

The Midcontinent Urban Corridor Geologic Mapping Project operates under two programs within the U.S. Geological Survey—the National Cooperative Geologic Mapping Program and the Earthquake Hazards Reduction Program. One of the basic objectives of the project is to enhance our understanding of the geologic framework of a broad corridor between St. Louis, Mo., and Memphis, Tenn., through geologic mapping at 1:100,000 and 1:24,000 scales.

A second objective is to identify previously undiscovered potential earthquake-source zones within this broad corridor beyond the New Madrid seismic zone, an area of current microseismicity and site of historical, great earthquakes. This objective will be approached through map-related studies of Quaternary geology and landforms and investigations of recent seismic activity that has occurred within the past 15,000 years. Characteristics of earthquakes are evaluated by studying surficial or near-surface deformation such as faults and folds. Project work is in part in cooperation with the Missouri Department of Natural Resources, Division of Geology and Land Survey, and is partially supported by the Nuclear Regulatory Commission.

Investigations of Recent Seismic Activity

One major application of our geologic mapping is to evaluate potential national earthquake hazards by identifying previously undiscovered seismic zones in the midcontinental United States beyond the New Madrid seismic zone. Seismicity in midcontinental regions, far from tectonic

Earthquake magnitude comparisons		
Magnitude	Description	Rough energy equivalent
2	Very weak	Lightning bolt
4	Light	1-kiloton explosion.
6	Strong	Hiroshima atomic bomb.
8	Great	1980 eruption of Mount St. Helens.
9.5	---	Largest recorded earthquake (Chile, 1960).
10	---	Annual U.S. energy consumption.

plate margins, is enigmatic and poorly understood. Yet, midcontinental regions of Asia, Australia, and North America have experienced some of the largest earthquakes known.

During the winter of 1811–12, a swarm of earthquakes occurred in the New Madrid area that were locally devastating and were felt more than a thousand kilometers away along the Atlantic seaboard. At least six, and as many as nine, of these earthquakes had estimated moment magnitudes of $M \geq 7$ and two of $M \sim 8$ (Johnston and Schweig, 1996). Recent earthquakes of lesser magnitude have

caused highways to crack and buckle and bridges and buildings to sway and collapse. A magnitude-7 earthquake today could produce major damage to St. Louis, Memphis, and other urban areas. Recent studies in the New Madrid seismic zone suggest recurrence intervals of approximately 300–600 years for such great earthquakes (Schweig and Tuttle, 1996).

Although our knowledge of the New Madrid area is growing, important questions remain unanswered—Are there other seismic-source zones in the midcontinent capable of producing large earthquakes? If so, what are the recurrence intervals of these large earthquakes? Until all such zones are identified and evaluated, the seismic-hazards potential for the midcontinental United States cannot be accurately determined.

In addressing these questions, the project has focused on the Benton Hills of southeast Missouri. This area is approximately 45 km north of the New Madrid seismic zone, and it is characterized by moderate recent seismicity. Also, the Benton Hills area overlies the “Commerce geophysical lineament,” a prominent structural feature identified deep in the Precambrian basement by Hildenbrand and Hendricks (1995) that extends for hundreds of kilometers and is near the intersection of the Reelfoot rift and Rough Creek graben, two other major structures in the midcontinental region. Great earthquakes are believed to occur in proximity to such major geologic features.

In cooperative work with the Missouri Department of Natural Resources, Division of Geology and Land Survey, late Quaternary faulting in the Middle Mississippi Valley outside of the New Madrid seismic zone was first identified at the English Hill site in the Benton Hills in 1995. This faulting was episodic and very complex, and it strongly deformed surficial deposits as young as the Peoria Loess—a wind-blown silt deposited from about 25,000 to 12,500 years before present. Accompanying earthquakes are interpreted to have had magnitudes of $M > 5.5$ to 6 in order to have ruptured the surface as extensively as demonstrated, and quite possibly were much higher.

Initial dating of faulted deposits indicates that a major episode of faulting in the Benton Hills occurred approximately 4,000–5,000 years ago. This episode had been preceded by multiple episodes and was followed by at least one other episode, all of undetermined ages. Other age constraints indicate that faulting in the Benton Hills has not been active in the past 1,540 years. Much additional work remains in order to better determine recurrence intervals, magnitude, and areal extent of earthquake-induced faulting in the midcontinent.



◀ Old quarry trench at the English Hill site in the Benton Hills, southeast Missouri. Qpl, Peoria Loess. Arrows indicate relative motion across faults.

Recent Geologic Maps That Are Part of the National Geologic Map Database:

- Map showing the surficial geology of the St. Louis 30' × 60' quadrangle, Missouri and Illinois, by Art Schultz, 1993, U.S. Geological Survey Open-File Report 93-288 (1:100,000 scale).

- Geologic map of the Coffman 7.5-minute quadrangle, Ste. Genevieve County, Missouri, by R.W. Harrison and Art Schultz, 1994, U.S. Geological Survey Open-File Report 94-419 (1:24,000 scale).

- Geologic map of the Minnith 7.5-minute quadrangle, Ste. Genevieve and Perry Counties, Missouri, by Art Schultz and R.W. Harrison, 1994, U.S. Geological Survey Open-File Report 94-421 (1:24,000 scale).

- Geologic map of the Eolia 7.5-minute quadrangle, Lincoln and Pike Counties, Missouri, by R.W. Harrison, 1995, U.S. Geological Survey Miscellaneous Field Studies Map MF-2277 (1:24,000 scale).

- Geology of the Fort Leonard Wood Military Reservation and adjacent areas, south-central Missouri, by R.W. Harrison, R.C. Orndorff, and R.E. Weems, 1996, U.S. Geological Survey Open-File Report 96-60 (1:24,000 scale).

- Geologic map of the Thebes 7.5-minute quadrangle, Illinois and Missouri, by R.W. Harrison, in press, U.S. Geological Survey Geologic Quadrangle Map GQ-1779 (1:24,000 scale).

- Bedrock geologic map of the St. Louis 30' × 60' quadrangle, Missouri and Illinois, compiled by R.W. Harrison, in press, U.S. Geological Survey Miscellaneous Investigations Series Map I-2533 (1:100,000 scale).

Geologic Maps That Are in Progress or Planned:

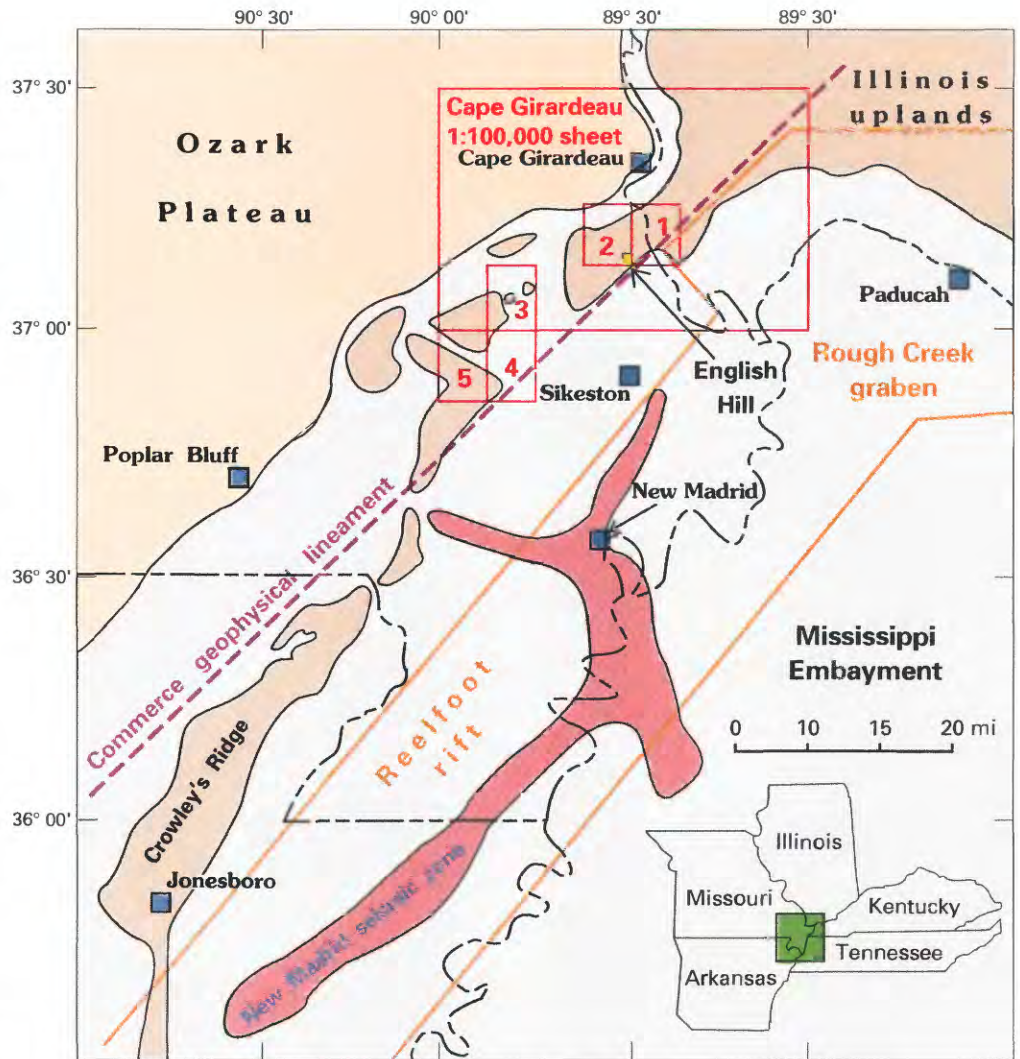
- Geologic map of the Scott City 7.5-minute quadrangle, Scott County, Missouri (1:24,000 scale).

- Geologic map of the Bell City 7.5-minute quadrangle, Stoddard and Scott Counties, Missouri (1:24,000 scale).

- Geologic map of the Clines Island 7.5-minute quadrangle, Stoddard County, Missouri (1:24,000 scale).

- Geologic map of the Bloomfield 7.5-minute quadrangle, Stoddard County, Missouri (1:24,000 scale).

- Geologic map of the Cape Girardeau 30' × 60' quadrangle, Missouri, Illinois, and Kentucky (1:100,000 scale).



Location map showing current work of the Midcontinent Urban Corridor Geologic Mapping Project. 1, Thebes 7.5-minute quadrangle; 2, Scott City 7.5-minute quadrangle; 3, Bell City 7.5-minute quadrangle; 4, Clines Island 7.5-minute quadrangle; 5, Bloomfield 7.5-minute quadrangle.

References Cited

- Hildenbrand, T.G., and Hendricks, J.D., 1995, Geophysical setting of the Reelfoot rift and relations between rift structures and the New Madrid seismic zone, in Shedlock, K.M., and Johnston, A.C., eds., Investigations of the New Madrid seismic zone: U.S. Geological Survey Professional Paper 1538-E, 30 p.
- Johnston, A.C., and Schweig, E.S., 1996, The enigma of the New Madrid earthquakes of 1811-1812: Annual Review of Earth and Planetary Sciences, v. 24, p. 339-384.
- Schweig, E.S., and Tuttle, M.P., 1996, Paleoseismology and earthquake recurrence in the New Madrid seismic zone—Are the apparent rates reasonable? [abs.]: Seismological Research Letters, v. 67, no. 2, p. 54.

For more information, please contact:

Richard W. Harrison
U.S. Geological Survey, MS 926A
Reston, VA 20192
Phone: (703) 648-6928
Fax: (703) 648-6953
e-mail: rharrison@usgs.gov