis	Tuttle and others (1999 #3904) examined sand blows, sand dikes, and sand sills that were found during systematic searches of streams in southeastern Missouri and southwestern Illinois. The search extended approximately 50-90 km west and east of the Mississippi River, between the St. Louis area on the northwest and the Cape Girardeau area on the southeast. Correlation and dating of the liquefaction features remain uncertain. The present interpretation infers an earthquake of estimated moment magnitude M > 6, and perhaps exceeding 7, that occurred approximately 6,500 years ago, roughly 60 km east of St. Louis. If the magnitude of this 6,500-yr-old event is smaller, then there is a corresponding increase in the likelihood that another earthquake of M > 5.2 occurred in or very near St. Louis. A second earthquake caused strong ground shaking in the area during the past 4,000 years. These liquefaction features are evidence of

	strong shaking, but they do not identify the specific fault or faults that caused an earthquake or earthquakes. Because individual Quaternary faults remain unidentified, it is not possible to define and measure specific attributes (azimuth, length, dip, etc.) for the St. Louis-Cape Girardeau liquefaction features.
Name comments	Tuttle and others (1999 #3904) examined sand blows, sand dikes, and sand sills that were found during systematic searches of stream valleys in southeastern Missouri and southwestern Illinois. The search extended approximately 50-90 km west and east of the Mississippi River, between the St. Louis area on the northwest and the Cape Girardeau area on the southeast. The study area is named here informally after these two cities.
County(s) and State(s)	BOLLINGER COUNTY, MISSOURI CAPE GIRARDEAU COUNTY, MISSOURI FRANKLIN COUNTY, MISSOURI JEFFERSON COUNTY, MISSOURI PERRY COUNTY, MISSOURI ST. FRANCOIS COUNTY, MISSOURI ST. LOUIS COUNTY, MISSOURI STE. GENEVIEVE, COUNTY, MISSOURI WASHINGTON COUNTY, MISSOURI WAYNE COUNTY, MISSOURI CLINTON COUNTY, ILLINOIS JACKSON COUNTY, ILLINOIS JOHNSON COUNTY, ILLINOIS MADISON COUNTY, ILLINOIS MASSAC COUNTY, ILLINOIS MONROE COUNTY, ILLINOIS PULASKI COUNTY, ILLINOIS RANDOLPH COUNTY, ILLINOIS ST. CLAIR COUNTY, ILLINOIS WASHINGTON COUNTY, ILLINOIS
Physiographic province(s)	CENTRAL LOWLAND OZARK PLATEAUS INTERIOR LOW PLATEAUS COASTAL PLAIN
Reliability of location	Poor Compiled at 1:700,000 scale. *Comments:* The prehistoric liquefaction was recognized as the type that is caused by strong ground motion (Obermeier, 1996

	#2256), and the strong motions are presumed to have been caused by slip on one or more preexisting faults. However, the causative faults have not been identified, and the locations and sizes of the liquefaction features studied to date provide poor constraints on the sources of the shaking.
Geologic setting	The study area straddles the Mississippi River and the western edge of the Illinois basin, spanning approximately 37?-39? N. The New Madrid seismic zone is immediately southeast of the study area. Regionally, bedrock consists of Paleozoic strata that dip northeastward from the Ozark uplift toward the center of the Illinois basin. Historical earthquakes are scattered throughout the study area. The earthquakes are part of the broad, diffuse halo of scattered seismicity that surrounds the New Madrid seismic zone. Numerous large faults, monoclines, and other folds of Paleozoic age are known throughout the region, and most involved the basement.
Length (km)	km.
Average strike	
Sense of movement	No data *Comments:* The sense of fault movement is unknown. The prehistoric earthquakes are known only from locations and age estimates of liquefaction. No surface ruptures or other deformation are known from the earthquakes.
Dip	No data *Comments:* The causative fault or faults remain unidentified and uncharacterized.
Paleoseismology studies	Two coeval, multiple-year studies covered areas that overlap in west-central Illinois. (1) Tuttle and others (1996 #3956; 1998 #3957; 1999 #3904) searched for liquefaction features along 447 km of stream cutbanks in southeastern Missouri and southwestern Illinois, within approximately 50 to 90 km east and west of the Mississippi River. The search area was chosen to include several large faults and anticlines that are near clusters of epicenters; however, no faults were found to cut Quaternary strata. In addition, Tuttle and others (1999 #3904) documented 308 sites having liquefaction and soft-sediment structures and dateable

	materials. They found possible or confirmed liquefaction features (sand dikes, blows, or sills) at 48 sites, and soft-sediment structures of less certain origin (folds, small faults, sand diapirs, load structures, slumps, and the like) at some of these sites as well as at another 24 sites. Geotechnical data from 51 boreholes at 15 locations near liquefaction features allowed estimation of the magnitudes and distances of earthquakes that could have produced the observed liquefaction features. (2) McNulty and Obermeier (1997 #3900; 1997 #3901; 1999 #3906) reported results from 21 sites, some of which were also documented by Tuttle and others (1999 #3904). The 21 sites had been found during extensive surveys of the region that is immediately to the east of, and overlapped by, the study area of Tuttle and others (1999 #3904) (Obermeier, 1996 #3903; Munson and others, 1997 #2839; McNulty and Obermeier, 1997 #3900; 1997 #3901; Obermeier, 1998 #3902; McNulty and Obermeier, 1999 #3906). Tuttle and others (1999 #3904) suggested three alternative scenarios that could explain the results: (1) an earthquake of moment magnitude M > 7 with an epicentral area 50-60 km east of St. Louis, near Germantown, Illinois; (2) an earthquake of M > 7.5 with an epicentral area 35 km farther east near Centralia, Illinois, perhaps on the Centralia fault-Du Quoin monocline; or (3) three separate earthquakes, an M > 6 near Germantown (McNulty and Obermeier, 1997 #3900; 1997 #3901; 1999 #3906), an M > 5.2 near St. Louis, and an M > 7.5 near New Madrid, Missouri. The absence of dikes in liquefiable deposits of suitable age near Centralia argues against scenario (2) (McNulty and Obermeier, 1999 #3906). Consistent with scenario (1), McNulty and Obermeier (1999 #3906) estimated that the earthquake near Germantown was at least as large as M 6.5, based on the greatest distance to observed liquefaction features. Under scenarios (1) and (2), other liquefaction features that formed during the last 4,000 years might have been caused by one or more of the very large earthquakes that other studies have shown occurred in the New Madrid seismic zone in approximately A.D. 900 +/- 100 yr and A.D. 1530 +/- 140 yr, and during the winter of 1811-1812 (Tuttle and others, 1999, p. 1-5).
Geomorphic expression	None. Sand blows, dikes, and sills are exposed in cut banks of streams. Among the recognized liquefaction features, sand dikes are far more numerous than sills or sand blows.
Age of faulted	The liquefaction features are in late Wisconsinan and Holocene

surficial deposits	deposits (Tuttle and others, 1999 #3904; McNulty and Obermeier, 1999 #3906). None of these deposits is known to be tectonically faulted.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Timing remains uncertain, and depends on how liquefaction features are correlated. Resolution of the uncertainty requires more study, dates, and geotechnical work (Tuttle and others, 1999 #3904; McNulty and Obermeier, 1999 #3906).
Recurrence interval	*Comments:* The number, location, and size of prehistoric earthquakes in the study area remain uncertain, and depend on uncertain correlation of liquefaction features.
Slip-rate category	Insufficient data *Comments:* There are no data from which to estmate a slip rate. No causal fault, surface rupture, or dated fault offset is known.
Date and Compiler(s)	2000 Russell L. Wheeler, U.S. Geological Survey, Emeritus
References	#3900 McNulty, W.E., and Obermeier, S.F., 1997, Liquefaction evidence for Holocene paleo-earthquakes in central and southwestern Illinois: Eos, Transactions of the American Geophysical Union, v. 78, no. 17, p. S316. #3901 McNulty, W.E., and Obermeier, S.F., 1997, Liquefaction evidence for two Holocene paleo-earthquakes in central and southwestern Illinois: U.S. Geological Survey Open-File Report 97-435, 22 p. #3906 McNulty, W.E., and Obermeier, S.F., 1999, Liquefaction evidence for at least two strong Holocene paleo-earthquakes in central and southwestern Illinois, USA: Environmental & Engineering Geoscience, v. 5, no. 2, p. 133-146. #2839 Munson, P.J., Obermeier, S.F., Munson, C.A., and Hajic, E.R., 1997, Liquefaction evidence for Holocene and latest Pleistocene seismicity in the southern halves of Indiana and Illinois—A preliminary overview: Seismological Research

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