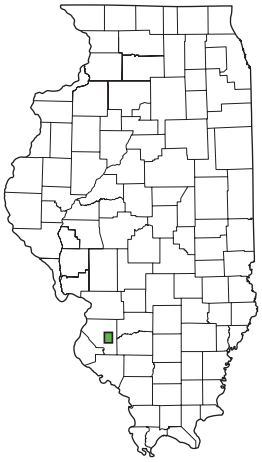
Illinois Geologic Quadrangle Map
IGQ Mascoutah-SG Revision

Surficial Geology of Mascoutah Quadrangle

St. Clair County, Illinois

David A. Grimley

2010



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Introduction

The surficial geology map of the Mascoutah 7.5-minute Quadrangle, located in Illinois about 20 miles southeast of downtown St. Louis, Missouri, provides an important framework for land and groundwater use, resource evaluation, engineering and environmental hazard assessment, and geological study. This study is part of a broader geologic mapping program undertaken by the Illinois State Geological Survey (ISGS) in the St. Louis Metro East region (Grimley and McKay 2004, Phillips 2004), which includes Madison, St. Clair, and Monroe counties in Illinois.

The Mascoutah Quadrangle is located in east-central St. Clair County, about 15 miles southeast of the Mississippi River valley (fig. 1) and about 25 miles northeast of the maximum extent of glacial ice during the Illinois and pre-Illinois Episodes (Grimley et al. 2001). Glacial ice in southwestern Illinois generally advanced from the northeast, originating from the Lake Michigan basin during the Illinois Episode and from the Lake Michigan basin and/or the eastern Great Lakes Region during the pre-Illinois Episode (Willman and Frye 1970). Deposits of both glacial episodes in this region have also been reported by McKay (1979) and Phillips (2004). Glacial ice did not reach the study area during the Wisconsin Episode; however, glacial meltwater streams from the upper Mississippi River drainage basin deposited outwash throughout the middle Mississippi Valley. This outwash was the source for loess deposits (windblown silt) that blanket the uplands in southwestern Illinois. During the Illinois and pre-Illinois Episodes, outwash was regionally deposited in ancestral valleys of Silver Creek (Phillips 2004) and the Kaskaskia River, both of which drained to the south and southwest. During interglacial (Yarmouth and Sangamon episodes) and postglacial periods, the Kaskaskia River and its tributaries were incised in response to downcutting of the Mississippi River (Curry and Grimley 2006). Thus, the Kaskaskia River valley has experienced a succession of cut-and-fill sequences over approximately the last 500,000 years.

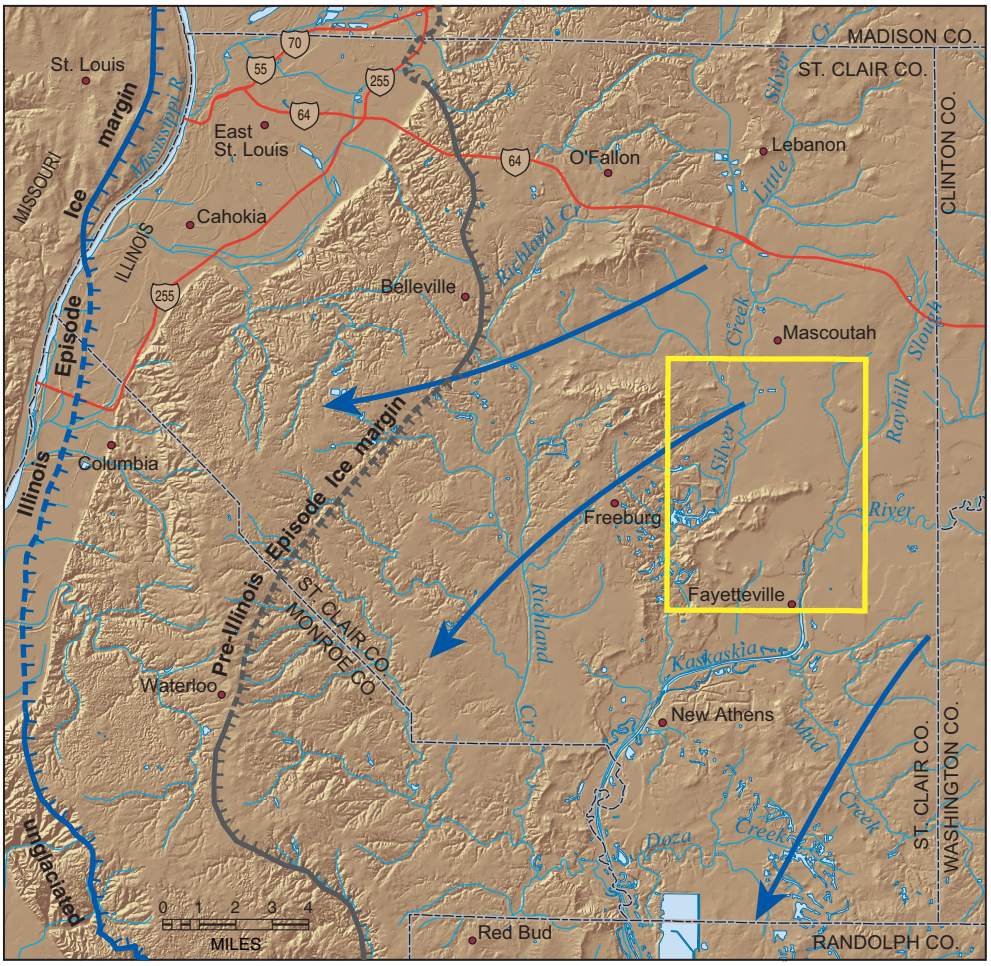

Figure 1 Shaded relief map of the St. Louis Metro East area (southern portion). The Mascoutah Quadrangle is outlined in yellow. Blue arrows indicate approximate ice flow direction during the Illinois Episode.

Methods

Surficial Map

The surficial geology map is based in part upon soil parent material data (Wallace 1978, Natural Resources Conservation Service 1999), supplemented by data from outcrop studies, stratigraphic test holes obtained for this STATEMAP project, engineering borings from the Illinois Department of Transportation (IDOT) and St. Clair County Highway Department, coal test borings, and water-well records. Map contacts were also adjusted according to the surface topography, geomorphology, and observed landform-sediment associations. Localities of important data used for the surficial geology map, cross sections, or landform-sediment associations are shown on the map.

Cross Sections

The cross sections portray unconsolidated deposits as would be seen in a vertical slice through the earth down to bedrock (vertically exaggerated 20 times). The lines of cross section are indicated on the surficial map. Data used for subsurface unit contacts (in approximate order of quality) are from studied outcrops, stratigraphic test holes, engineering boring records, water-well records, coal test borings, and oil-well records. Units less than 5 feet thick are not shown on the cross sections. Dashed contacts are used to indicate where data are less reliable or not present. The full extent of wells that penetrate deeply into bedrock is not shown.

Surficial Deposits

The surficial deposits are divided into four landform-sediment associations: (1) dissected uplands in the northwestern portion of quadrangle that include relatively thin glacial and windblown (loess) sediments with sporadic bedrock outcrops; (2) upland ridges and knolls, mainly in central and southwestern areas, containing ice-contact sediment, with loess cover; (3) broad terraces and tributary valleys containing glacial and postglacial waterlain sediments with loess covering the older terraces; and (4) the terraces and modern floodplain of the Kaskaskia River valley, containing near-surface waterlain sediment from the last glaciation to recent times. There are also older concealed deposits associated with early glaciations and, in some cases, preglacial times. Their occurrence and thickness are more closely related to the bedrock surface topography (fig. 2). Areas of disturbed ground are mapped mainly at former surface mines for coal that include areas of waste material (in artificial hills) and areas of removed sediment and rock (under lakes).

Dissected Uplands (West of Silver Creek Valley)

The upland area in the northwest portion of the quadrangle is blanketed by up to 15 feet of loess that is underlain by relatively thin glacial till and ice-marginal deposits. In other areas, the loess (Peoria and Roxana Silts) is typically 7 to 10 feet thick but is thinner on steeper eroded slopes. The loess was deposited during the last glaciation (Wisconsin Episode) when silt-size particles in Mississippi Valley glacial meltwater deposits were periodically windswept and carried in dust clouds eastward to vegetated upland areas, where they gradually settled across the landscape. The deposits are typically a silt loam to heavy silt loam where unweathered. In the modern soil solum (generally the upper 3 to 4 feet), the loess is altered to a heavy silt loam or silty clay loam (Wallace 1978). The Peoria Silt is the upper and younger loess unit. The Roxana Silt, with a slight pinkish hue, is the lower loess unit (Hansel and Johnson 1996). Both loess units are relatively thin, slightly to moderately weathered, leached of carbonates, and fairly similar in physical properties.

On some side slopes and ravines, where the loess has been eroded to less than 5 feet thick, the underlying diamicton (a massive, poorly sorted mixture of clay, silt, sand, and gravel), weathered diamicton, and/or associated sorted sediment are mapped as the surficial unit (Glasford Formation). Compared to overlying loess deposits, the Glasford diamicton is considerably more pebbly and dense, has a lower moisture content (11 to 16%), and has greater unconfined compressive strength (Q_u), than do the loess deposits (table 1). The Glasford Formation, deposited during the Illinois Episode, may in places include sand and gravel lenses deposited from glacial meltwater streams within, in front of, or below glacial ice. The upper 10 to 12 feet of Glasford Formation, where uneroded, is generally more weathered, is leached of carbonates, has a higher water content, and is less stiff than the majority of the unit. Stronger alteration features are prevalent in the upper 4 to 6 feet, including root traces, fractures, carbonate leaching, oxidation or color mottling, strong soil structure, clay accumulation, and/or clay skins. This weathering is due to the occurrence of a buried interglacial soil known as the Sangamon Geosol, which further helps to delineate the Glasford Formation from overlying loess deposits. Oxidation and fracturing may extend 10 to 20 feet or more into the Glasford diamicton.

Pennsylvanian sandstone, shale, and limestone crop out in a few places along Hazel Creek and tributaries to Hazel Creek (e.g., Secs. 3 and 10, T1S, R7W) and also in places along Silver Creek (e.g., northwest Sec. 34, T1S, R7W), where up to 8 feet of fossiliferous limestone is exposed above the creek level. This western and northwestern portion of the map is a topographic high on the bedrock surface (fig. 2), up to 150 feet higher in bedrock elevation than to the east, which explains why glacial meltwater deposits (sand and gravelly sand) and associated terraces occur primarily east of Silver Creek. It also explains the thinner drift in this area (generally <50 feet) and the distribution of former surface coal mines.

Upland Ridges and Knolls

In the central and southwestern portions of the quadrangle, a prominent ridge system, consisting of curvilinear hills and knolls, occurs in a general east-northeast to west-southwest orientation, approximately parallel to regional ice flow during the Illinois Episode (fig. 1; Grimley et al. 2001). Such

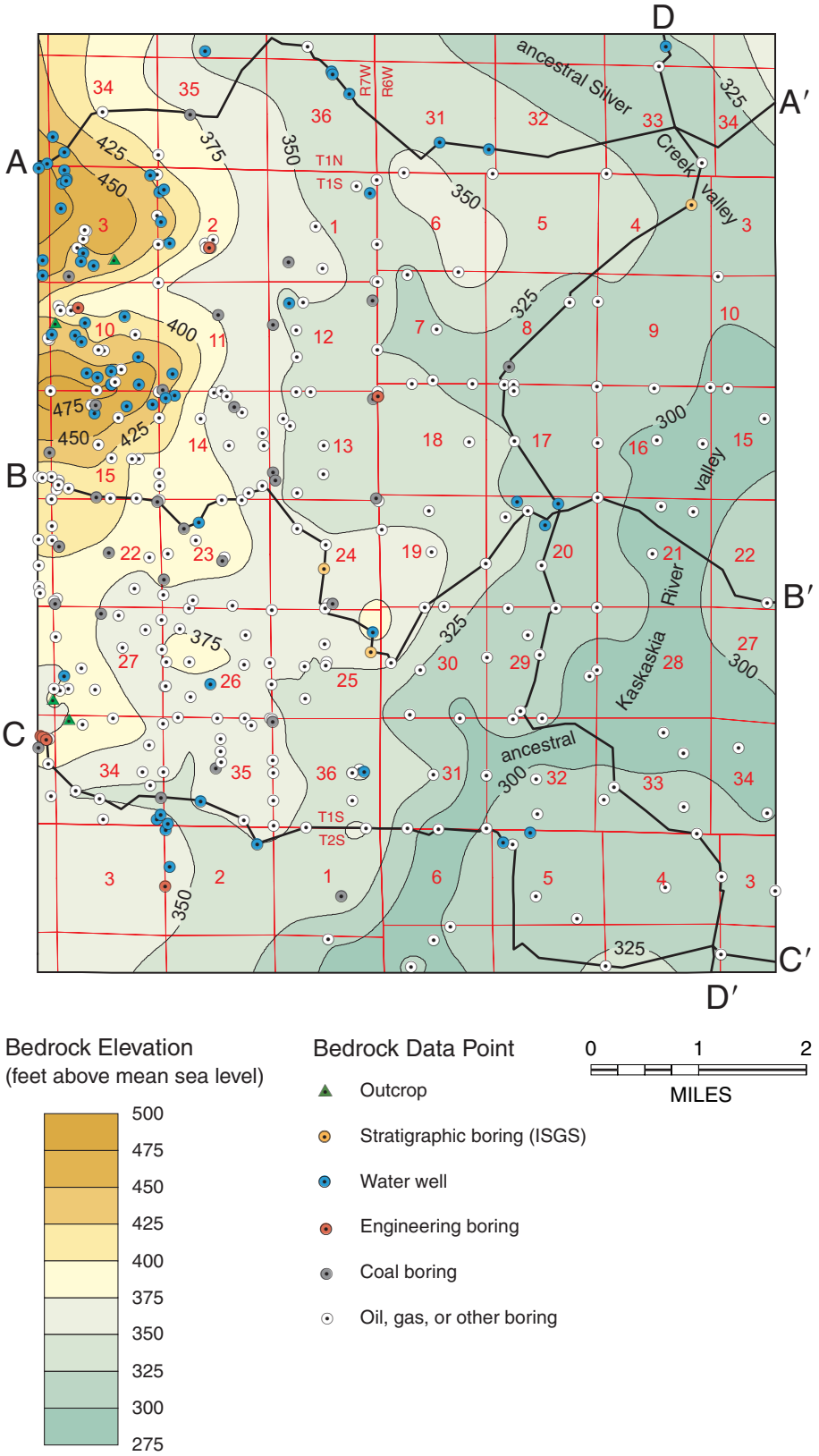

Figure 2 Bedrock topography of the Mascoutah Quadrangle. Section boundaries are shown in red, and cross section lines are shown in black. Localities of all data that reliably indicate the bedrock surface are shown (many data are not shown on surficial map). Scale is 1:100,000.

Table 1 Physical and chemical properties of selected map units (typical ranges listed).

Unit	Geotechnical properties[1]			Particle size and compositional data[2]					Geophysical data[3]	
	w (%)	Q_u (tons/ft^2)	N	Sand (%)	Silt (%)	Clay (%)	Clay mineralogy	Carbonate content	Natural gamma	MS
Cahokia Formation	20–33 (if saturated)	0.25–1.25	2–10	——— variable texture ———			high expandables	typically 0%	variable	ND[4]
Equality Formation	22–45 (if saturated)	0.25–1.5	2–8	ND	ND	ND	20–60% illite (high expandables)	ND	high	4–30
Henry Formation	ND	0.5–2.0	15–40	ND	ND	ND	ND	ND	low	15–25
Peoria and Roxana Silts	20–30	0.5–2.0	5–10	2–9	67–75	20–25	30–65% illite (high expandables)	typically 0%	mod.	6–80
Berry Clay Member	14–20	0.5–1.75	8–11		ND		10–20% illite (high expandables)	typically 0%	high	2–20
Pearl Formation	ND	0.1–2.0	5–50	– generally >50% sand; some gravel –			ND	ND	low	2–20
Hagarstown Member	19–22 (where loamy)	0.1–2.0	8–25	——— variable texture; sometimes 50–90% sand ———			55–72% illite	ND	low–mod.	5–50
Glasford Formation (till)[5]	11–20	2.0– >4.5	10–45	15–41	38–64	20–25	51–62% illite (significant chlorite)	10–26%	mod.–high	8–35
Banner Formation (till)[5]	13–23	2.0– >4.5	11–35	15–40	30–65	21–35	50–55% illite (significant chlorite)	5–10% (20–25 in pink zone)	high	25–45 (up to 70 in pink zone)
Canteen member, Banner Formation	17–24	1.5–4.0	ND	2–28	37–61	23–55	30–50% illite	0–15%	high	5–25
Shale bedrock	ND	>4.5	50–100	ND	ND	ND	ND	typically <7%	very high	5–25

[1]Geotechnical properties are based on hundreds of measurements (total for all units) from about 25 engineering (bridge) borings and 8 stratigraphic test borings in the quadrangle. w, moisture content = mass of water/mass of solids (dry); Q_u, unconfined compressive strength; N, blows per foot (standard penetration test).

[2]Particle size and compositional data are based on a more limited data set (~20 samples) from 8 stratigraphic borings. Sand = % >63 µm; silt = % 4–63 µm; clay = % <4 µm (proportions in the <2-mm fraction). Clay mineralogy = proportions of expandables, illite, and kaolinite/chlorite (in <4-µm clay mineral fraction) using Scintag X-ray diffractometer (about one-fourth more illite than previous results by H.D. Glass with General Electric diffractometer).

[3]Geophysical data: natural gamma, relative intensity of natural gamma radiation (data from 3 stratigraphic borings). MS, magnetic susceptibility ($\times 10^{-8}$ m^3/kg) (detailed data from 8 stratigraphic borings).

[4]ND, no data available.

[5]Properties for Glasford Formation are mainly for calcareous till (excludes sand and gravel lenses and strongly weathered zones); weathered upper portions can be less stiff, more clayey, leached of carbonates, and have higher water contents.

areas, historically termed the "ridged drift," tend to contain a higher proportion of loamy to sandy deposits than in surrounding areas. The lithologically complex deposits in the ridges are classified as the Hagarstown Member of the Pearl Formation. The Hagarstown Member was originally classified as a member of the Glasford Formation since it generally overlies glacial till (Willman and Frye 1970), but the unit was later redefined as a member of the Pearl Formation (Killey and Lineback 1983) due to its closer association with glacial stream deposits and for consistency with Wisconsin Episode terminology. Near-surface Hagarstown Member (mapped solid reddish brown) with <5 feet of loess cover occurs in ravines along Pleasant Ridge where the loess has been eroded. Where 5 to 15 feet of loess blankets the Hagarstown Member, stipples are shown on the map to indicate this unit in the subsurface. Previous studies in south-central Illinois have noted significant sand and gravel in similar ridges (Jacobs and Lineback 1969); however, some ridges contain a high proportion of intermixed diamicton and fine-grained sediment (Phillips 2004). In the Pleasant Ridge area of the Mascoutah Quadrangle, the Hagarstown Member can include up to 110 feet thick of various grades of well-sorted to poorly sorted sand (cross section B–B′), including some gravelly zones and some zones of very fine sand. Such sandy areas (with a loess cover) are shown with larger stipples and tend to occur in hills on the southeast side of the main ridge system. These areas were delineated based on test holes, water-well records, and geophysical studies. Deposits of the Hagarstown Member on the main portion of Pleasant Ridge (Secs. 19 and 20, T1S, R6W; center of Sec. 24, T1S, R7W) include interbedded sand, loam, and variably textured diamicton, as well as ice-thrusted inclusions of pre-Illinoian paleosol fragments (Yarmouth Geosol), glacial, and preglacial materials.

The upper 5 to 15 feet of material immediately above the Hagarstown Member of the Pearl Formation is a clay loam to sandy clay loam with pedogenic alteration features (clay skins, root traces, etc.) This deposit, mapped as the Berry Clay Member of the Pearl Formation, includes ice-contact sand deposits that were weathered and pedogenically mixed with overlying silt deposits during interglacial soil development (Sangamon Geosol). Secondary alteration, such as clay infiltration into zones that were originally sandy, has resulted in finer textures. The Berry Clay Member was originally defined as an accretionary deposit on the Glasford Formation (Willman and Frye 1970); however, its use is here being extended to an accretionary deposit or significant weathered zone in the upper Pearl Formation.

The origin of Pleasant Ridge may be related to the presence of a bedrock topographic high in the central portion of the quadrangle (fig. 2; near Sec. 19). This bedrock high, oriented roughly parallel to regional ice flow (northeast to southwest), may have caused divergent flow of glacial ice during the waning phase of Illinois Episode glaciation. As thinning ice flowed to the southwest over the bedrock high, cavities may have developed underneath glacial ice, possibly leading to development of a subglacial channel and/or a crevasse system. During the final melting phase, subglacial channels may have become open-air channels in reentrant areas between local sublobes that developed near and in the wake of bedrock high obstacles. Supraglacial channels, common to interlobate areas, could also have developed, leading to sediment accumulation (e.g., debris flows) on the ice surface adjacent to bedrock highs. Upon melting of glacial ice, the sediment in supraglacial, subglacial, and ice-marginal channels would begin to form the observed ridges. The sediment in supraglacial channels would normally include sorted sediment as well as diamicton (from debris flows and till inclusions), as is found in northern portions of Pleasant Ridge. Areas on the southern side of Pleasant Ridge that are dominantly sandy may be related to ice-marginal channels that developed between bedrock topographic highs and the active glacier as the ice margin retreated. It is also possible that the northern, arcuate portion of Pleasant Ridge may be morainal. Overall, the origin of the ridged drift landscape and deposits may be quite complex and similar to that in the kettle moraine area of southeastern Wisconsin (Carlson et al. 2005).

Broad Terraces and Tributary Valleys

As a result of alternating periods of sediment aggradation (mainly during glacial times) and river incision (mainly during interglacial periods), several terrace levels were formed during the last two glaciations (Illinois and Wisconsin Episodes) and during postglacial times. Areas of terraces and valleys cover much of the central and northeastern portions of the quadrangle. Alluvial deposits in terraces and in tributary valleys (all valleys other than the Kaskaskia River valley) consist of coarse- to fine-grained stratified stream or lake deposits; up to 15 feet of loess covers the oldest surfaces (Illinois Episode).

The oldest terrace is a loess-covered Illinois Episode terrace, mapped as loess and given a diagonal line pattern on the map where sand and gravel outwash (Pearl Formation) occurs at depth. This terrace is mapped principally in the northern portion of the map, north of Pleasant Ridge, where surface elevations for the terrace range from about 440 to 415 feet asl (above sea level). Due to a cover of loess, accretionary, and pedogenically altered material, elevations for the top of the underlying loose sand (typically fine to medium grained) are typically 420 to 390 feet asl. Elevations of 400 to 395 feet asl are consistently found for the top of the sand across the northeastern portion of the map near Mascoutah and immediately to the south (cross section A–A′). The Illinois Episode age for this terrace is based on the presence of interglacial soil alteration features (Sangamon Geosol) and finer-grained accretionary deposits at the top of the outwash sequence. Accretionary deposits, up to 20 feet thick, are included in the Berry Clay Member of the Pearl Formation. These deposits likely include glacial and interglacial lake sediments as well as eolian silt additions, all pedogenically altered. The Berry Clay Member is consistently covered by 10 to 15 feet of

Wisconsin Episode loess deposits (Peoria and Roxana Silts). The underlying outwash deposits were deposited by glacial meltwater streams along the south- and southwest-flowing Silver Creek and Kaskaskia River valleys, as the waning Illinois Episode ice margin receded to the northeast.

Two younger terraces, of last glacial age (Wisconsin Episode), are found in the central and southern portions of the map and contain lake sediment related to slackwater conditions in the Silver Creek and Kaskaskia River valleys. The older of these two terraces, the upper terrace, is the most extensive and was likely formed during the peak of the Wisconsin Episode when Mississippi River sediment aggradation was also its maximum, causing slackwater conditions far up the low-gradient Kaskaskia River valley. Since this older terrace is typically covered by 3 feet of Peoria Silt, incision of the terrace occurred prior to late glacial times (likely prior to 15,000 radiocarbon years). Deposits in this terrace predominantly consist of faintly to prominently stratified silt loam and silty clay loam with minor beds of fine sand. Such deposits in the upper terrace, much of which appears to be reworked and redeposited loess material, are mapped as Equality Formation (unit e-2). Portions of this unit, where relatively thick and unweathered, may be calcareous and even fossiliferous. At one exposure along the Kaskaskia River (no. 30275; Sec. 22, T1S, R6W), small (<5 mm) fossil gastropods were found in calcareous deposits of unit e-2, immediately below unit e-1. The gastropods were mainly aquatic and indicative of shallow water conditions. At some locations (including 30275), lower portions of unit e-2 have a slight reddish brown cast and are leached and slightly more clayey—all likely a result of redeposition of the Roxana Silt during the mid-Wisconsin Episode. Where present, this zone typically grades into the Berry Clay Member of the Pearl Formation below.

Deposits of the Equality Formation in the younger and lower terrace are generally more clay-rich, ranging from silty clay loam to silty clay, and have faint to prominent stratification. Such deposits, mapped as unit e-1, have been found to be leached of carbonates and are generally more brown in color than the more tan or gray unit e-2. The younger terrace also has a much thinner loess cover (<1 foot), which was the one basis for the separation of soil series by soil mappers (Wallace 1978; Natural Resources Conservation Service 1999). The age of the e-1 terrace may be similar to that of the sandy Savanna Terrace in northwest Illinois and the Wood River Terrace in the Mississippi Valley east of St. Louis, both of which have a thin (<1 foot) loess cover. The Wood River Terrace underwent its last phase of aggradation between 15,500 and 13,000 radiocarbon years before present (RCYBP) and was incised ~12,300 to 12,000 RCYBP when the Mississippi River downcut its valley (Hajic 1993).

Postglacial stream deposits in Silver Creek, Rayhill Slough, Reinhardt Slough, and other tributary valleys are mainly fine grained (silty clay loam to silt loam) and weakly stratified. These deposits, mapped as Cahokia Formation, can include loamy zones or beds of fine sand, particularly at the unit base or in channels. The Cahokia Formation in these valleys is <20 feet thick and consists mainly of reworked loess and lake deposits from surrounding areas. The fine-grained nature of these deposits can be explained by the rare occurrence of sand, gravel, or till exposures in the creek drainage area. Due to periodic flooding during postglacial times, areas mapped as the Cahokia Formation have relatively youthful modern soil profiles that generally lack B horizons compared with profiles for upland soil (Wallace 1978, Natural Resources Conservation Service 1999).

Kaskaskia River Valley

Near-surface deposits in the postglacial Kaskaskia River valley consist of interstratified fine to medium sand, silt loam, silty clay loam, and silty clay. Sandy deposits (up to 20 feet thick) in channels and point bars of the Kaskaskia River are mapped Cahokia–sandy facies (c(s)); sandy deposits range from recent and historical in modern point bars to possibly early to mid Holocene (last 10,000 years) at higher elevations. The clayey facies of the Cahokia Formation is separated into two units: older deposits generally on low terraces above 390 feet (unit c(c)-2) and younger deposits at lower elevations on the modern floodplain (unit c(c)-1). Both deposits range from silt loam to silty clay loam to silty clay and are interpreted mainly as overbank flood deposits and swale fills. Deposits of c(c)-2 are relatively thin (generally <10 feet) and overlie Wisconsin Episode glacial deposits of the Equality or Henry Formation. Aerial photographs display overflow channels crossing to the south-southwest across Sections 4 and 9 (T2S, R6W) in low areas. These features probably represent high flood events (or chutes) during the Holocene that deposited c(c)-2. Both c(c)-2 and c(c)-1 are interstratified laterally with sandy deposits of c(s). Aerial photographs portray many abandoned meander channels within the modern floodplain, all now infilled with clayey sediment (c(c)-1). Exposures along the Kaskaskia River generally display well-sorted, fine- to medium-grained sand below 8 to 15 feet of clayey floodplain deposits. At one exposure (no. 30274; Sec. 5, T2S, R6W), fossil wood in a gray silt at the base of the clayey Cahokia (at river level ~15 foot depth below top of bank) was radiocarbon dated at 6,020 ±100 years (ISGS-5875).

Fine- to medium-grained sand immediately below the Cahokia and/or Equality Formations is interpreted as Henry Formation deposits, although the exact age of these deposits is unknown. Some of the areas mapped as Henry Formation may include sandy Cahokia Formation in upper portions or Pearl Formation near its base, as the distinction among these alluvial units can be subtle and difficult to interpret. The Pearl Formation tends to be somewhat coarser and contains more gravel than the Henry Formation in the Kaskaskia Valley area (probably due to closer proximity to ice margin). Cahokia Formation sand is generally fine to medium in texture and tends to be noncalcareous, whereas sand in the Henry Formation is generally calcareous and may be intermixed

with thin calcareous beds of silt loam (intercalated with Equality Formation). The Illinois Episode Pearl Formation and pre-Illinois Episode deposits occur in many places in the subsurface below last glacial and postglacial river deposits. Thus, the Kaskaskia River valley contains a complex record of fluvial and glacial deposits from perhaps the past 500,000 years, all overlying Paleozoic bedrock.

Concealed Deposits

In much of the map area, pre-Illinois Episode deposits (classified as the Banner Formation) are preserved between the overlying Glasford Formation and the bedrock below (see cross sections). The Banner Formation is here divided into two units: (1) an olive-brown to greenish gray, weakly laminated silty clay with some beds of fine sand (Canteen member (b-c); lower unit); (2) a silty clay loam to loam diamicton with sand and gravel bodies (Banner Formation (b); undifferentiated). The Banner Formation, which does not crop out or seem to occur within 30 feet of the surface, is present mainly in preglacial bedrock valleys or lowlands (fig. 2 and cross sections). In places, the Banner Formation has been severely eroded by Illinois Episode glaciers or glacial meltwater streams (during deposition of Glasford or Pearl Formation), and its distribution is sporadic. The Banner Formation has been entirely eroded from some of the bedrock topographic highs in the western portion of the quadrangle.

The Canteen member of the Banner Formation was found in one stratigraphic test boring (no. 30329, cross section D–D′) and recognized in several well-described water-well logs (e.g., nos. 27078 and 27026) where it occurs below Banner till. The Canteen member tends to infill local bedrock lowlands (fig. 2) or regional preglacial valleys (Phillips and Grimley 2004). This unit includes mainly fine-grained sediment, but can include thick beds of fine sand. In its uppermost 5 feet, the Canteen member in some places exhibits weak to moderate soil structure, typical of a buried floodplain soil. In some places, multiple alluvial paleosols are observed within the unit. The origin of this unit is interpreted as being mainly preglacial Quaternary alluvium and colluvium because it lacks glacial erratics, has low magnetic susceptibility, and is noncalcareous to weakly calcareous (table 1). Its composition is thus quite similar to the local shale bedrock. Nonetheless, the Canteen member may in places include slackwater lake deposits or redeposited loess related to early Quaternary glaciations. The Canteen member here occurs almost exclusively between elevations of 290 and 350 feet asl.

The undifferentiated Banner Formation is interpreted mainly as till, ice-marginal sediment, and outwash. In comparison to Glasford till, the Banner till is slightly more clayey and has slightly greater water content on average (table 1). Banner till also typically has a lower carbonate content and slightly greater natural gamma radiation (table 1). In some cores, such as 30329 in the northeast part of the quadrangle, the upper few feet of Banner till is slightly pink; it has higher carbonate content and much higher magnetic susceptibility, suggesting a more distal source area (perhaps far-travelled debris worked up to the top of glacial ice). Bodies of sand and gravel included within the Banner Formation can be up to 30 feet thick and occur at the unit base, some of which could include preglacial (early-mid Quaternary) alluvium.

Interglacial soil development (Yarmouth Geosol) or gleyed interglacial accretionary deposits in the uppermost Banner Formation, by definition, help to distinguish the Banner from the Glasford Formation (Willman and Frye 1970). Such interglacial deposits and/or soils are generally leached of carbonates and often have a greenish gray color (as described in water-well logs) due to their typical poorly drained condition in areas where they have been preserved below the basal unconformity of the Glasford Formation. The Yarmouth Geosol has been severely truncated in stratigraphic test holes (e.g., nos. 30329 and 30333), but inclusions of the paleosol were found in the overlying Glasford Formation. The Yarmouth Geosol was also detected in subsurface borings (e.g., no. 27078, cross sections B–B′ and D–D′).

Economic Resources

Sand and Gravel

Potentially minable deposits in the quadrangle include various textures of sand, with some gravel, that are mapped as ice-contact deposits (Hagarstown Member, Pearl Formation) or outwash (Pearl Formation), both blanketed by 5 to 15 feet of loess. Sand and gravel was once mined at a small pit in southwestern Mascoutah Quadrangle (Sec. 34, T1S, R7W), where approximately 50 feet of sand (relatively fine-grained) of the Hagarstown Member was encountered according to undocumented local reports. Other portions of these ice-contact ridges may contain economically usable deposits; however, in many places, the sand is relatively fine grained, limited in thickness, poorly sorted, intermixed with diamicton, and/or unpredictable in extent. In other areas, up to 110 feet of sand (fine to coarse sand with gravel) is present, but such areas may be limited in extent. Additional boreholes or geophysical tests will be necessary for site-specific projects.

Groundwater

Groundwater is extensively used for household, public, and industrial water supplies in southwestern Illinois. Surface water resources such as the Kaskaskia River are also present in this quadrangle. Saturated sand and gravel in the Henry Formation, Pearl Formation (outwash facies and Hagarstown Member), Glasford Formation, and Banner Formation constitute the predominant glacial aquifer materials in the quadrangle. Known sand and gravel lenses are stippled in the cross sections. Static water levels, reported by drillers for some water-well and engineering borings, are denoted by triangles on the cross sections. These reported water levels are typically 10 to 30 feet below terraces and lowlands in the eastern half of the map but are significantly deeper (>80 feet) in higher relief ridges with unconfined sand (e.g., nos. 29977 and 30332; cross section B–B′). Aquifer material in

the Pearl Formation (outwash facies) in the eastern portion of the map area is particularly extensive and is widely used for household water supply. In upland areas, saturated sand and gravel bodies within the Glasford Formation or Hagarstown Member are sometimes utilized for household water supply (some of which are large-diamteter wells). Sand and gravel bodies in the lower Banner Formation are sometimes utilized, particularly above the ancestral Kaskaskia Bedrock Valley in central and eastern areas of the quadrangle. Bedrock aquifers are also commonly utilized for water supply, particularly Pennsylvanian sandstones or fractured limestones.

The water-yielding intervals reported by drillers are blue shaded vertically along wells on the cross sections. Additional information on measurement dates are available from the ISGS Geological Records Unit or Web site (http://www.isgs.illinois.edu/maps-data-pub/wwdb/wwdb.shtml).

Environmental Hazards

Groundwater Contamination

Surface contaminants pose a potential threat to groundwater supplies in near-surface aquifers that are not overlain by a protective confining (clay-rich and unfractured) deposit such as till or lake sediment (Berg 2001). Groundwater in near-surface sand and gravel units (e.g., the Hagarstown Member) is most vulnerable to agricultural, household, or industrial contaminants. The potential for groundwater contamination depends on the thickness and character of fine-grained alluvium, loess, or till deposits that overlie an aquifer. Deeply buried glacial aquifers near the base of the Glasford Formation or within the Banner Formation generally have a lower contamination potential than do more shallow aquifers if the groundwater is protected by a considerable thickness of unfractured, clay-rich till. Aquifer material in the Pearl Formation (outwash facies), covering much of the eastern portion of the quadrangle, is moderately protected by 20 to 30 feet (combined) of mainly fine-grained loess, Berry Clay Member and/or Equality Formation.

Subsidence over Mined-Out Areas

Approximately 10% of the area was mined underground for coal between 1882 and 1989 (Chenoweth and Barrett 2001). Underground mined-out areas are located predominantly in the northwestern portion of the quadrangle (north of surface mines) and immediately east of Mascoutah. Coal, 6 to 9 feet thick, was mined from the Herrin Coal Member of the Carbondale Formation and was extracted by the room-and-pillar method at depths of 90 to 185 feet below the ground surface. Land subsidence in mined-out areas can be a serious potential problem for developers and construction projects (Treworgy and Hindman 1991, Bauer 2006).

Seismic Hazards

Near-surface fine sands in the Pearl, Henry, and Cahokia Formations are potentially liquefiable where materials are saturated (below the water table) and subject to strong ground shaking. Tuttle (2005) identified paleoliquefaction features, such as ancient sand blows, in outcrops along the Kaskaskia River south and east of the Mascoutah Quadrangle and at other locations in the region. These features likely formed during past earthquake activity in the New Madrid Seismic Zone or other seismic activity in southern Illinois or southeastern Missouri. Seismic shaking hazards are also an important issue in areas of loose sand, disturbed ground (fill), and soft clay in Illinois (Bauer 1999). Areas mapped with near-surface Equality Formation or especially Cahokia Formation sand and clay can be susceptible to seismic shaking because they are relatively soft and unconsolidated and have low density. Both of these conditions amplify earthquake ground motions.

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