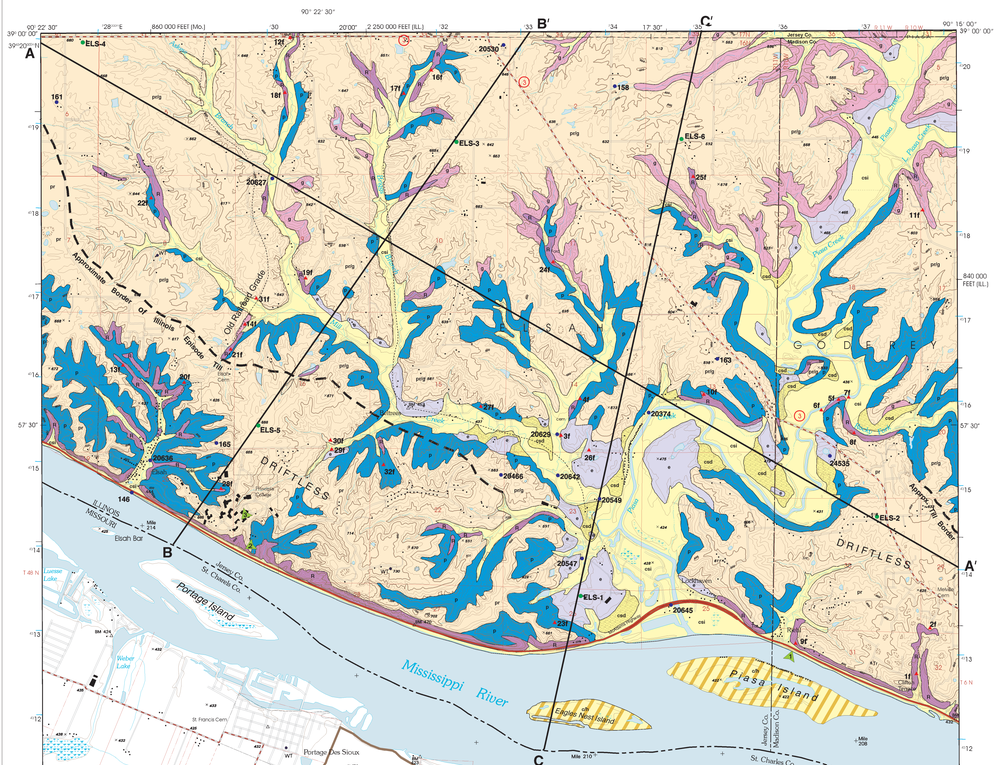
George H. Ryan, Governor

Department of Natural Resources
Brent Manning, Director
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geological Quadrangle Map: IGQ-Elsah-SG
William W. Shilts, Chief
2002

SURFICIAL GEOLOGY MAP

Elsah 7.5-minute Quadrangle (Illinois Portion), Jersey and Madison Counties, Illinois

David A. Grimley



Topographic map by the Army Map Service.
Revised by the U.S. Geological Survey and the Illinois State Geological Survey.

Topographic map compiled by photogrammetric methods from imagery dated 1952 Field check 1954. Revised in cooperation with the U.S. Corps of Engineers from imagery dated 1991. PLSS and control current as of 1954. Map edited 1995; contours not revised. Digital base map compiled from USGS digital line graphs (DLGs) by the Illinois State Geological Survey (ISGS). Geology mapped by the ISGS from 1997-1998.

North American Datum of 1983 (NAD 83). Projection and blue 1000-meter ticks: Universal Transverse Mercator, zone 15 10,000-foot ticks: Illinois (west zone) and Missouri (east zone) Coordinate Systems of 1983

North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for the 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

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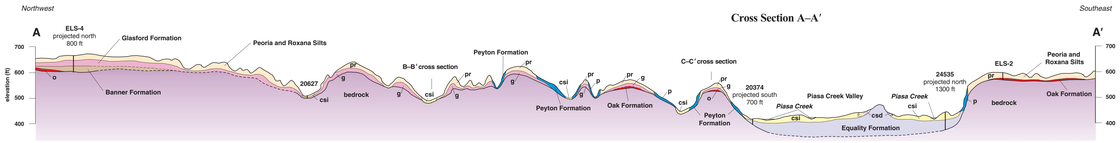

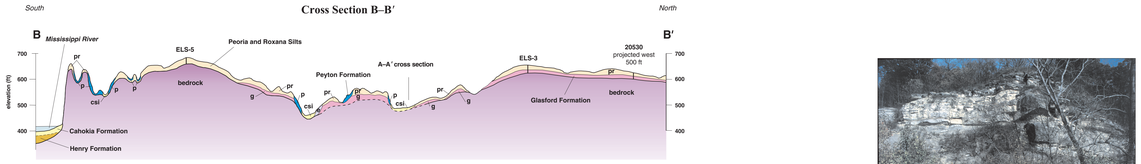

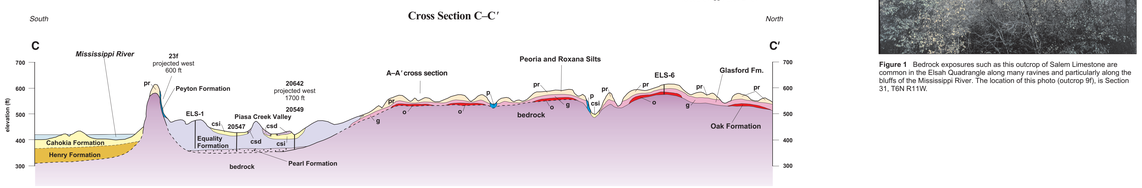

Figure 1 Bedrock exposures such as this outcrop of Salem Limestone are common in the Elsah Quadrangle along many ravines and particularly along the bluffs of the Mississippi River. The location of this photo (outcrop 9f), is Section 31, T6N R11W.

Figure 2 View to the west of the Mississippi Valley from the bluffs of Principia College (Sec. 21, T6N, R11W). The broad valley to the west and south was the source of sediment for loess deflation during the Wisconsin Episode when sediment-rich braided streams occupied this valley. In the distance are bedrock bluffs of the Grafton 7.5-minute Quadrangle.

Figure 3 This mammoth tooth, a few inches in length, was found several feet below the surface in loess exposed by sewer excavation on the grounds of Principia College (Sec. 21, T6N, R11W). Wear on this tooth indicates a mature age for this mammoth, which can have a life span of up to 70 years. A smooth, polished chewing surface reflects a prairie grass diet, typical for mammoths.

Material Description

Lithostratigraphy and Interpretation

QUATERNARY DEPOSITS
Hudson Episode (postglacial)
(10,000–0 years before present)

Stratified silt, sand, and gravel, with silt at the 5 foot depth; total thickness of up to 30 feet in Piasa and Mill Creek valleys and tributaries; some areas underneath Illinois Route 100 (Great River Road) along the bluffs contain up to 20 feet of sand and gravel fill. The modern soil is very weakly developed, lacking a notable subsoil (no B horizon).

csi **Cahokia Formation (silty at 5 feet)**
River sediment (alluvium); primarily silt; contains finer deposits in the lower portions of Mill and Piasa Creek valleys and contains some sand and gravel at depth, particularly in areas where bedrock is exposed.

Stratified silt, sand, and gravel, with sand or silt at the 5-foot depth; total thickness of up to 30 feet in Piasa and Mill Creek valleys and tributaries. The modern soil contains a B horizon at about the 1.5- to 3.5-foot depth.

csd **Cahokia Formation (sandy silt at 5 feet)**
Alluvium is found mainly in low terraces and fans in Piasa and Mill Creek valleys. Based on the presence of a soil B horizon, terraces may be early or middle Hudson Episode in age.

Stratified clay, silt, and medium sand, up to about 30 feet thick; overlying as much as 80 feet of sand and gravel. Sand and gravel thins toward the bluff line. The modern soil at the surface is generally weakly developed.

ch **Cahokia Formation overlying Henry Formation**
Postglacial alluvium in the Mississippi River valley; backswamp, fan, and channel deposits (Cahokia Formation) over outwash (Henry Formation).

Silt, pebbly silt, and/or pebbly clay; yellow-brown to reddish; 0 to 20 feet thick; underlain by silt, diamicton (unsorted mixture of gravel, sand, silt, and clay) or bedrock; contains a weakly developed modern soil in the upper 0 to 3 feet.

Peyton Formation
Slope sediment (colluvium) and eroded or redeposited loess; a mixture of underlying bedrock residuum, loess, and bedrock deposited on side slopes and foot slopes by mass wasting processes. Many areas covered about 17,000 and 15,500 radiocarbon years ago, although sediments in the terraces are older (Hajic et al.1991). The Equality Formation occurs below the Cahokia Formation in many areas of Piasa Creek and Mill Creek valleys (sites 29f, 31f) at elevations below 490 feet and also occurs as clay beds that interfinger with loess deposits at elevations below 500 feet (sites 27f, 31f). These clay beds are known to occur at many sites in the Peoria Silt of the St. Louis area at elevations between 485 and 505 feet and have been radiocarbon dated as being between 20,000 and 16,000 years before present (Hajic et al. 1991, Grimley et al. 1998). Although most deposits are probably Hudson Episode, some predate or were concurrent with loess deposition.

Wisconsin Episode (last glaciation)
(70,000–16,000 years before present)

Silt to silt loam; friable; yellow-brown to gray (Peoria Silt) in approximately upper two-thirds of unit in uneroded areas and pinkish brown to brown (Roxana Silt) in lower one-third. Total thickness is 18 to 40 feet on uneroded, relatively flat terraces and 5 to 18 feet along eroded slopes. Contains the modern soil solum in upper 4 feet. In glaciated areas (north of dashed line on map), this unit is underlain by weathered pebbly loam diamicton, silt, or sand. In driftless area (south of dashed line), it is underlain by red clayey residuum or bedrock.

pr **Peoria and Roxana Silts**
Loess; derived from Mississippi and Missouri River valley sediment and deposited during most recent episode of loess deposition. Loess thickness generally decreases away from the Mississippi Valley bluffs. Areas of severely eroded and redeposited loess on steep slopes are mapped as Peyton Formation. In glaciated areas, underlain by Sangamon Geosol (last interglacial soil) developed on Glasford Formation (till and ice marginal sediment). In driftless areas, underlain by residuum and/or bedrock.

Crudely stratified fine sand, silty clay, silt, and clay; gray to yellow-brown to pinkish brown or pinkish gray; as much as 110 feet thick (in core ELS-1); deposits thin upstream along Mill and Piasa Creeks. In large terraces, pink silty clay (lower half) is overlain by yellow-brown sandy silt (upper half). Overlain by up to 4 feet of silt (loess) containing the modern soil.

e **Equality Formation**
Slackwater lake deposits (formed by sediment damming by the Mississippi River) occur in terraces of 460 to 480 feet elevation along Mill and Piasa Creeks and in their tributaries up to about 490 feet. This unit is also found below the Cahokia Formation (cross-sections A–A′ and C–C′).

Illinois Episode (next to last glaciation)
(about 200,000–130,000 years before present)

Sand and gravel, with some clay, and sorted sediment; as much as 15 feet thick.

pe **Pearl Formation (in cross section C–C′ only)**
Outwash and/or preglacial sediment. This unit is probably related to Illinois Episode ice advance, but its presence is based on only three water-well records; underlain by bedrock and overlain by Equality Formation.

Pebbly loam diamicton (unsorted mixture of gravel, sand, silt, and clay) with some minor sand and silt beds. This unit is yellow-brown to gray, but can have a slight greenish to bluish hue. Upper 5 to 10 feet tends to be less dense, softer, sandier, and oxidized. Lower portions are commonly gray, uniform, and dense. Local limestone, dolomite, and shale pebbles and fragments are common in the diamicton. Overlain by 0 to 5 feet of silt (loess).

g **Glasford Formation (< 5 feet of loess cover)**
Till and ice marginal sediment; contains Sangamon Geosol in upper 4 to 7 feet where not eroded; sandy sorted deposits are more common in upper portions of the unit and near the mapped till border; more dense subglacial till occurs in lower portions of the unit; may also contain some Illinois Episode colluvium. Loess cover has been mostly eroded postglacially.

Pre-Illinois Episode
(about 500,00–450,000 years before present)

Silty clay diamicton, brown to brown-gray; upper portion is more weathered; underlain by silt, clay, or bedrock.

b **Banner Formation (in cross section A–A′ only)**
Till; found in core ELS-4, where preserved in a bedrock lowland. This unit contains the Yarmouth Geosol and is underlain by lake deposits, older paleosols (Oak formation), and/or bedrock.

TERTIARY/EARLY QUATERNARY DEPOSITS

Clay, cherty clay, silty clay; red to yellow-brown, sometimes with gray mottles.

o **Oak formation (in cross sections only)**
Weathered bedrock (residuum), weathered loess, and possibly weathered old till deposits that occurred on relatively stable upland areas. Formed by chemical dissolution of carbonate bedrock, with some admixed Quaternary deposits (Nelson et al. 1991). Chemical weathering of bedrock to residuum is thought to have occurred primarily during the Tertiary (Willman et al. 1989).

MISSISSIPPIAN BEDROCK

Bedrock exposures or bedrock within about 5 feet of land surface. Includes some talus-covered bedrock slopes at the bluffs of the Mississippi River valley. Faulted and tilted to flat-lying sedimentary rocks. Limestone, dolomite, shale, chert, and siltstone occur, with limestone and shale being the most common.

R **Near-surface bedrock**
St. Louis Limestone, Salem Limestone, Warsaw Shale, and Burlington Limestone are the most common units (F.B. Denny 2000, personal communication). The St. Louis and Salem Limestones, being very pure carbonate rock and without chert beds, are commonly associated with karst topography.

Water bodies

IMPORTANT INFORMATION ON THE USE OF THIS DOCUMENT

This document has been carefully reviewed and edited and meets the scientific and technical standards of the Illinois State Geological Survey. It is suited to the purposes and uses intended by its authors and presents reasonable interpretations of the geology of the area described based on the data then available. The interpretations are based on data that may vary with respect to accuracy of geographic location, the type and quantity of data available at each location, and the scientific and technical qualifications of the data sources. In particular, variations in the texture, color, and other characteristics of geologic deposits and bedrock commonly preclude their use to delineate unit boundaries, particularly those in the subsurface. Consequently, the accuracy of unit boundaries and other features shown in this document may vary from place to place. Any map or cross section in this document is not meant to be enlarged. Enlarging the scale of a published map or cross section, by whatever means, does not increase the inherent accuracy of the information and scientific interpretations it portrays.

This document provides a conceptual model of the geology of the area on which further work can be based. Any large-scale (1:24,000-scale) map and/or cross section shown herein may be used to screen the region for potentially suitable sites for a variety of purposes, but use of this document for such screening does not eliminate the need for detailed studies to fully understand the geology of a specific site. The Illinois State Geological Survey, the Illinois Department of Natural Resources, and the State of Illinois make no guarantee, expressed or implied, regarding the correctness of the interpretations presented in this document and accept no liability for the consequences of decisions made by others on the basis of the information presented here.

Data Type

- ELS-1 — stratigraphic test holes
- 32f — outcrops examined
- 20466 — water wells and engineering borings (county numbers indicated)
- Location of figure
- Approximate border of Illinois Episode till (till is not presently found south and west of this line)

Quaternary Geology

This Illinois quadrangle, located about 20 miles north of St. Louis, contains the edge of the glacial till border in southwestern Illinois. Till (an unsorted mixture of clay, silt, sand, and gravel deposited directly by glaciers) occurs in the northeastern two-thirds of the Illinois portion of the quadrangle, but is not found on highlands adjacent to the Mississippi River or in the Grafton 7.5-minute Quadrangle to the west (Grimley 1999a). Pre-Illinois and Illinois Episode ice advances from the east and northeast (Willman and Frye 1970, McKay 1979, Grimley 1999b, Grimley et al. 2001) deposited the till, which was later eroded from some of the steeper side slopes. Glaciers probably did not overtop bedrock highs within 1.5 miles of the Mississippi River bluffs, such as near Elsah, Principia College, Lockhaven, and Clifton Terrace; however, earlier deposits could have since been eroded.

Bedrock and Residuum Outcrops of Mississippian limestone, dolomite, and shale are common in the Elsah Quadrangle (F.B. Denny, personal communication 1999). Bedrock crops out along many creeks, several road cuts, and the bluffs of the Mississippi River, where rock is commonly exposed to heights of 75 to 100 feet (fig.1). Bedrock residuum, mapped in cross-section as the informally defined Oak formation (Nelson et al. 1991), was formed mainly by in situ weathering of carbonate bedrock. The Oak formation also includes some strongly weathered loess (windblown silt) mixed with the residuum (Willman et al. 1989, Nelson et al. 1991). The Oak formation is up to 7 feet thick (see ELS-2) and is commonly found at the surface beneath gently rolling upland areas. In many areas, the Oak formation has been stripped by slope erosion and/or glacial erosion during pre-Illinois and Illinois Episode ice advances.

Pre-Illinois Episode Deposits Ice advance during the pre-Illinois episode was likely from the east or northeast. The distribution of pre-Illinois episode drift (Banner Formation) is extremely patchy, having been found presently only in core ELS-4 (fig.4) in a bedrock low in the northwestern corner of the quadrangle (cross section A–A′). In this area of relatively flat topography, Illinois Episode glaciers did not completely erode this older till. In most of this quadrangle, pre-Illinois drift likely was weathered and eroded from hillsides during the long Yarmouth Episode, when a strong soil was developed into the till, as found in the ELS-4 core. Pre-Illinois episode till was slightly thicker than the Illinois Episode till in this one core.

Illinois Episode Deposits Based on occurrences of striations immediately to the east in the Alton Quadrangle (Grimley 1999b), Illinois Episode ice is known to have advanced from the northeast. Illinois Episode diamicton (Glasford Formation) in this quadrangle, mainly interpreted to be till, ranges from 0 to 20 feet in thickness and is present on uplands and valley slopes, mostly north of Mill Creek and Rocky Fork Branch. Till deposits are typically less than 15 feet thick, are interbedded with silt and sand in some areas, and are weathered in upper portions by the Sangamon Geosol (last interglacial soil).

Glasford Formation till in this area is highly variable in composition and texture, likely because of erosion and incorporation of pre-existing loess, till, clayey residuum (weathered bedrock), and local bedrock into the basal debris load of a relatively thin advancing glacier. Inclusion of silt and other local sediments and rocks was observed in basal portions of the till. Zones of uniform, dense till, primarily in lower portions of Glasford Formation, were deposited subglacially. The proportion of illite in the <2- m clay mineral fraction of the Glasford Formation ranges from 20 to 45%. Clay-size particles (<4 m) in the Glasford Formation range from 18 to 40% (ELS-3, ELS-4, ELS-6,14f, 21f). Outwash sand and gravel (Pearl Formation) occurs in the lower reaches of Piasa and Mill Creek valleys, based on three water-well descriptions (20547, 20629, and 20642). This outwash occurs above bedrock and below Wisconsin Episode loess deposits and is probably related to the advance of glacial ice during the Illinois Episode.

Wisconsin Episode Deposits (Waterlaid) Outwash sand and gravel (Henry Formation) in the Mississippi River valley is attributed to Wisconsin Episode glaciation, which occurred well to the north in northeastern Illinois and the Upper Mississippi River drainage basin. As much as 50 feet of Henry Formation sand and gravel (overlain by as much as 50 feet of postglacial sand, silt, and clay) was deposited in the Illinois portion of the Mississippi River valley during the Wisconsin Episode as a result of sedimentation in the main valley during the last glaciation. This coarse-grained sediment (Henry Formation) grades into fine sand to silty clay lake sediment (Equality Formation) in terraces along tributary valleys, such as Piasa and Mill Creeks.

In the lower Piasa and Mill Creek valleys, lake sediment was deposited by backwaters of the Mississippi River, forming what are known as slackwater lake sediments. Postglacial downcutting into these lake sediments has created slackwater terraces. These terraces, capped by a few feet of loess, occur along these creeks at an elevation of about 460 to 480 feet (fig. 2). The terraces contain fine-grained sediment (fine sand to silty clay) as thick as 110 feet (core ELS-1) near the mouth of the Piasa Creek valley (fig. 2). Loess is up to 40 feet thick in unroded near-bluff areas but thins to about 18 feet on flat uplands in the northeastern portions of the quadrangle. Most loess overlies Glasford Formation sediments, but some overlies residuum or bedrock in driftless areas.

In June 1999, an excavation for a manhole on the grounds of Principia College (near Rackham Court dormitory; Sec. 23, T6N, R11W) revealed fossil teeth and bony parts from an "Ice Age" mammoth (fig. 3). Hajic was at a depth of several feet in the Peoria Silt, deposited between about 25,000 and 12,000 years ago (McKay 1979, Hansel and Johnson 1996). Other large mammalian fossil remains have been found in the area. In 1960, a mammoth tusk (now in the Principia College collection) was found in Equality Formation silt and clay deposits near site 31f (Section 9, T6N, R11W). In the late nineteenth century, varieties of mammalian fossil remains were found in loess deposits near the Alton bluffs (Leighton 1921), several miles to the east of Principia College. These fossils, some species of which are now extinct, included remains of deer, ground sloth, horse, moose, peccary, beaver, mastodon, gopher, brown bear, reindeer, eland, and musk ox (Leighton 1921). A detailed investigation of the site is planned in the future.

Postglacial Deposits Slope (colluvial) deposits (Peyton Formation) occur along many steep side slopes and ravines where the force of gravity has moved and mixed loess with local bedrock fragments and clasts from eroded till. In valleys, river sand and silt (Cahokia Formation) typically overlie slackwater deposits (Equality Formation) at elevations below 490 feet and overlie till (Glasford Formation) or bedrock at higher elevations. In some ravines near the bluffs, the Cahokia Formation is gravelly because of its derivation from local bedrock.

Environmental Hazards

Karst (Sinkhole and Cavern Development) Karst topography occurs in many areas of the quadrangle where the limestone bedrock is within about 25 feet of land surface. Sinkholes and underground cavern development are especially common in the central and eastern areas of the quadrangle where thin loess, thin till, and/or residuum overlie pure limestone such as the Salem or St. Louis Formations (Panno et al. 1997). Underground streams in karst areas near the Alton area (several miles to the east of Elsah) were calculated to flow at velocities greater than 0.5 mile per day and commonly followed joint sets in the N60 E and N45 W directions toward the Mississippi River valley (Lamar 1928). Many of the streams in this quadrangle also follow joint sets with these orientations. As a result, bedrock aquifers underlying karst regions are highly susceptible to contamination because surface water sinks quickly into cavernous bedrock and is not filtered through soil, clay, or slowly permeable bedrock (Panno et al. 1997, Panno and Weibel 1998). Karst regions also pose a hazard to buildings because of the danger of sinkhole collapse and widening.

Groundwater Contamination Groundwater supply on the uplands is primarily from fractured carbonate bedrock, mostly limestone. Shallow bedrock aquifers, at less than 50 feet depth, are highly susceptible to contamination through conduit flow if the aquifers are located in karst areas (as just discussed) and are not overlain by a significant cover of shale or clayey till. Henry Formation sand and gravel and Cahokia Formation sand in the Mississippi River floodplain constitute the most significant Quaternary aquifers in the quadrangle. However, north of the Illinois border these areas are limited in extent. Their potential for contamination is also high because of the relatively thin covering of silt and clay (approximately 15 to 30 feet). A summary of the factors affecting the potential for contamination in shallow aquifers in Illinois is provided by Berg et al. (1984).

Mass Wasting Erosion, undercutting, and slumping of thick loess deposits and Warsaw shale bedrock (Mississippian) at bluff edges are potential hazards (Killey et al. 1985). Slumps in unconsolidated deposits in this area commonly occur when water collects on top of the clayey Sangamon Geosol or Glasford Formation where they underlie the relatively permeable loess. Higher pore water pressures in these perched water tables increase the likelihood of slumping or failure along steep slopes. Slumping and other types of mass wasting of bedrock occur mostly where jointed carbonate rock overlies impermeable shale. One such slump occurred in Graham Hollow in the Grafton Quadrangle, several miles to the west of Elsah (Collinson et al. 1954).

Soil Erosion Because of the nature of loessal soils, steep slopes along ravines and bluffs are subject to severe soil erosion. Areas where the Peoria and Roxana Silts and Peyton Formation are present have loose, windblown, near-surface silt deposits that are soft and weakly cohesive and, thus, have a low shear resistance. These loessal deposits are easily eroded by running water during heavy rainfalls. Runoff during storms can quickly enlarge rills and gullies, thereby accelerating the process of erosion, as water is channeled into the growing drainage system.

Flooding Severe flooding occurs periodically in the Elsah and Lockhaven areas. During the flood of 1993 (Chrzastowski et al. 1994), the Mississippi River rose almost to the an elevation of 440 feet, which was at least 22 feet above the normal river level. As a result, according to discussions with local land owners, backwaters inundated a large part of the Piasa Creek floodplain, leaving behind a thin layer of sand, silt, and clay on the floodplains. A sign marking the flood height can be found on the west side of Clifton Terrace Road near the intersection with Illinois Route 100.

Material Resources (Unconsolidated)

Sand and Gravel Sand and gravel deposits in this quadrangle, which lie predominantly below the water table, are a potential source for construction materials. Sand in the Mississippi River channel is currently being dredged in the Alton area (Bluff City Minerals), several miles downstream from Elsah. The sands near Alton are primarily siphoned from the upper 15 feet of channel sediment and are used for asphalt and mortar. Gravel is not abundant, which somewhat limits the use of these sediments by the construction industry (Goldman 1994). Economically usable river sands probably exist in the Mississippi River channel or in the subsurface on Piasa or Eagles Nest Island, where the cover of clay, silt, and finer sands could be 5 to 40 feet thick.

Mapping Techniques

This surficial geologic map is based in part upon soil series of parent materials compiled from the Jersey County soil survey (Fehrenbacher and Downey 1966) and the Madison County soil survey (Goddard and Sabata 1986). Those data were considerably modified based upon field observations and drilling operations performed as part of this STATEMAP project. Well log data, Illinois Department of Transportation records, and other engineering boring data on file at the Illinois State Geological Survey were used to further aid in mapping and, especially, in constructing the three cross sections. Field outcrop and stratigraphic test hole descriptions are available from the ISGS Geological Records Unit or ISGS Library.

Map boundaries that are indicated by dashed lines are less reliable subsurface contacts, such as the till boundary. Cross section unit boundaries are dashed where the data are limited or less reliable.

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