Illinois Geologic Quadrangle Map
IGQ Olmsted-G

Geology of Olmsted Quadrangle

Pulaski County, Illinois

W. John Nelson, F. Brett Denny, John H. McBride, and Laura Williams
2009

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Institute of Natural Resource Sustainability
William W. Shilts, Executive Director
ILLINOIS STATE GEOLOGICAL SURVEY
E. Donald McKay III, Interim Director
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.uiuc.edu

Introduction

This map shows geologic formations at or near the surface in the Olmsted Quadrangle. On the floodplains of the Ohio River and smaller streams, the surface formation generally is the Cahokia Formation, which consists of alluvial sediment. Upland areas of the Olmsted Quadrangle are mantled in loess, which is wind-blown silt of Pleistocene age. Three loess units are recognized: Peoria Silt (at surface), Roxana Silt, and Loveland Silt. In order to portray underlying units, loess is not shown on the geologic map. It is shown on the stratigraphic column and described in accompanying text.

Faults are a key geologic feature of the Olmsted Quadrangle. Aside from short-lived exposures in clay pits, faults are not visible at the surface. Faults have been interpreted on the basis of borehole data and seismic reflection profiles. Because all faults are concealed, they are depicted by dotted lines. Two categories of faults are distinguished on the map:

1. Faults that displace Paleozoic bedrock and at least the lower part of the Cretaceous McNairy and Owl Creek Formations. Such faults are labeled "K" on the map.
2. Faults that displace Tertiary strata (as young as the Mounds Gravel), in addition to older units. These faults are labeled "T" on the map.

Methodology

This map was constructed using several types of data. Outcrop study was carried out primarily by Brett Denny, assisted by Laura Williams and John Nelson. We also consulted field notes made by geologists of the Illinois State Geological Survey (ISGS) and archived in the ISGS Library. Ravines and steep bluffs near the Ohio River between Olmsted and Lock and Dam 53 are the only places where outcrops are numerous.

All well records in ISGS files were consulted. Most are water wells for which drillers' logs, sketchy at best, are the only record. A few water wells and one deep oil-test hole have sample studies made by ISGS geologists. More detailed logs are available for boreholes made by the U.S. Army Corps of Engineers for the new lock and dam at Olmsted. The Corps also made available several drill cores into bedrock at the dam site. We supplemented these logs by drilling 14 shallow (maximum depth 80 feet) holes with an AMS Power Probe, which yields continuous cores. Two deeper holes (the Bierbaum and Johnston holes) were continuously cored using the Survey's wireline drilling rig.

Seismic reflection data are a major component of this map. Seismic surveys were carried out by the ISGS, funded by grants from the National Earthquake Hazards Reduction Program (NEHRP) of the U.S. Geological Survey. The principal goal was to characterize faults that deform geologically young sediments. Our network of high-resolution surveys totals more than 10½ miles of coverage in Illinois and Kentucky. Compressional (P-wave) surveys were supplemented by several short horizontally polarized (SH-wave) surveys. For P-wave surveys, the energy source was an accelerated elastic weight-dropper device. Shots were spaced 10 feet apart, and signals were recorded on geophones also spaced at 10-foot intervals. For SH-wave surveys, the energy source was sledgehammer blows to the end of a long beam pinned to the ground by the recording truck. A train of geophones on small sleds was towed by the recording truck. All seismic acquisition, processing, and interpretation were carried out by ISGS staff under the direction of André Pugin and John McBride. McBride et al. (2003) and Bexfield et al. (2005) published details of seismic data acquisition, processing, and interpretation.

The Kentucky part of the Olmsted Quadrangle was mapped by Olive (1969). We show surficial geology in Kentucky as Olive mapped it, but with changes in nomenclature. Olive's "Quaternary alluvium" is revised to Cahokia Formation and his "loess-covered terrace" (overlying silt and sand member of continental deposits) to Metropolis Formation. Added are subsurface faults that we interpreted on the basis of our seismic reflection profiles in Kentucky.

Structure

Regional Setting

The Olmsted Quadrangle lies within the Mississippi Embayment, a northern extension of the Gulf Coastal Plain. During late Cretaceous and early Tertiary time, an arm of the Gulf of Mexico extended up the lower Mississippi Valley into southernmost Illinois. Clay, silt, sand, and gravel were deposited here in a variety of coastal, deltaic, estuarine, and shallow-marine environments. Embayment sediments are thinnest at the northern margin, thickening southward. They also dip southward with progressively younger units shingling in to the south. Embayment sediments unconformably overlie Paleozoic bedrock.

Paleozoic (Cambrian through Mississippian) sedimentary rocks underlie the Mississippi Embayment. During latest Precambrian to Middle Cambrian time, roughly 520 to 550 million years ago, the North American continental plate nearly broke apart. A fault-bounded trough known as the Reelfoot Rift developed under what is now the central Mississippi Valley, extending from eastern Arkansas into southern Illinois where it turned eastward into Kentucky (fig. 1). The rift filled with marine sediments and became inactive by Late Cambrian time, but its faults have been reactivated repeatedly up to the present day. The New Madrid seismic zone, running from Northeast Arkansas through the Missouri "bootheel" to Cairo, Illinois, is currently the locus of earthquake activity (fig. 1).

Previous Research

Pryor and Ross (1962) mapped the geology of an area including the Olmsted 7.5-minute Quadrangle. They showed no faults near Olmsted, the nearest being close to Thebes, Illinois. Ross was the first geologist to map faults in the Olmsted area. Based on borehole data, Ross's map depicts the "America Graben" running northeast from Cairo through Olmsted and Grand Chain. This narrow downfaulted block corresponds to the area of thickest Cretaceous strata. Other faults mapped by Ross have diverse orientations, outlining triangular and polygonal patterns on the map. A structure map (Pryor and Ross 1962, Ross 1964) on the base of the Clayton Formation (Paleocene) depicts no faulting. Ross concluded that the America Graben likely was active during latest Cretaceous time, but prior to Clayton deposition. Ross suggested that some faults in southernmost Illinois (but not near Olmsted) displace units as young as the Mounds Gravel.

Kolata et al. (1981) again mapped the structure of southernmost Illinois, relying chiefly on well data. Their map shows fewer faults than that of Ross (1964) and omits the America Graben. Kolata et al. (1981) recognized the area of thick Cretaceous sediments centered near Olmsted but did not associate it with fault activity. Like Ross, Kolata et al. (1981) mapped the Clayton Formation as dipping uniformly and not faulted. Kolata et al. (1981) also investigated several sites where Cretaceous and younger sediments are deformed. They attributed all of this deformation to non-tectonic processes, such as landsliding and collapse of sinkholes. In conclusion, they found no convincing evidence for Cretaceous or younger tectonic faulting anywhere in southern Illinois.

New Findings

Seismic reflection profiles, borehole data (especially cores), and exposures in clay pits reveal an intricate system of large faults in the Olmsted Quadrangle. The dominant trend is north-south to north-northeast; some small faults strike east-west to east-northeast. Principal movements took place near the end of the Cretaceous Period during deposition of the McNairy Formation. Small displacements continued on some faults during Tertiary and early Quaternary time. The youngest unit that is visibly offset at the surface is the Mounds Gravel. However, earthquake activity within the map area indicates that faults at depth are still active.

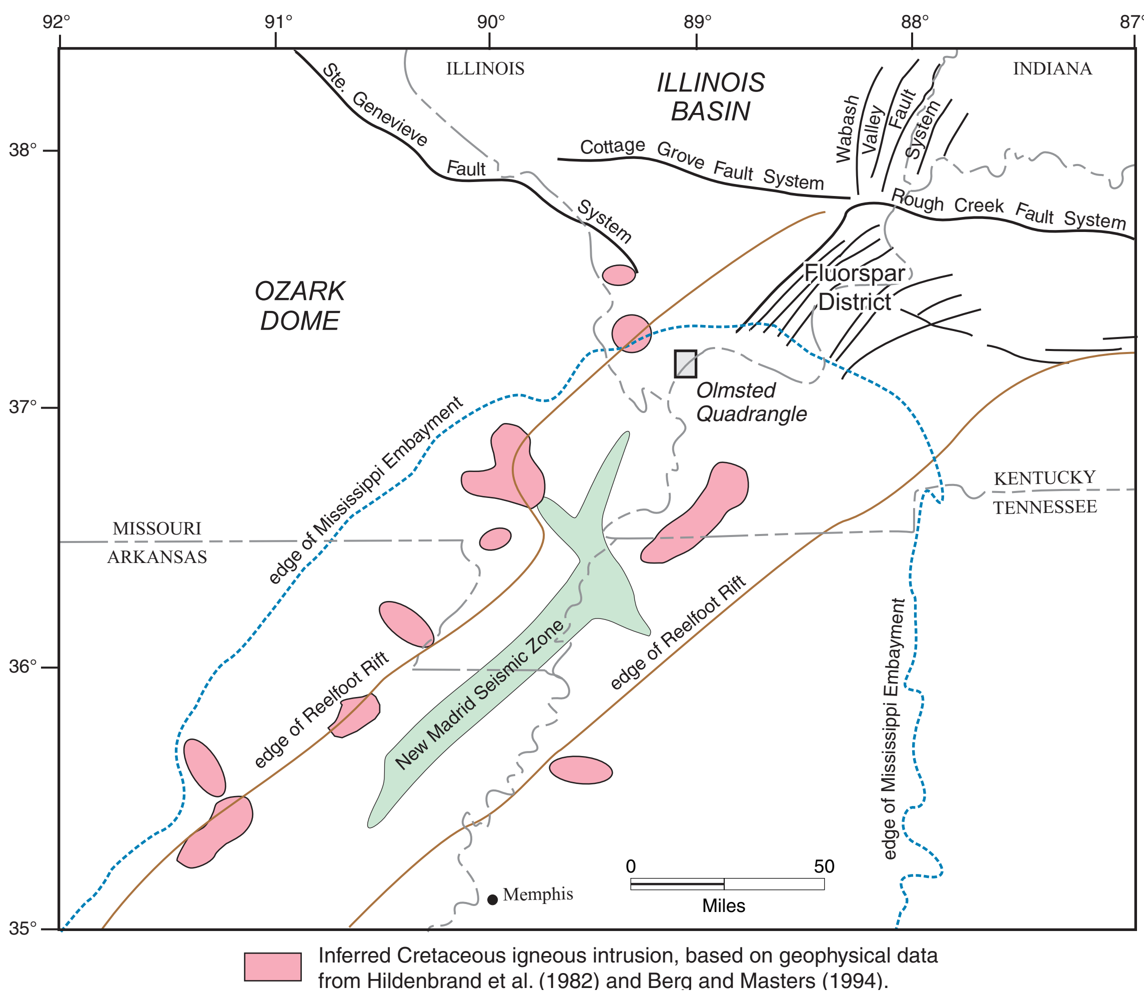

Figure 1 Map of central Mississippi Valley, showing the study area and selected geologic features.

Olmsted Fault Zone

The largest fault in the map area passes through Olmsted village, trending slightly east of north. North of the village the fault splits into a complex zone that widens northward. The easternmost branch, best defined, passes west of Grand Chain and continues at least 2 miles north of the Olmsted Quadrangle, as shown by well records. Major displacement on the Olmsted Fault Zone is down to the west. This fault zone corresponds in a general way to the east side of the America Graben of Ross (1964).

The Baltimore Road seismic profile shows the main Olmsted fault is a high-angle normal fault. The base of Cretaceous (top of Paleozoic bedrock) is downthrown 400 to 500 feet on the west. Smaller faults on both sides of the main one have throws of 30 feet or less. The seismic profile shows a small wedge-shaped anticline in the hanging wall (west) of the main fault. The presence of such a compressional structure along a normal fault suggests an element of strike-slip (Bexfield et al. 2005).

Cretaceous strata are abnormally thick on the downthrown side of the Olmsted fault. The Olmsted village water well penetrated 440 feet of Cretaceous, whereas the Johnston cored test hole penetrated 455 feet without reaching the base. The Baltimore Road seismic profile indicates Cretaceous strata are approximately 600 feet thick. This is more than double the maximum Cretaceous thickness anywhere else in Illinois and thicker than any known Cretaceous in the Mississippi Embayment north of Arkansas and Tennessee. Clearly the Olmsted Fault was active during Cretaceous sedimentation.

The upper 140 feet of Cretaceous sediment in the Johnston core, below the Clayton Formation, is typical McNairy: highly micaceous clay, silt, and sand with abundant burrows and rhythmic lamination. Below this depth the sediment becomes increasingly lignitic and contains multiple paleosols (ancient soils). Chert gravel was encountered near the bottom of the hole with more lignitic sand beneath. Fossil pollen from lignite layers at depths of 61, 219, 328, and 490 feet in the Johnston core indicates Maastrichtian age (latest Cretaceous; approximately 65 to 73 million years ago) (Norman Frederiksen, U.S. Geological Survey, written communication 2003).

A series of west-dipping reflectors on the Baltimore Road seismic profile probably correspond with the chert gravel near the bottom of the Johnston borehole. These reflectors likely depict alluvial fans at the base of the active fault scarp.

The Baltimore Road seismic profile indicates slight offsets of units younger than Cretaceous. The Clayton Formation is only 12 to 15 feet lower west of the fault than to the east. Small faults (throws of 10 feet or less) have been observed in Porters Creek Clay in pits that lie directly along the fault trace. None of these affect the Wilcox Formation (Eocene) or younger strata. Bexfield et al. (2005) interpreted offset of units as young as Wisconsinan loess based on the seismic data, but such offsets have not been verified in the field.

Southern Illinois was still upland when the Olmsted fault began to move. Chert gravel eroded from Paleozoic bedrock on the upthrown block accumulated in fans on the downthrown block. The fault moved episodically, frequently creating ponded peat mires on the downthrown side separated by intervals of subaerial exposure and soil development. In late Maastrichtian time, the Mississippi Embayment reached the Olmsted area, and sedimentation proceeded in shallow marine, tidally influenced settings. Large fault movements came to an end before deposition of the Clayton Formation. Minor adjustments continued through Paleocene time and possibly thereafter.

Where the Olmsted Fault Zone crosses Clark Road, two miles north of Olmsted, the zone is at least one mile wide. The seismic profile here depicts a shallow trough, or complex graben. The easternmost fault has roughly 100 feet of throw down to the west. This fault is thought to continue east-northeast beyond the northern edge of the Olmsted quadrangle. Other faults that cross Clark Road probably run nearly due north.

A seismic profile along Bethlehem Road (due north of Olmsted) reveals a fault zone north of the junction with Clark Road (west edge of NW¼ Sec. 11, T15S, R1E). Seismic reflectors along this half-mile segment are greatly broken and tilted. Moreover, water-well records suggest that units as young as the Mounds Gravel are displaced. The seismic profile along Price Road (N½ Sec. 2, T15S, R1E) crossed the apparent northward continuation of these faults. A linear valley coincides with this fault zone, further suggesting young age.

Feather Trail Fault Zone

The Feather Trail Fault Zone runs N 15°E near the western edge of the map area. The name refers to Feather Trail Road, which crosses the zone. As mapped from well records and a seismic profile along Old Feather Trail Road, the zone comprises a pair of faults outlining a graben ¼ to ½ mile wide. The bedrock surface (base of Cretaceous) is downthrown 100 to 130 feet between the faults. Both faults dip west on the seismic profile, the eastern one being normal and the western one reverse (fig. 2).

The seismic profile indicates little or no displacement at the top of Cretaceous, so once again, most fault movement occurred during the Cretaceous. The core from the Junkerman borehole (near center of west line Sec. 3, T15S, R1E) showed bedding in the McNairy Formation inclined 30° to 45° off horizontal. This hole was drilled near the eastern fault. Water-well records in the adjoining Pulaski Quadrangle suggest that the Feather Trail Fault Zone may displace the Mounds Gravel (Nelson and Williams 2004).

Having a normal fault (extensional) side by side with a reverse fault (compressional) implies either (1) more than one episode of faulting under different stress fields, or (2) strike-slip movement. Given that both faults are apparently the same age, we favor the strike-slip alternative.

Other Faults

The Old Feather Trail seismic profile (figs. 2, 3, and 4) indicated as many as eight smaller faults east of the Feather Trail Fault Zone. Only the three largest are shown on the map. Their orientations are unknown; they probably strike north-northeast, parallel to known larger faults. Time of movement differs among the eight faults. Some offset only Paleozoic bedrock. Others affect Paleozoic rocks and also the lower part of the Cretaceous succession. One pair of faults outlines a graben at the base of Cretaceous and a small horst at the top of Cretaceous (fig. 4). Apparent offset at the two levels was in opposite directions. Again, the seeming discrepancy might reflect either multiple episodes of displacement or else strike-slip faulting.

Core drilling at the new lock and dam site near Olmsted revealed large elevation differences on Paleozoic formation contacts, as well as zones of gouge, breccia, and steeply inclined bedding. Despite density of control, the pattern of faults is poorly known. The best-defined fault trends roughly east-west and has at least 100 feet of throw on the New Albany Shale (Devonian). No offset of Cretaceous or younger units can be detected at the dam site. The base of Cretaceous (top of Paleozoic bedrock) at the site has maximum relief of 60 feet and local relief of only 20 feet. All of the observed relief is easily explained by erosion on this major unconformity.

A high-resolution seismic line was shot along Turner Landing Road in Kentucky from Oscar to the Ohio River. A complex fault zone 1¼ mile wide is interpreted to cross the southeastern part of the seismic line (fig. 4). Only the three largest faults interpreted from seismic data appear on the map. Their orientation is unknown, but they are drawn striking north-northeast in order to parallel better-documented faults. The Turner Landing seismic profile shows mostly normal faults that outline grabens. Displacements are largely confined to Paleozoic bedrock and the lower part of Cretaceous strata. A fault near the northwest edge of the zone has large normal (southeast side down) offset of the base of Cretaceous, but reverse (southeast side up) at the top of Cretaceous. Once again, either more than one movement or strike-slip appears to be involved.

Olive (1969) mapped a fault in Kentucky that strikes N 55°E and passes just east of the southeast corner of the Olmsted Quadrangle. Evidence for this structure is weak, including a "tonal lineament on air photos" and slight elevation and dip changes of Tertiary formations in the subsurface. The trend as mapped by Olive deviates from the more northerly strike of better-documented faults in the area.

Many small normal faults have been observed in pits in the Porters Creek Clay. These have varying orientations and are commonly listric; that is, the upper part dips steeply and the lower part more gently. Displacements range from a few inches to approximately 10 feet. Fault surfaces are lined with crushed clay, stained by iron oxide, and bear faint vertical striations. Faults exposed in 1986 in a pit east of Olmsted offset the Porters Creek but not the overlying Wilcox Formation, indicating the faults formed in late Paleocene or early Eocene time. It is not clear whether faults in Porters Creek Clay are products of tectonic activity or of ancient landslides. Large landslides are common today where streams undercut bluffs of Porters Creek Clay. Faults at the Moses clay pit about 8 miles southwest of Olmsted were formed by ancient landslides (Kolata et al. 1981).

Faults displacing early Quaternary sediments were visible in 2004 at the Oil-Dri Corporation clay pit (SE¼ SE¼ SE¼ Sec. 16, T15S, R1E). The nearly vertical faults ran east-west to N 70° E and outlined a small graben offsetting Porters Creek, Wilcox, and Mounds Gravel. Within the graben, a deposit of strongly mottled dark red to yellowish brown clay about 6 feet thick overlaid the Mounds Gravel. The sand-free clay had angular blocky structure and abundant glistening "clay skins," indicative of an ancient soil formed under oxidizing conditions. This could be the Sangamon Geosol or an older soil. The faults did not displace the Wisconsinan Roxana and Peoria Silts. Therefore, the last movements were no younger than early Wisconsinan and could be much older.

Altered and Silicified Bedrock

Paleozoic bedrock in the map area has been extensively leached, altered, and silicified. Many drill cores from the new lock and dam site north of Olmsted encountered altered rock. Cuttings from deep wells elsewhere in the Olmsted quadrangle also sampled altered rocks.

The Fort Payne Formation (Mississippian) normally is siliceous limestone or dolomite. In cores from the dam site, the unit is a dark brown, indistinctly layered, porous material that resembles siltstone. Site geologists initially misidentified altered Fort Payne as weakly lithified silt of the Cretaceous McNairy Formation. Its true identity is betrayed by rare marine invertebrates (crinoid stems, shell fragments, and sponge spicules) in addition to bands of hard chert similar to unaltered Fort Payne. In some cores, the brown silt-like rock alternates with layers of limestone.

Limestone of the Middle Devonian St. Laurent and Grand Tower Formations was dissolved away in some wells, leaving a residual deposit of clay, chert fragments, and loose sand.

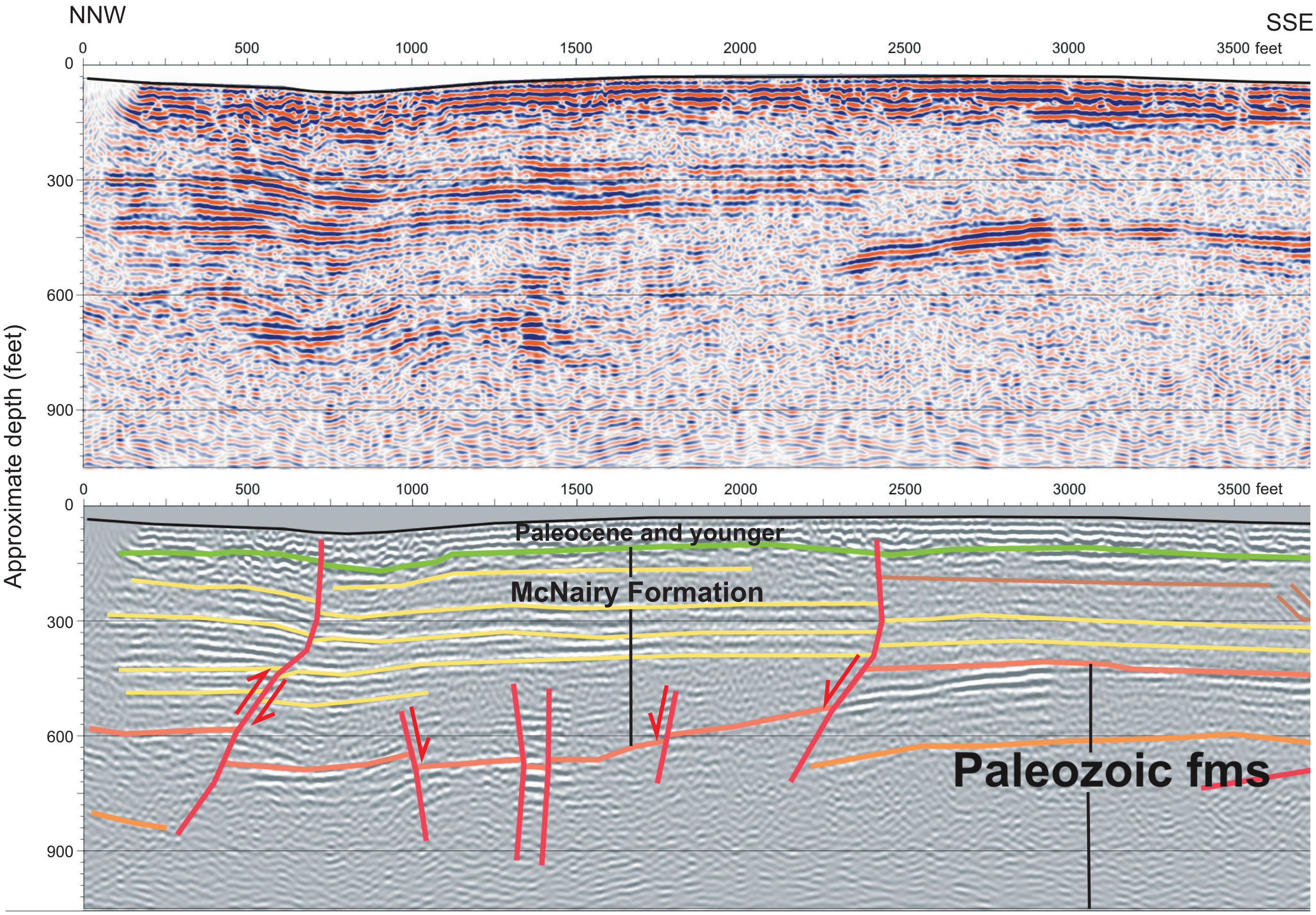

Figure 2 Northern portion of Old Feather Trail seismic profile. Upper section is uninterpreted; lower is interpreted.

The Lower Devonian Clear Creek Formation, normally a cherty limestone, is entirely converted to tripolitic chert in some wells. Non-calcareous formations, including the Springville (Mississippian) and New Albany (Upper Devonian) Shales, are not altered.

The sample log of the R.G. Williams Number 1 Richey (or Rickey) oil-test hole in Sec. 9, T15S, R1E indicates that the Lower Devonian Clear Creek Formation is entirely chert to a depth of 800 feet below the bedrock surface. Below this depth the log (by geologist Frank E. Tippie of the ISGS) records dolomite containing "abundant euhedral quartz crystals." The Ordovician Kimmswick ("Trenton") Limestone, normally high-calcium limestone in this part of Illinois, is almost entirely dolomite in the Richey well. The notation "metamorphosed?" appears on Tippie's log for samples from the upper part of the Plattin Limestone underlying the Kimmswick. The Kimmswick and Plattin are more than 2,000 feet below the bedrock surface in the Richey well.

Near Lock and Dam 53, the driller's log of the U.S. War Department borehole records the top of bedrock at 175 feet depth and describes bedrock as mostly comprising limestone, chert, and flint. "Iron formation" was logged at 473 to 495 feet and "flint or granite?" at 550 to 665 feet. Unfortunately, samples are available only below 838 feet. A sample log by ISGS geologist L.E. Workman records chert, silica, and siliceous limestone tentatively identified as Lower Devonian Clear Creek Formation. Describing samples from 878 to 884 feet deep, Workman recorded white to buff silica or porous chert containing "angular grains [of] clear quartz and perfect crystals [of] glassy dolomite the size of very fine sand grains. The clear quartz is probably a second deposit of quartz after the first replacement of the limestone by the porous silica."

Altered rocks in the Olmsted area closely resemble the same formations in the tripoli district of Alexander and Union Counties (northwest of the present map area). Weller and Ekblaw (1940) and Lamar (1953) attributed altered rocks of the tripoli district to deep weathering on a long-exposed peneplain or erosion surface. Berg and Masters (1994) and Nelson et al. (1995) advocated hydrothermal alteration along networks of intersecting faults and fractures. Evidence for the hydrothermal model includes these findings:

1. Tripoli is microcrystalline silica—tiny, perfectly formed quartz crystals. Large quantities of silica must have been

added, replacing carbonate rock. Weathering would have simply dissolved away carbonates, leaving a residuum of detrital and biogenic clay and silt.

2. Fluid inclusion studies indicate that silica was precipitated from low salinity fluids at temperatures of about 200°C (Berg and Masters 1994).
3. Depth of alteration is discordant to Cretaceous and Tertiary erosion surfaces.
4. Prominent magnetic highs, interpreted as mafic igneous intrusions within Precambrian basement, coincide with tripoli districts.

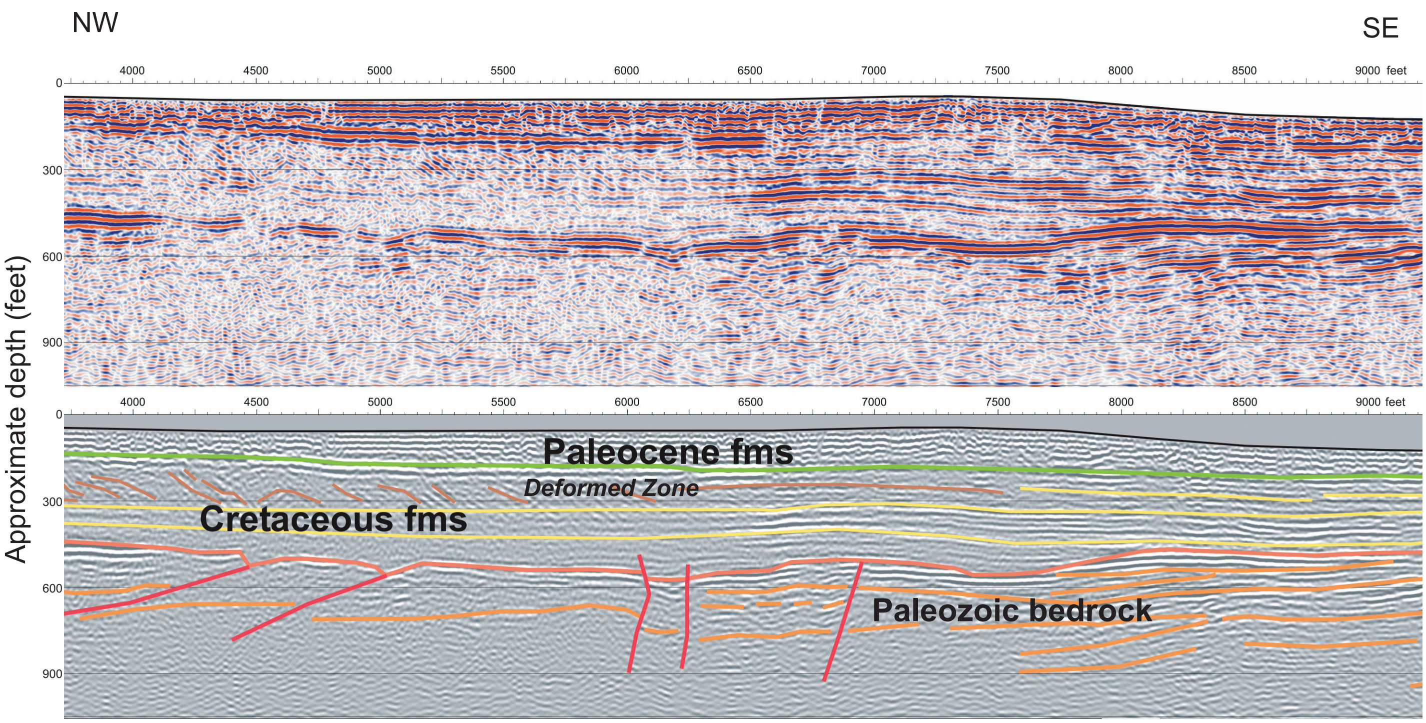

Figure 3 Central portion of Old Feather Trail seismic profile. Upper section is uninterpreted; lower is interpreted.

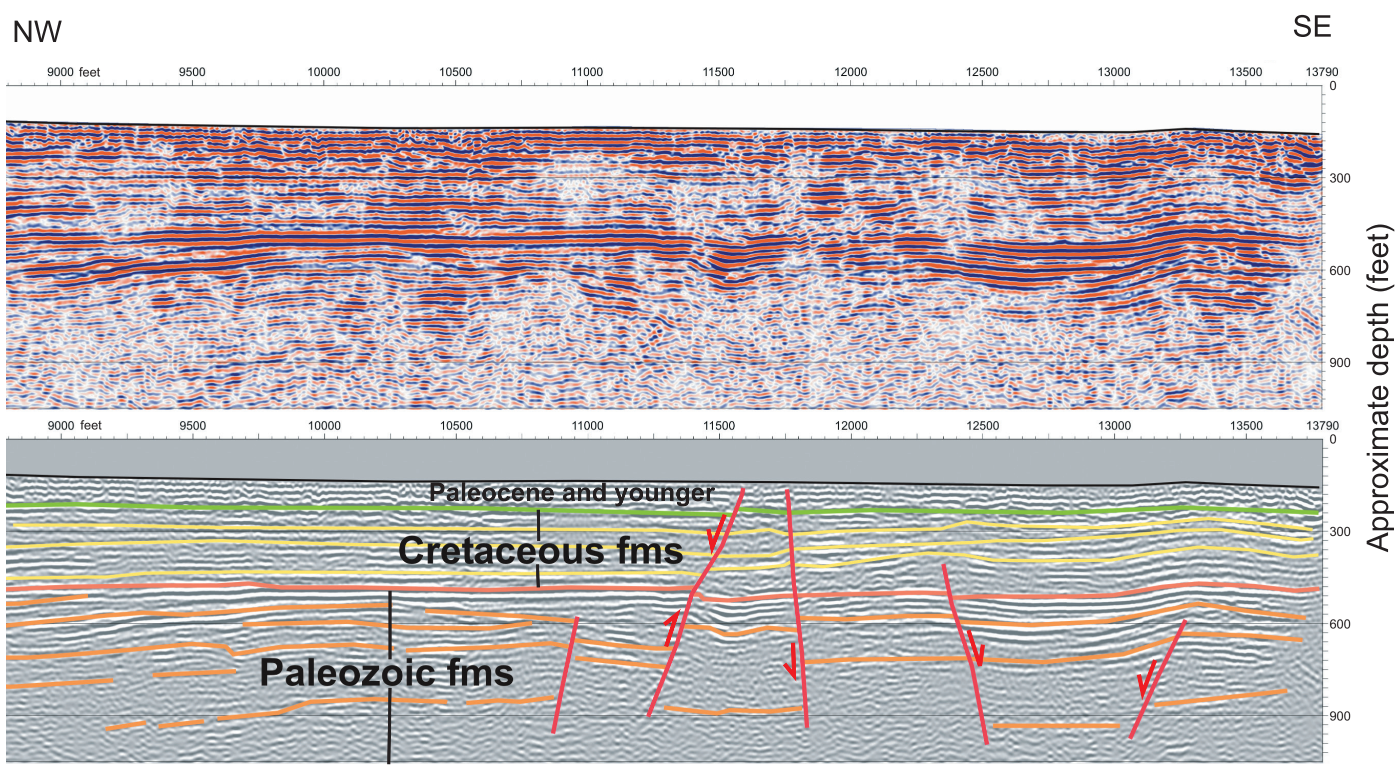

Figure 4 Southern portion of Old Feather Trail seismic profile. Upper section is uninterpreted; lower is interpreted.

Silicified rocks in the Olmsted Quadrangle extend at least 800 feet below the bedrock surface; rocks more than 2,000 feet deep may have been affected. Well samples contain euhedral quartz and dolomite crystals. The War Department boring encountered iron ore and possible igneous rock. The Olmsted area, like the Alexander and Union County tripoli districts, is intensely faulted. The deep-weathering theory is untenable. We interpret altered rocks in the Olmsted Quadrangle as hydrothermally modified carbonate rocks. Hot fluids emanating from igneous intrusions followed faults and fracture zones, dissolving calcite and precipitating silica.

Earthquakes

A swarm of small earthquakes took place in 1983 and 1984 near Lock and Dam 53 on the Ohio River in the Olmsted Quadrangle. The first quake occurred on November 16, 1983; activity sharply climaxed February 14–16, 1984, when 141 tremors were recorded. The largest, on the 14th, registered magnitude 3.6 and was felt through a three-state area. After a period of quiet from March through July, small tremors resumed in August through October. In all, 190 events were recorded (Stauder et al. 1984, Stover 1988, Taylor 1991).

We plotted the hypocenters of the 1983–1984 earthquakes based on data provided by Robert Herrmann of the St. Louis University Earthquake Center. The data plot to an ellipse with a long axis trending northeast immediately northeast of Lock and Dam 53 (fig. 5). Mean depth of the swarm was 7.2 km or about 24,000 feet (Taylor 1991), which should be within Precambrian basement. A focal mechanism calculated by Taylor (1991) was nodal planes striking northeast and northwest. The northeast plane is nearly vertical and signifies right-lateral strike-slip. The northeast plane is favored because of the northeast orientation of the ellipse of hypocenters and of mapped faults in the vicinity.

Although the earthquake swarm cannot be linked to a specific fault, many faults are close to Lock and Dam 53. A deep borehole at the dam (U.S. War Department) encoun-

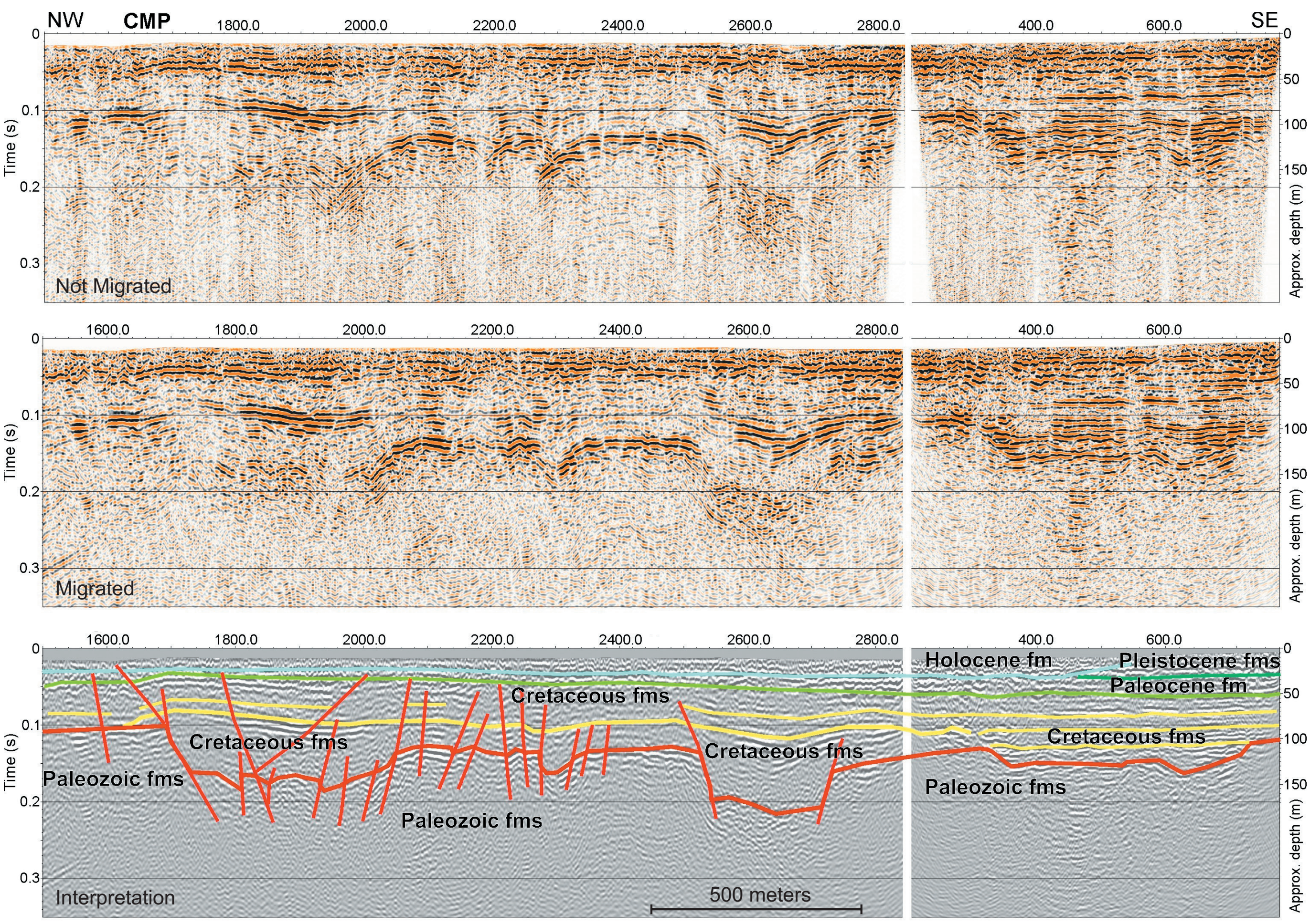

Figure 5 Three versions of southeast part of Oscar seismic profile. Largest fault movements took place during deposition of lower part of Cretaceous strata. A few faults produce small offsets of Paleocene and younger units. The white gap in the profile is at a stream crossing where no data could be acquired. The top section is unmigrated, the middle is migrated, and the bottom is migrated and interpreted.

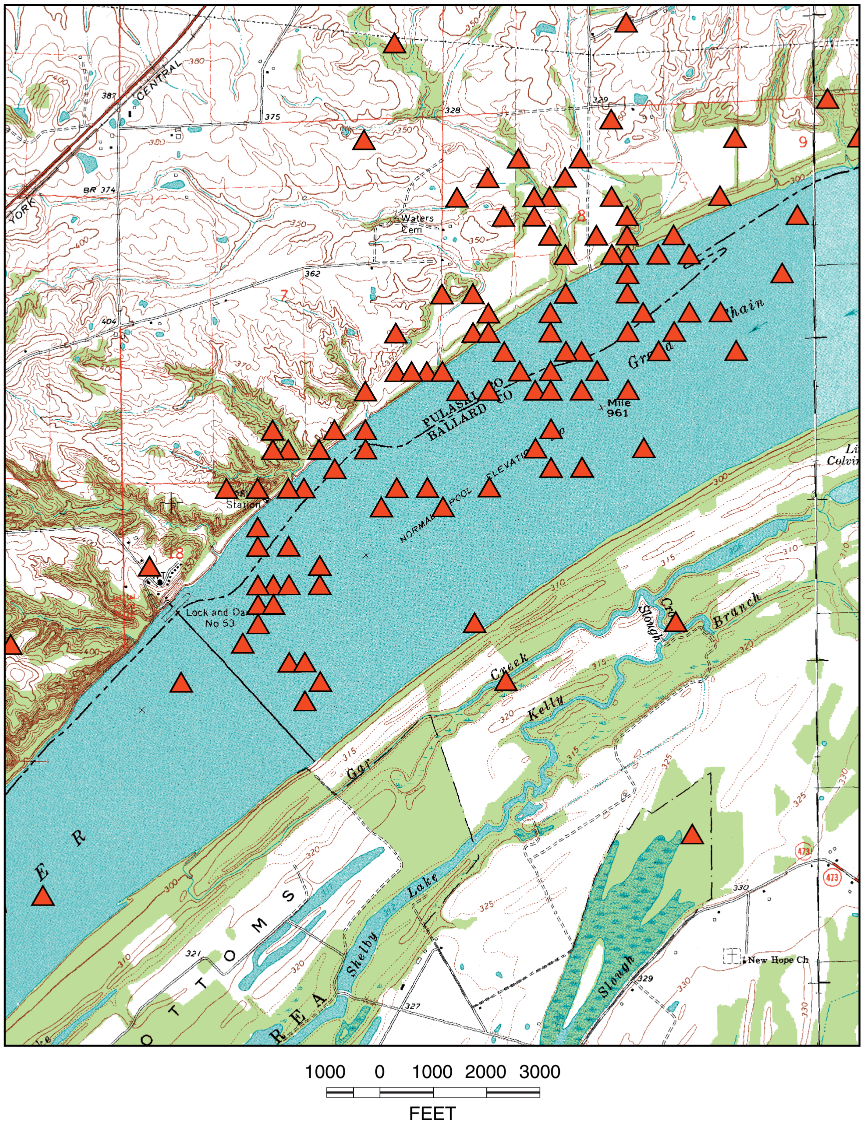

Figure 6 Earthquake swarm of 1984; red triangles represent epicenters. Data from St. Louis University Earthquake Center.

tered hydrothermally altered rock and possible igneous rock ("granite"). The lack of coherent reflectors on the Dam 53 Road seismic profile suggests rock layers highly disrupted by fracturing and/or hydrothermal alteration.

Olmsted lies immediately north of the zone of ongoing seismic activity associated with the great New Madrid, Missouri, earthquakes of 1811 and 1812. Defined by current seismicity (detected by instruments; most quakes too small to be felt), the New Madrid seismic zone extends from northeastern Arkansas through southeastern Missouri to Cairo, Illinois (fig. 1). The New Madrid seismic zone represents ancient faults of the Reelfoot Rift being reactivated under the current tectonic stress regime. Faults mapped in the Olmsted Quadrangle are directly in line with the New Madrid seismic zone. Although forecasting earthquakes is not possible at present, studies indicate that fault activity has shifted from one place to another in the central Mississippi Valley over the past several million years (Nelson et al. 1999).

Local soil and ground conditions play a large role in how much damage earthquakes produce. Soft materials, such as artificial fill and alluvium, amplify earthquake shocks. Water-saturated sand, such as that found beneath the Ohio River floodplain in the Kentucky portion of the Olmsted Quadrangle can liquefy during a violent earthquake. Thousands of sand blows erupted on the Mississippi floodplain near New Madrid, Missouri during the quakes of 1811 and 1812. Hundreds of landslides also took place along the river bluffs during these quakes (Jibson and Keefer 1988). The Porters Creek Clay is especially prone to large-scale landsliding where it is undercut on stream banks and river bluffs. Thus, the danger of earthquake-induced landsliding is high along the Ohio River bluffs between Olmsted and Lock and Dam 53.

On the basis of aerial photography and side-looking airborne radar (SLAR) data, Su and Stohr (2000) interpreted a "megalandslide" in the Olmsted area. The alleged landslide is nearly 5 miles long and more than 1 mile wide at its widest point, extending from north of Lock and Dam 53 to about 1 mile southwest of Olmsted. The northwestern “scarp” largely coincides with the stream that parallels S.R. 37. Su and Stohr called this feature a “rotational/translational slide” and stated that it “appears to have displaced the Ohio River.”

We found nothing to support the existence of such a feature, which should be evident on the Baltimore Road seismic profile, in outcrops along the bluffs, and in clay pits within the purported mega-landslide. Several small landslides, however, were observed where the Ohio River is undercutting the toe of the bluff between Olmsted and Dam 53. The largest of these slides were about 20 feet high and no more than 100 feet long.

Economic Geology

Clay

For many decades, the Porters Creek Clay has been mined in the Olmsted area and has been used for making absorbents. The Oil-Dri Corp. had an active pit one mile northwest of Olmsted at the time of mapping. The clay is absent in the northern part of the Olmsted Quadrangle and is too deep to mine in the southern part and in Kentucky. In the central area within Illinois, the Porters Creek is at or near the surface and is as thick as 70 feet. Generally the lower part is not mined because of its higher sand content.

Gravel

Mounds Gravel has been quarried from many small pits in Pulaski County and has been used for fill and for surfacing light-duty roads and driveways. Attractive ornamental gravel can be made by screening and washing Mounds. No pits were active in the map area during the time of study. Gravel pits in the Mounds elsewhere in southern Illinois generally operate only intermittently.

Oil and Gas

Two petroleum test holes are on record in the Olmsted Quadrangle. The W.R. White Number 1 John Goza test in Sec. 20, T15S, R1E was drilled in 1948 to a total depth of 1,150 feet. No shows of oil or gas were encountered, and the hole was plugged. The R.G. Williams Number 1 Richey (or Rickey) hole, located in Sec. 9, T15S, R1E, was drilled in 1941 and 1942 to a total depth of 3,883 feet in the Ordovician St. Peter Sandstone. Although small oil shows were encountered in the Ordovician Plattin Limestone, the Richey well was plugged and abandoned.

The outlook for oil and gas in the Olmsted area is not favorable. The nearest producing wells are near Marion, about 35 miles north. Given the degree of faulting, fracturing, and hydrothermal alteration in the Olmsted area, it is likely that any hydrocarbons originally present have escaped at the surface.

Acknowledgments

Geophysical surveys and deep core drilling for this project were supported by the U.S. Geological Survey through its National Earthquake Hazards Reduction Program (NEHRP). Jack Masters and Joe Devera of the ISGS assisted with outcrop study, test drilling, and geophysical surveys. The Absorbent Clay Corp., American Colloids Co., Golden Cat Corp., and Oil-Dri Corp. granted access to clay pits. The U.S. Army Corps of Engineers supplied copious amounts of geologic and engineering data in addition to providing access to drill cores and safekeeping of our equipment. The Village of Olmsted and Pulaski County Highway Department facilitated geophysical surveys and drilling operations. The Ballard Wildlife Management Area granted access for geophysical surveys. Clayton Bierbaum, Mildred Henderson, George Holhubner, Adeline Huddleston, Robert Johnston, Donna Junkerman, Michael Mayer, Herman Reichert, Cecilia Tennis, Mr. Ulrich, and John Walbridge allowed us to drill test holes on their land. Many other individuals, too numerous to mention, allowed us onto their land for outcrop study and helped us locate wells.

References

Berg, R.B., and J.M. Masters, 1994, Geology of microcrystalline silica (tripoli) deposits, southernmost Illinois: Illinois State Geological Survey, Circular 555, 89 p. and 1 plate.

Bexfield, C.E., J.H. McBride, A.J.M. Pugin, W.J. Nelson, T.H. Larson, and S.L. Sargent, 2005, The Olmsted fault zone, southernmost Illinois: A key to understanding seismic hazard in the northern New Madrid seismic zone: Engineering Geology, v. 81, p. 179–201.

Cluff, R.M., M.L. Reinbold, and J.A.Lineback, 1981, The New Albany Shale Group of Illinois: Illinois State Geological Survey, Circular 518, 83 p. and 4 plates.

Cope, K.H., 1999, Paleontology and paleoecology of the fauna of the Clayton Formation (Paleocene) in southern Illinois: Southern Illinois University, Carbondale, M.S. thesis, 62 p.

Harrison, R.W., and R.J. Litwin, 1997, Campanian coastal plain sediments in southwestn Missouri and southern Illinois—Significance to the early geologic history of the northern Mississippi embayment: Cretaceous Research, v. 18, p. 687–696.

Hildenbrand, T.G., M.F. Kane, and J.D. Hendricks, 1982, Magnetic basement in the upper Mississippi embayment region—A preliminary report: Reston, Virginia, U.S. Geological Survey, professional paper 1236, p. 39–53.

Jibson, R.W., and D.K. Keefer, 1988, Landslides triggered by earthquakes in the central Mississippi Valley, Tennessee and Kentucky: Reston, Virginia, U.S. Geological Survey, Professional Paper 1336-C, 24 p. and 1 plate.

Kolata, D.R., J.D. Treworgy, and J.M. Masters, 1981, Structural framework of the Mississippi Embayment of southern Illinois: Illinois State Geological Survey, Circular 516, 38 p.

Lamar, J.E., 1953, Siliceous materials of extreme southern Illinois: Illinois State Geological Survey, Report of Investigations 166, 39 p.

McBride, J.H., A.J.M. Pugin, W.J. Nelson, T.H. Larson, S.L. Sargent, J.A. Devera, F.B. Denny, and E.W. Woolery, 2003, Variable post-Paleozoic deformation detected by seismic reflection profiling across the northwestern "prong" of the New Madrid seismic zone: Tectonophysics, v. 368, p. 171–191.

Nelson, W.J., F.B. Denny, L.R. Follmer, and J.M. Masters, 1999, Quaternary grabens in southernmost Illinois: deformation near an active intraplate seismic zone: Tectonophysics, v. 305, p. 381–397.

Nelson, W.J., J.A. Devera, and J.M. Masters, 1995, Geology of the Jonesboro 15-minute Quadrangle, southwestern Illinois: Illinois State Geological Survey, Bulletin 101, 57 p.

Nelson, W.J., and L. Williams, 2004, Surficial geology of Pulaski 7.5-minute Quadrangle, Pulaski County, Illinois: Illinois State Geological Survey, Open File Series, OFS-Pulaski-SG, 3 sheets, 1:24,000.

Olive, W.W., 1969, Geologic map of parts of the Bandana and Olmsted quadrangles, McCracken and Ballard Counties, Kentucky: U.S. Geological Survey, Map GQ-799, 1 sheet, 1:24,000.

Pryor, W.A. and C.A. Ross, 1962, Geology of the Illinois parts of the Cairo, La Center, and Thebes quadrangles: Illinois State Geological Survey, Circular 332, 39 p. and 2 plates, 1:62,500.

Reed, P.C., J.M. Masters, N.C. Hester, and H.D. Glass, 1977, Lithology and geochronology of Cretaceous and Tertiary deposits in Illinois (abs.): Geological Society of America, Abstracts with Programs, v. 9, no. 5, p. 646.

Ross, C.A., 1964, Structural framework of southernmost Illinois: Illinois State Geological Survey, Circular 351, 28 p.

Stauder, W., R. Herrmann, J. Chulick, M.J. Mascarenas, V. John, P. Leu, T. Shin, H. Yepes, and C. Finn, 1984, Central Mississippi Valley Earthquake Bulletin, Quarterly Bulletin No. 39, First Quarter 1984: St. Louis, Missouri, Saint Louis University, Department of Earth and Atmospheric Sciences, 83 p.

Stover, C.W., 1988, United States earthquakes, 1984: Reston, Virginia, U.S. Geological Survey, Bulletin 1862, 179 p.

Su, W.J., and C. Stohr, 2000, Aerial-photointerpretation of landslides along the Ohio and Mississippi Rivers: Environmental & Engineering Geoscience, v. VI, no. 4, p. 311–323.

Taylor, K.B., 1991, Seismotectonics of the Illinois Basin and the northern half of the Ozark Uplift: St. Louis, Missouri, Ph.D. dissertation, Saint Louis University, 152 p.

Thomas, A.R., and H.H. Murray, 1989, Clay mineral segregation by flocculation in the Porters Creek Formation: Clays and Clay Minerals, v. 37, no. 2, p. 179–184.

Weller, J.M., and G.E. Ekblaw, 1940, Preliminary geologic map of parts of the Alto Pass, Jonesboro, and Thebes quadrangles: Illinois State Geological Survey, Report of Investigations 70, 26 p. and map, 1:62,500.