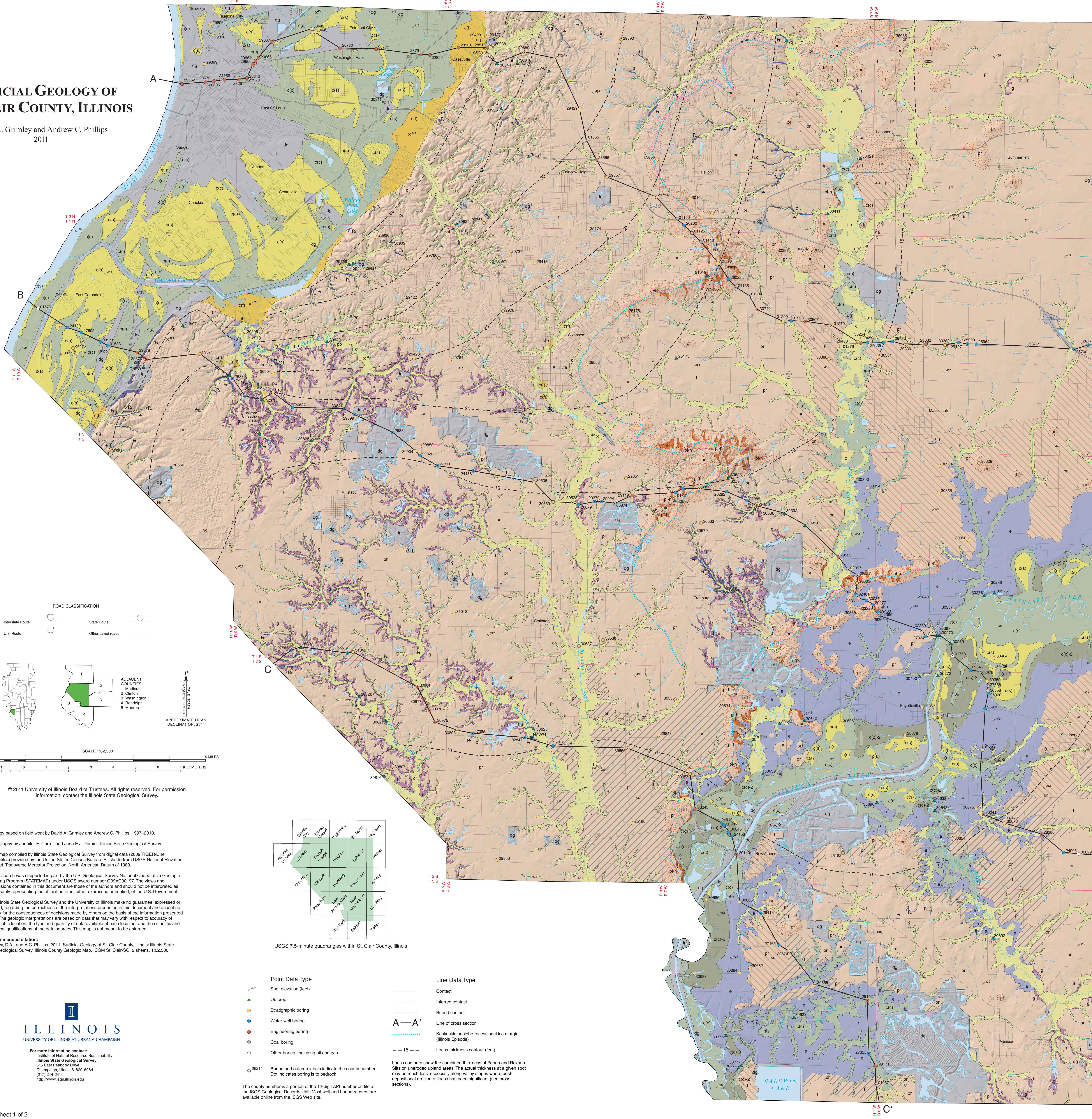
Institute of Natural Resource Sustainability
William W. Shilts, Executive Director
**ILLINOIS STATE GEOLOGICAL SURVEY**
E. Donald McKay III, Director



# SURFICIAL GEOLOGY OF ST. CLAIR COUNTY, ILLINOIS

David A. Grimley and Andrew C. Phillips
2011




ROAD CLASSIFICATION

Interstate Route — State Route
U.S. Route — Other paved roads



SCALE 1:62,500

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 6 7 KILOMETERS



Geology based on field work by David A. Grimley and Andrew C. Phillips, 1997–2010.

Cartography by Jennifer E. Carrell and Jane E.J. Domier, Illinois State Geological Survey.

Base map compiled by Illinois State Geological Survey from digital data (2009 TIGER/Line Shapefiles) provided by the United States Census Bureau. Hillshade from USGS National Elevation Dataset. Transverse Mercator Projection. North American Datum of 1983.

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USGS 7.5-minute quadrangles within St. Clair County, Illinois

## Point Data Type

| | |
|---|---|
| × 422 | Spot elevation (feet) |
| ▲ | Outcrop |
| ● | Stratigraphic boring |
| ● | Water well boring |
| ● | Engineering boring |
| ● | Coal boring |
| ○ | Other boring, including oil and gas |
| ⊙ 26211 | Boring and outcrop labels indicate the county number. Dot indicates boring is to bedrock |

The county number is a portion of the 12-digit API number on file at the ISGS Geological Records Unit. Most well and boring records are available online from the ISGS Web site.

## Line Data Type

| | |
|---|---|
| —— | Contact |
| – – – – – | Inferred contact |
| ........ | Buried contact |
| A—A′ | Line of cross section |
| ••••••••• | Kaskaskia sublobe recessional ice margin (Illinois Episode) |
| – – 15 – – | Loess thickness contour (feet) |

Loess contours show the combined thickness of Peoria and Roxana Silts on uneroded upland areas. The actual thickness at a given spot may be much less, especially along valley slopes where post-depositional erosion of loess has been significant (see cross sections).

## QUATERNARY DEPOSITS

| Description | Unit | Interpretation |
|---|---|---|
| HUDSON EPISODE (~12,000 years before present (B.P.) to today)[1] | | |
| **Fill or removed earth;** various sediment types; generally, but not exclusively, fine-grained deposits; up to 50 feet thick; excavations up to hundreds of feet deep | Disturbed ground<br>dg | **Man-made fill or excavations;** includes former strip mines for coal, levee fills, dredged channel fill (Kaskaskia River valley), urban rubble; quarries, interstate interchanges, and road fill |
| **Mainly silt, silty clay, and fine sand;** weakly to well stratified; includes some coarser beds, especially in basal portions; mainly noncalcareous; up to 30 feet thick | Cahokia Formation (undivided)<br>c | **Alluvium (stream deposits);** mapped in floodplains of small to medium-sized tributary valleys; not mapped in Mississippi and Kaskaskia valleys |
| **Silt loam with thin fine sand beds;** weakly stratified; noncalcareous; up to 25 feet thick | Cahokia Formation (fan facies)<br>c(f) | **Alluvial fan deposits;** mainly derived from resedimentation of thick, erodible loess deposits on east side of Mississippi River valley |
| **Silty clay loam, silty clay, and silty loam;** massive to stratified; some fine sand lenses; soft and saturated; noncalcareous; up to 60 feet thick in Mississippi River valley | Cahokia Formation (clayey facies)<br>c(c) | **Overbank alluvium, abandoned channel and swale fills;** mapped in Mississippi and Kaskaskia valley floodplains and in valleys tributary to the Kaskaskia |
| **Very fine, fine, and medium sand;** capped by up to 5 feet of silt and clay; crudely to well stratified; moderately to well sorted; noncalcareous; up to 35 feet thick | Cahokia Formation (sandy facies)<br>c(s) | **Alluvium;** point bar, natural levee, and channel deposits; mapped only in Mississippi and Kaskaskia valley floodplains |
| **Silty clay loam to silt loam;** massive to weakly stratified; noncalcareous; soft; up to 20 feet thick | Cahokia Formation (clayey facies–high level)<br>c(c)-2 | **Overbank alluvium;** within early to middle Holocene terrace at ~395 feet asl; mapped only in Kaskaskia River valley and adjacent tributaries |
| WISCONSIN EPISODE (~60,000–12,000 years B.P.)[1] | | |
| **Silt loam to silty clay loam with some fine sand;** massive to laminated; leached to calcareous; may contain mollusk shells (<1 cm) or conifer wood fragments; up to 50 feet thick | Equality Formation<br>e | **Lacustrine deposits;** large area of deposits in glacial Lake Kaskaskia; slackwater origin during high levels of Mississippi River aggradation; in terraces at 410 to 425 feet asl in Kaskaskia River valley |
| **Fine, medium, and coarse sand;** stratified; generally coarsens with depth; some basal gravelly zones in Mississippi River valley, mainly fine to medium sand in Kaskaskia River valley; leached to calcareous; up to 70 feet thick | Henry Formation (cross sections only)<br>h | **Outwash (glacial meltwater deposits);** extensive in subsurface in the Mississippi River valley, localized deposits in the Kaskaskia River valley |
| **Silt loam;** massive; upper 3/5 of unit is typically more tan or gray (Peoria Silt); lower portion has pinkish hue (Roxana Silt); leached to dolomitic; thickness contours shown on map | Peoria and Roxana Silts<br>pr | **Loess (windblown silt);** blankets all uplands; thins eastward from Mississippi River valley bluffs; thickest adjacent to broad portion of valley |
| ILLINOIS AND SANGAMON EPISODES (~150,000–60,000 years B.P.) | | |
| **Silty clay to silt loam to clay loam;** may contain fine sandy or loamy beds; mottling or iron oxide staining in upper portion; leached to calcareous; faintly stratified to rhythmically laminated locally; up to 20 feet thick | Berry Clay Member and/or Teneriffe Silt<br>bct<br>(beneath >5 feet loess) | **Accretionary deposits, alluvium, lake deposits, and loess;** upper portions contain strong pedogenic alteration of the Sangamon Geosol (interglacial); diagonal line pattern shown for subsurface occurrences of late Illinois Episode lake or stream deposits (mainly Teneriffe Silt) below loess cover and where Pearl Formation is not present |
| ILLINOIS EPISODE (~190,000–130,000 years B.P.) | | |
| **Sand with some gravel;** stratified; may include silty or clayey zones, especially near surface; leached to calcareous; up to 55 feet thick | Pearl Formation (Mascoutah facies)<br>pl(m)<br>(where buried by loess in terraces) | **Outwash;** common in loess-covered terraces along Silver Creek and along Kaskaskia River valley; below Cahokia Formation or in terraces ~430 to 440 feet asl; may contain Sangamon Geosol in upper portions |
| **Mixture of loam, fine to coarse sand, fine gravel, silt loam, and diamicton (mixed facies);** locally comprising thick sand and gravel with few fine interbeds (sandy facies); poorly to well-sorted sands; weakly stratified; may be fractured or faulted by glacial tectonics; may contain inclusions of older sediment; leached to calcareous; up to 120 feet thick | Hagarstown Member, Pearl Formation<br>pl-h<br>(mixed facies where buried by >5' loess)<br>(sandy facies where buried by >5 feet loess) | **Ice-contact sediments;** in ice-marginal areas, kames, or ice-walled channels; includes debris flows interspersed with subglacial or supraglacial outwash; locally includes ice-dammed lacustrine deposits and glaciotectonically faulted or deformed beds; stippled areas distinguish mainly sandy facies (ice-walled channels, fans) from mixed facies (moraines, kames, other); contains Sangamon Geosol in upper 5 to 10 feet |
| **Pebbly loam diamicton (mixture of clay, silt, sand, and gravel);** generally massive; includes some sand and gravel lenses up to 10 feet thick; leached and weathered in upper part (Sangamon Geosol); calcareous and very stiff in lower part; up to 90 feet thick | Glasford Formation (<5 feet of loess cover)<br>g<br>(morainic areas beneath >5 feet loess) | **Till and ice-marginal deposits;** includes subglacial and supraglacial deposits; contains Sangamon Geosol alteration in upper 5 to 10 feet; morainic areas stippled on map may contain sheared inclusions of older paleosol, sediments, or bedrock in the till |
| **Fine sand to gravelly sand;** up to 20% gravel; yellowish brown to grayish brown; stratified; loose; well sorted; calcareous; up to 50 feet thick | Grigg tongue, Pearl Formation (cross sections only)<br>pl-g | **Outwash;** proglacial deposits from advancing Illinois Episode glaciers, subsequently buried by Glasford Formation diamicton |
| **Silt loam to silty clay loam;** massive to weakly stratified; calcareous to leached; locally may contain conifer wood and small terrestrial or freshwater mollusk shells (<1 cm); up to 90 feet thick | Petersburg Silt<br>pb | **Lacustrine sediment or loess;** mainly slackwater lake deposits caused by aggradation in the Mississippi River valley or ice-marginal proglacial lakes caused by glacial ice blockage; loess occurs in western uplands and typically <10 feet thick |
| YARMOUTH EPISODE (~420,000–190,000 years B.P.) | | |
| **Silty clay loam to silty clay to clay loam;** yellowish brown to pale olive; can contain strong soil structure with clay skins, iron and manganese oxide staining; few pebbles; may be faintly stratified; leached; stiff to very stiff; up to 15 feet thick | Lierle Clay Member, Banner Formation (cross sections only)<br>b-l | **Accretionary deposits, alluvium, and lake sediment;** accumulated in closed depressions or lowlands; deposited and strongly weathered during the Yarmouth interglacial episode |
| PRE-ILLINOIS EPISODE (~700,000–420,000 years B.P.) | | |
| **Pebbly silty clay loam diamicton;** generally massive; may include sand and gravel lenses or zones of stratified fine-grained deposits; leached to calcareous; stiff; up to 70 feet thick | Banner Formation, (undivided) (cross sections only)<br>b | **Till and ice-marginal deposits;** includes subglacial till and supraglacial debris flows; may include lake sediment or glaciofluvial sediment; includes Yarmouth Geosol alteration in upper part but commonly truncated in the east |
| **Silt loam, silty clay loam, and sandy loam**; laminated to bedded; may contain conifer wood fragments and small terrestrial or freshwater aquatic mollusk shells (<1 cm); calcareous; up to 30 feet thick | Harkness Silt Member, Banner Formation (cross sections only)<br>b-h | **Lacustrine deposits with deltaic and alluvial zones;** deposited in slackwater lakes resulting from pre-Illinois Episode glacial aggradation in the Mississippi River valley; typically found below 370 feet asl in bedrock valleys; alluvial and deltaic materials deposited during periods of lower lake levels |
| **Silty clay loam, silty clay, silt loam, and sandy loam;** weakly stratified; may contain some fine sand beds; noncalcareous to weakly calcareous; soft to stiff; may contain subangular platy pebbles of local origin; up to 35 feet thick | Canteen member, Banner Formation (cross sections only)<br>b-c | **Preglacial alluvium and colluvium;** occurs mainly in preglacial bedrock valleys generally below 350 feet asl; matrix mineral composition and pebble lithology reflect local bedrock |

## TERTIARY AND EARLY QUATERNARY DEPOSITS

| Description | Unit | Interpretation |
|---|---|---|
| **Clay, cherty clay, silty clay, and silty clay loam;** pebbles primarily of local angular sedimentary bedrock; rare erratics | Oak formation (cross sections only)<br>To | **Residuum (bedrock weathered in situ) or paleosol complex;** may include some Quaternary loess, dust, and perhaps thin till deposits that are highly weathered and indistinguishable from the residuum |

## PALEOZOIC BEDROCK

| Description | Unit | Interpretation |
|---|---|---|
| **Shale, siltstone, limestone, and sandstone;** less common beds of coal and underclay; laminated, bedded or massive; up to 150-feet-thick exposures of limestone in bluffs east of Dupo; upper portion may be more weathered; rocks may contain marine or terrestrial fossils | Pennsylvanian or Mississippian bedrock<br>Pz | **Bedrock outcrops or bedrock within 5 feet of land surface;** most common in western areas of the county and localized along courses of east-flowing tributaries to Silver Creek; includes Pennsylvanian and Mississippian rock |

[1]The time periods for the Wisconsin Episode and the Hudson Episode are reported as calibrated radiocarbon years and can be directly compared to calendar years before 1950 (Stuiver et al. 2005).

## Introduction

This surficial geology map of St. Clair County, Illinois (1:62,500 scale), is a compilation of portions of 17 1:24,000-scale quadrangle maps funded by the STATEMAP component of the National Cooperative Geologic Mapping Program and the ISGS between 1997 and 2010 (Barnhardt et al. 1999; Grimley 1998, 2009, 2010; Grimley and McKay 2004; Grimley et al., 2007; Grimley and Webb 2009, 2010; Phillips 1999, 2004a, 2004b, 2005, 2007, 2008, 2010; Phillips and Aper 2006; Phillips et al. 2000). The 1:24,000 maps are available from the ISGS in three map series: IGQ (substantial review), IPGM (moderate review), and STATEMAP contract deliverables (limited review, only available from the ISGS Web site). St. Clair County is located in southwestern Illinois (fig. 1), immediately east of St. Louis, Missouri, and includes such towns as East St. Louis, O'Fallon, Belleville, Mascoutah, New Athens, and Millstadt (fig. 2). Southwestern Illinois was glaciated twice during the middle Pleistocene (pre-Illinois and Illinois Episodes), but during the last glaciation (Wisconsin Episode), glaciers did not advance beyond central Illinois (fig. 1). A prominent, but discontinuous, recessional morainic system of the Illinois Episode glaciation occurs in eastern St. Clair County and is demarcated by a blue dotted line on the 1:62,500 surficial map (sheet 1) and by a whitish line on figures 1 and 2.

## Methods

Previously completed 1:24,000-scale surficial geology maps were compiled and digitally merged with new surficial maps in the remaining portions of the county. Where recent work has improved our geologic understanding (such as recognition of a recessional morainic system), modifications were made to the previous quadrangle maps. Data inputs used include outcrop studies, soil reports (Natural Resources Conservation Service 2006), geophysical studies, and descriptions of samples from numerous stratigraphic, engineering, coal, oil, and water-well borehole records archived at the ISGS Geologic Records Unit. Hundreds of outcrops and thousands of borehole records were examined over the past decade. The most useful of these data for constructing the surficial map are shown in figure 3. Data point locations in figure 3 were verified when possible and are generally horizontally accurate to within a few hundred feet. Due to cartographic considerations, only a limited data set, consisting of data points along cross section lines and key stratigraphic borings and outcrops, are shown on the surficial geology map. The cross sections were constructed by tiling previously made 1:24,000 cross sections, adding newly available data, and modifying contacts based on current interpretations of the geologic succession. Original descriptions of map units, cross sections, and other supplementary data are also available within individual quadrangle map publications. The methods for construction of drift thickness and bedrock topography maps (figs. 4 and 5) are similar to that outlined in Grimley and Webb (2010).

## Surficial Geology

The surficial geology of St. Clair County varies widely from thick alluvium (>100 feet) in the broad Mississippi River and Kaskaskia River valleys, to thin glacial sediment (typically <25 feet) over karstic Mississippian bedrock in southwestern uplands, to thick loess (up to 90 feet) immediately east of the broad Mississippi River River valley, to ice-contact deposits (up to 150 feet thick) in a train of ridges between the Richland Creek and Kaskaskia River valleys (sheet 1 and fig. 2). St. Clair County was overrun by continental glaciers twice during the middle Pleistocene; first, during a pre-Illinois Episode glaciation (~700,000 to 420,000 years ago) and second, during the Illinois Episode glaciation (~180,000 to 130,000 years ago). During both glacial episodes, glaciers generally advanced from the northeast; Illinois Episode ice more specifically originated from the Lake Michigan Basin (Willman and Frye 1970, McKay 1979, Grimley et al. 2001). During the last glaciation, the Wisconsin Episode (~60,000 to 12,000 calendar years ago), glacial ice reached northeastern Illinois (fig. 1), northern Iowa, Wisconsin, and Minnesota, but not as far as southern Illinois (Hansel and Johnson 1996). However, the effects of this glaciation were felt throughout the St. Louis metropolitan area: glacial meltwater deposited outwash in the Mississippi and Kaskaskia River valleys (Grimley et al. 2007), a large slackwater lake formed in the Kaskaskia River valley (Phillips 2008, Grimley and Webb 2009), and thick loess was deposited on all upland areas (McKay 1979, Grimley and McKay 2004). Postglacial deposits occur in modern valleys, most prominently in the formerly active high-sinuosity meander belts of the Mississippi and Kaskaskia River valleys. Channelization, straightening, and confinement by levees of these rivers and of some smaller creeks has altered the natural depositional regimes during the past century and a half.

Mississippian limestone is extensively exposed in stream valleys on the flanks of the Waterloo-Dupo Anticline (Nelson 1995), especially near and along the Mississippi bluffs in the western uplands. Karst topography is present in these areas where limestone occurs within about 30 feet of land surface (fig. 2). Exposures of Mississippian and Pennsylvanian bedrock are also common along Prairie du Pont Creek, West Fork Richland Creek, and Prairie du Long Creek valleys. Bedrock outcrops are less prevalent in the northern and eastern part of the county. Limited Pennsylvanian bedrock exposures occur where creeks have incised into bedrock topographic highs, particularly on the west side of Silver Creek valley. The bedrock topography (fig. 4) contains north-south and northwest-southeast–trending valleys in the eastern portion of county that probably developed as preglacial cuestas, with more erodible shales underlying lowlands and more resistant sandstone or limestones underlying highlands. The trend of these bedrock lowlands and ridges parallels the strike of Paleozoic rocks on the west side of the Illinois Basin, where bedrock dips gently to the east or northeast.

The pre-Illinois Episode Banner Formation (including the Canteen, Harkness Silt, and Lierle Clay Members) contains deposits of various origins that partially infill the preglacial bedrock valleys (see cross sections). Banner Formation deposits are generally absent from bedrock topographic highs due to nondeposition or erosion. The Canteen member, an informally classified unit based on subsurface drilling (Phillips 2004), includes preglacial Quaternary alluvium and colluvium preserved in deep buried bedrock valleys (fig. 6). Excluding the Canteen member, the bulk of the Banner Formation in St. Clair County was probably deposited during a single pre-Illinois glacial advance (till border based on available observations is shown in fig. 2). The presence of the Yarmouth Geosol, a widely recognized paleosol, in upper portions of the Banner Formation allows for differentiation of pre-Illinois Episode and Illinois Episode deposits.

During the maximum glaciation of the Illinois Episode, glaciers advanced to lower downtown St. Louis (Goodfield 1965), thus completely covering the pre-Illinois Episode deposits in St. Clair County and depositing diamicton and ice-marginal sediments, classified as the Glasford Formation. In some areas, the pre-Illinois Episode deposits were removed by glacial or glaciofluvial erosion. In other areas, fine-grained, crudely stratified and fossiliferous sediments classified as the Petersburg Silt were deposited in proglacial lakes that formed as a result of ice-blockage or slackwater conditions. The silts were buried and preserved below till deposits. Later, as glacial ice thinned and the ice margin retreated to a position in eastern St. Clair County, a recessional morainic margin developed in the central part of the county; this margin was perhaps part of a regional glacial sublobe in the Kaskaskia drainage basin (Grimley and Webb 2010). Thinner glacial ice would have allowed for greater influence of the local bedrock topography on glacial flow, resulting in small lobate forms, up to a few miles across, that protruded from the overall margin. In this model, glacial sedimentation would have been concentrated along concave portions of the ice margin, in reentrants between small sublobes where convergent ice flow would have concentrated direct glacial, glaciocolluvial (debris flows), and glaciofluvial sedimentation (subglacial and supraglacial stream outflow) in areas of locally stagnant ice. Thus, the most prominent glacial ridges today (i.e., Shiloh Ridge, Turkey Hill; fig. 2) were formed in these convex ice-marginal areas and comprise mixed facies of the Hagarstown Member, Pearl Formation. Divergent glacial ice in convex areas of the ice margin (small protruding lobes) was more sediment-starved and more typically morainal in character (ice more active), and tends to be composed mainly of fine-grained material with more limited sand bodies. These deposits are classified in the Glasford Formation. Overall, the somewhat discontinuous system of ridges in the central part of the county is interpreted as an Illinois Episode recessional ice margin (including both stagnant and active ice zones) along which till, debris flows, ice-contact glaciofluvial sediment, and outwash fans were deposited. Ogles Creek and Richland Creek appear to have developed as ice-marginal outwash channels on the west side of the morainic border (fig. 2). A proglacial lake (identified by deposits of lacustrine Teneriffe Silt) may have developed in the vicinity of lower Richland Creek valley due to ice blockage in the lower Kaskaskia River valley. During and following the stagnation and final melting of Illinois Episode glaciers in St. Clair County, proglacial outwash (Pearl Formation, Mascoutah facies) and lacustrine silt (Teneriffe Silt) were deposited, especially along Silver Creek and in the lower Kaskaskia drainage basin. The Berry Clay Member was deposited as accretionary sediment in depressions and lowlands during the subsequent interglacial period (Sangamon Episode, 130,000 to 60,000 years ago), a time when Sangamon Geosol weathering extended into the uppermost Illinois Episode deposits. The Berry Clay Member was weathered concurrently with its deposition.

During the last period of continental glaciation, the Wisconsin Episode, glacial ice did not reach the area, but glacial meltwater, emanating from glacier margins in the upper Midwest, deposited silt, sand, and gravel (outwash of the Henry Formation) in the Mississippi River valley and, to a lesser extent, in the Kaskaskia River valley. Silty waterlain deposits in the Mississippi River valley were repeatedly entrained by prevailing westerly winds into intense dust clouds. Subsequent settling of silt particles deposited a cover of loess (Peoria and Roxana Silts) up to 90 feet thick on the Mississippi bluffs and becoming thinner southeastward to ~7 feet thick on uplands adjacent to the Kaskaskia River valley (dashed contour lines on map). Concurrent with loess deposition on uplands and outwash deposition in major valleys, a large slackwater lake called glacial Lake Kaskaskia formed in the Kaskaskia drainage basin up to about 425 feet above sea level, probably the result of high aggradation of outwash sediment in the Mississippi River valley. Radiocarbon dating of fossil gastropod (snail) shells and conifer wood in the lake deposits (Equality Formation) preserved in terraces and valley fill sequences indicates that the lake was at its maximum extent between about 25,000 and 15,000 calendar years ago (Grimley and Webb 2009, Grimley and Webb 2010).

Postglacial deposits up to 60 feet thick include various alluvial facies of the Cahokia Formation. An early to mid-Holocene terrace (~395 feet asl) in the Kaskaskia River valley contains postglacial deposits (high-level clayey facies, c(c)-2), which may have resulted from slackwater conditions or extensive overbank flooding. Clayey and sandy facies of the Cahokia Formation were only differentiated in the large valley meander belts of the Mississippi and Kaskaskia River valleys, whereas undifferentiated, largely fine-grained alluvium was mapped in the tributary valleys. Alluvial fans (Cahokia Formation, fan facies) were mapped at the base of the eastern bluffs of the broad Mississippi River valley, where loess deposits were eroded and then redeposited on the valley edge. The Mississippi and Kaskaskia River valley regions were areas of extensive native American occupation during the postglacial period, continuing nearly to the historical period (Pauketat 2004). Significant areas of modern and ancient anthropogenic fill (disturbed ground) were mapped in disturbed urban lands (e.g., East St. Louis), landfills, man-made levees, former surface coal mines, limestone quarries, aggregate mines, and the many interstate interchanges.

## References


Barnhardt, M.L., J.A. Devera, and A.C. Phillips, 1999, Surficial geology of Millstadt Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, STATEMAP Millstadt-SG, 1:24,000.

Goodfield, A.G., 1965, Pleistocene and surficial geology of the city of St. Louis and the adjacent St. Louis County: University of Illinois at Urbana-Champaign, Ph.D. dissertation, 207 p.

Grimley, D.A., 1998, Surficial geology of O'Fallon Quadrangle, St. Clair County: Illinois State Geological Survey, STATEMAP O'Fallon-SG, 1:24,000.

Grimley, D.A., 2009, Surficial geology of Columbia Quadrangle, Monroe and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Columbia-SG, 2 sheets, 1:24,000.

Grimley, D.A., 2010, Surficial geology of Mascoutah Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Mascoutah-SG, revision, 2 sheets, 1:24,000; report, 9 p.

Grimley, D.A., and E.D. McKay III, 2004, Surficial geology of French Village Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ French Village-SG, 1:24,000.

Grimley, D.A., A.C. Phillips, L.R. Follmer, H. Wang, and R.S. Nelson, 2001, Quaternary and environmental geology of the St. Louis Metro East area, *in* David Malone, ed., Guidebook for Field Trip for the 35th Annual Meeting of the North-Central Section of the Geological Society of America: Illinois State Geological Survey, Guidebook 33, p. 21–73.

Grimley, D.A., A.C. Phillips, and S.W. Lepley, 2007, Surficial geology of Monks Mound Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Monks Mound-SG, 1:24,000.

Grimley, D.A., and N.D. Webb, 2009, Surficial geology of New Athens East Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ New Athens East-SG, 1:24,000; report, 12 p.

Grimley, D.A., and N.D. Webb, 2010, Surficial geology of Red Bud Quadrangle, Randolph, Monroe, and St. Clair Counties, Illinois: Illinois State Geological Survey, IGQ-Red Bud, 2 sheets, 1:24,000; report, 15 p.

Hansel, A.K., and W.H. Johnson, 1996, Wedron and Mason Groups: Lithostratigraphic reclassification of deposits of the Wisconsin Episode, Lake Michigan Lobe: Illinois State Geological Survey, Bulletin 104, 116 p.

McKay, E.D. III, 1979, Stratigraphy of Wisconsinan and older loesses in southwestern Illinois, *in* Geology of western Illinois, 43rd Annual Tri-State Geological Field Conference, Illinois State Geological Survey Guidebook 14, p. 37-67.

Nelson, W.J., 1995, Structural features in Illinois: Illinois State Geological Survey, Bulletin 100, 144 p.

Natural Resources Conservation Service, 2006, Soil Survey Geographic (SSURGO) database for St. Clair County, Illinois: U.S. Department of Agriculture, Natural Resources Conservation Service, www.soils.usda.gov/survey/geography/ssurgo/.

Pauketat, T.R., 2004, Ancient Cahokia and the Mississippians: Cambridge, United Kingdom, University Press, 236 p.

Phillips, A.C., 1999, Surficial geology of Cahokia Quadrangle, St. Clair County: Illinois State Geological Survey, STATEMAP Cahokia-SG, 1:24,000.

Phillips, A.C., 2004a, Surficial geology of Collinsville Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Collinsville-SG, 1:24,000.

Phillips, A.C., 2004b, Surficial geology of St. Jacob Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM St. Jacob-SG, 1:24,000.

Phillips, A.C., 2005, Surficial geology of Highland Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Highland-SG, 1:24,000.

Phillips, A.C. 2007, Surficial geology of Freeburg Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, STATEMAP Freeburg-SG, 1:24,000.

Phillips, A.C. 2008, Surficial geology of New Athens West Quadrangle, Monroe and St. Clair Counties, Illinois: Illinois State Geological Survey, STATEMAP New Athens West-SG, 1:24,000.

Phillips, A.C., 2010, Surficial geology of Paderborn Quadrangle, Monroe and St. Clair Counties, Illinois: Illinois State Geological Survey, IGQ-Paderborn, 2 sheets, 1:24,000; report, 7 p.

Phillips, A.C., and M.A. Aper, 2006, Surficial geology of Lebanon Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, STATEMAP Lebanon-SG, 1:24,000.

Phillips, A.C., D.A. Grimley, and S.W. Lepley, 2000, Surficial geology of Granite City Quadrangle: Illinois State Geological Survey, STATEMAP Granite City-SG, 1:24,000.

Stuiver, M., P.J. Reimer, and R.W. Reimer, 2005, CALIB 5.0. online program and documentation: http://radiocarbon.pa.qub.ac.uk/calib/.

Willman, H.B., and J.C. Frye, 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey, Bulletin 94, 204 p.


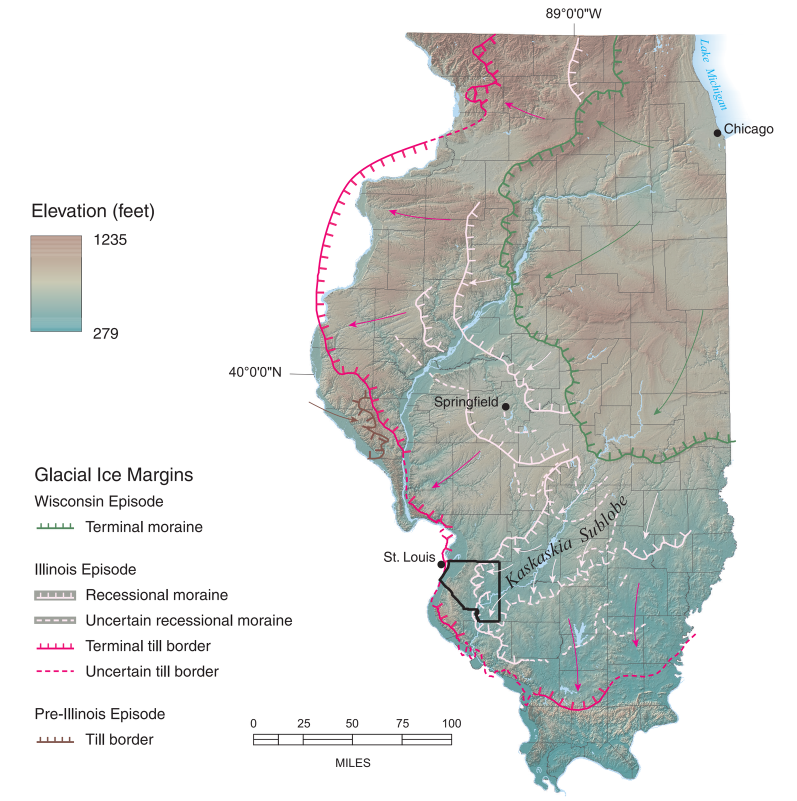


**Figure 1** Glacial ice margins in Illinois during the middle to late Pleistocene. St. Clair County is outlined in black. Arrows indicate approximate glacial ice flow directions

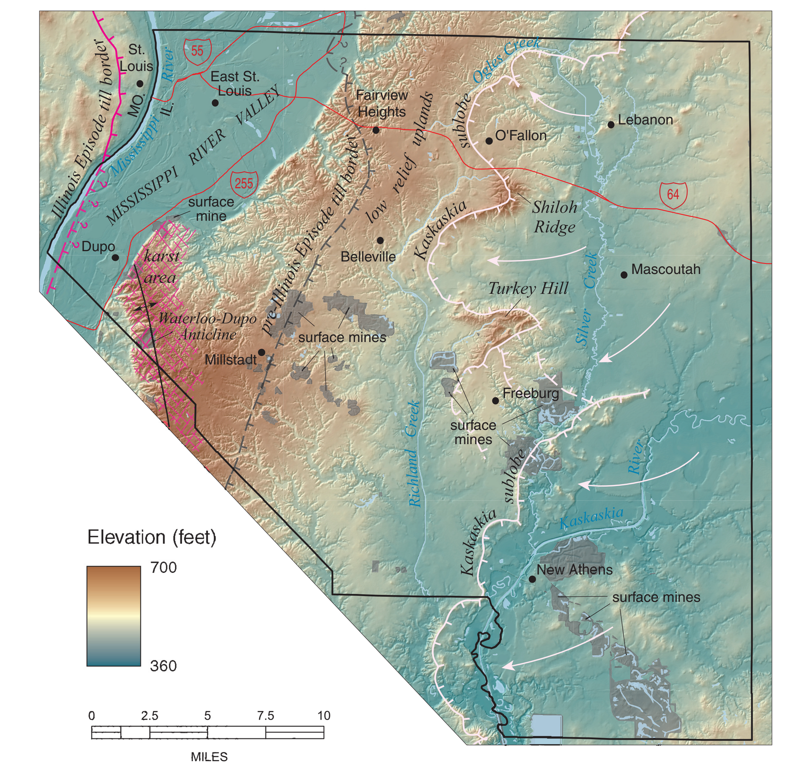


**Figure 2** Surface topography of St. Clair County. The land surface today in St. Clair County ranges from about 360 to 700 feet asl (above sea level), a total relief of 340 feet. The white line indicates a recessional ice margin in the Kaskaskia Basin during the Illinois Episode (shown as blue line on 1:62,500 surficial map).

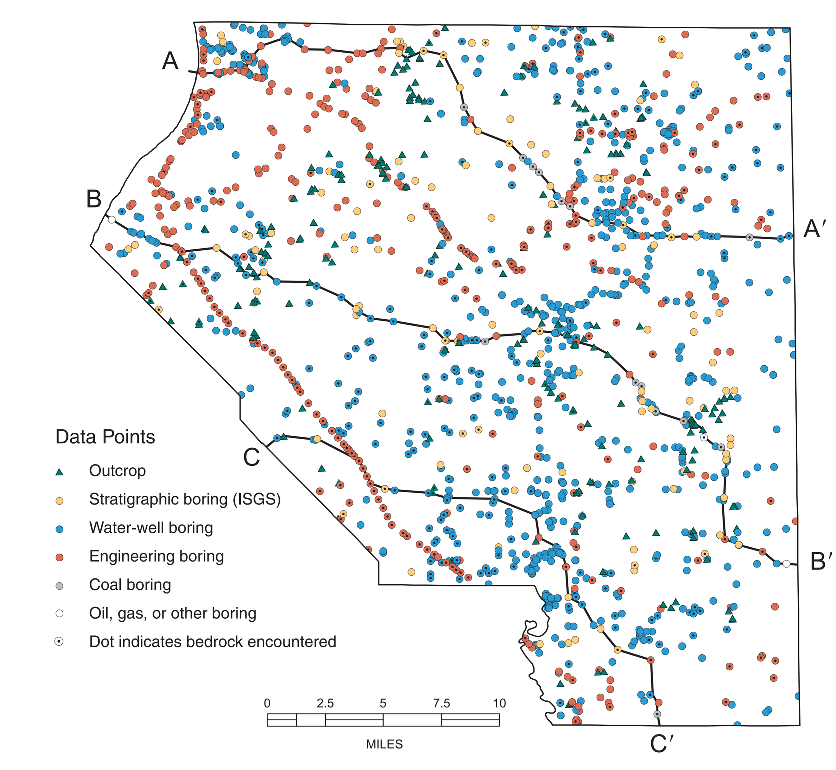


**Figure 3** Data point distribution map. Of the thousands of water wells, subsurface borings, and outcrop descriptions reviewed for this study, those shown here (n =1,569) were most useful in constructing the surficial geology map. Data were compiled from both ISGS geological records archives and from recent mapping for this study. Location and descriptive data quality vary considerably by data source. Data used for the bedrock topography and drift thickness maps (figs. 4 and 5) include all data to bedrock as well as additional borings not shown here. Digital data are available from the ISGS.

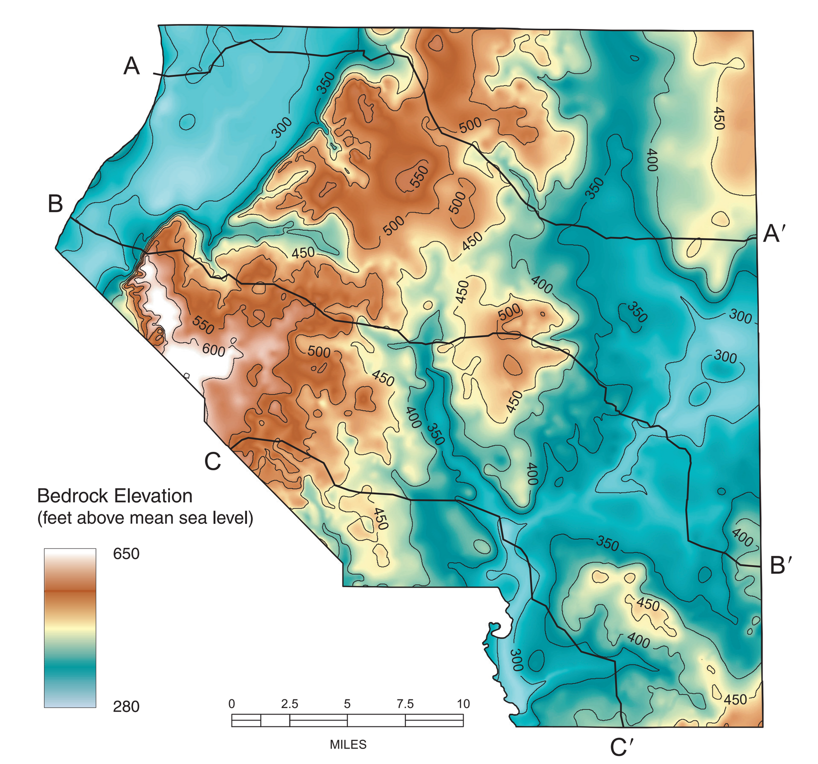


**Figure 4** Bedrock topography of St. Clair County. The elevation of the bedrock surface ranges from 280 to 300 feet asl in the Mississippi and Kaskaskia river valleys to 650 feet asl in bedrock uplands in the southwest part of the county. The total relief on the bedrock surface is ~370 feet.

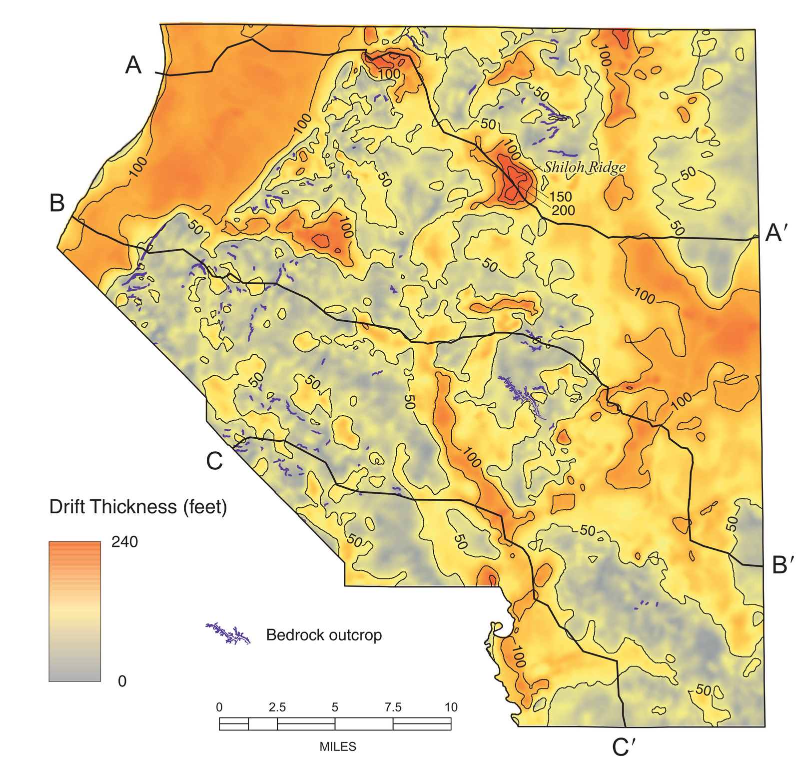


**Figure 5** Drift thickness (depth to bedrock) of St. Clair County. Unlithified Quaternary deposits (sediments above bedrock) typically range between 20 to 150 feet thick, but isolated areas have thicker drift. Glacial drift is ≥200 feet thick underneath Shiloh Ridge, an interlobate morainic ridge that overlies a preglacial valley in the north-central portion of the county.

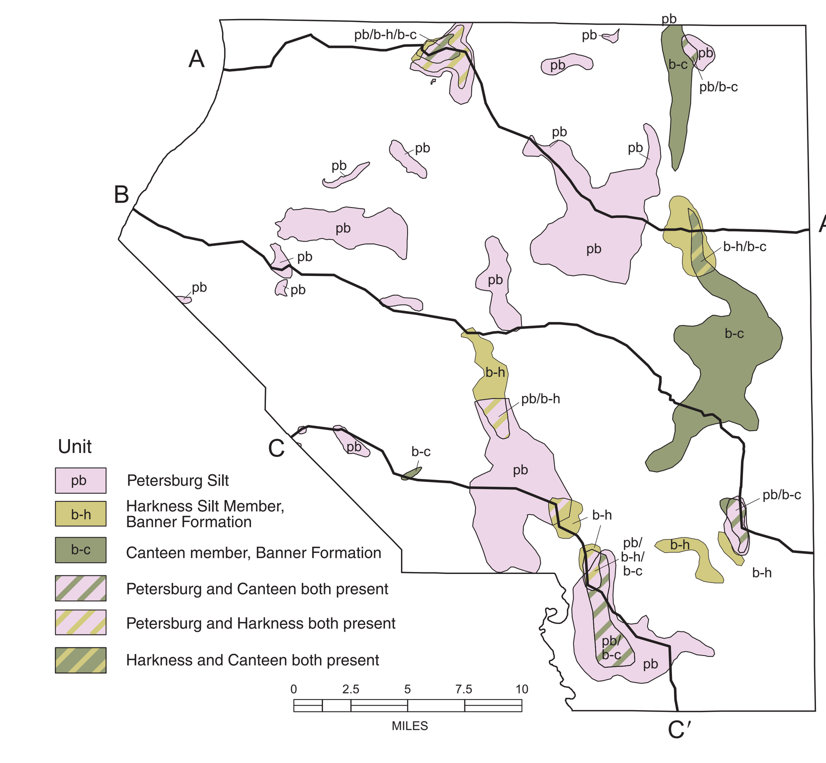


**Figure 6** Subsurface lacustrine and alluvial units of the Illinois and pre-Illinois episodes. This map shows the approximate subsurface distribution of the Illinois Episode Petersburg Silt (mainly lacustrine), as well as the pre-Illinois Episode Harkness Silt (mainly lacustrine) and Canteen members (preglacial alluvial) of the Banner Formation. These units partially infill lowlands in bedrock valleys (fig. 4) at the time of their deposition. The units are shown where thicker than about 5 feet, based primarily on stratigraphic test holes.