Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

Bedrock Topography of St. Clair County, Illinois

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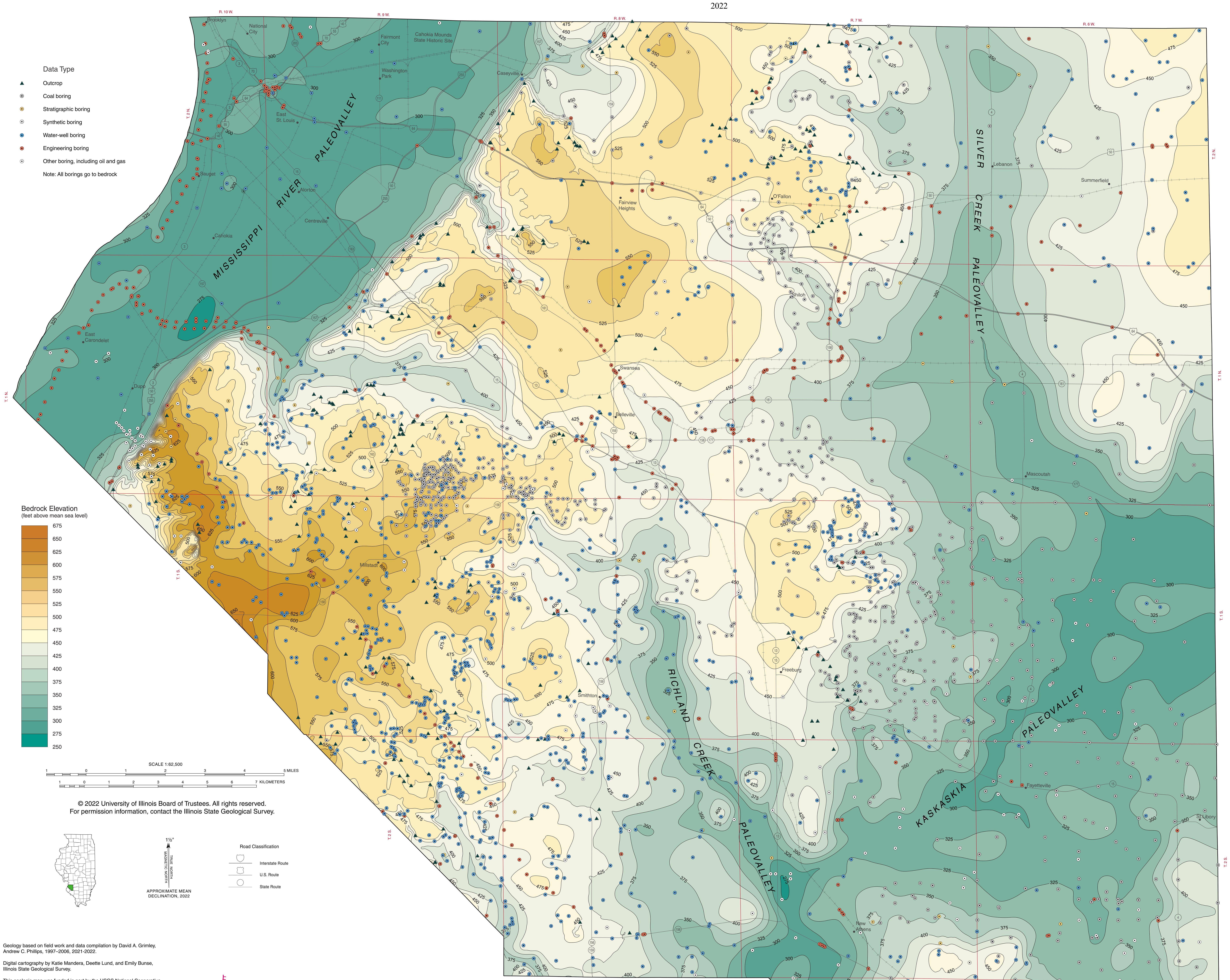

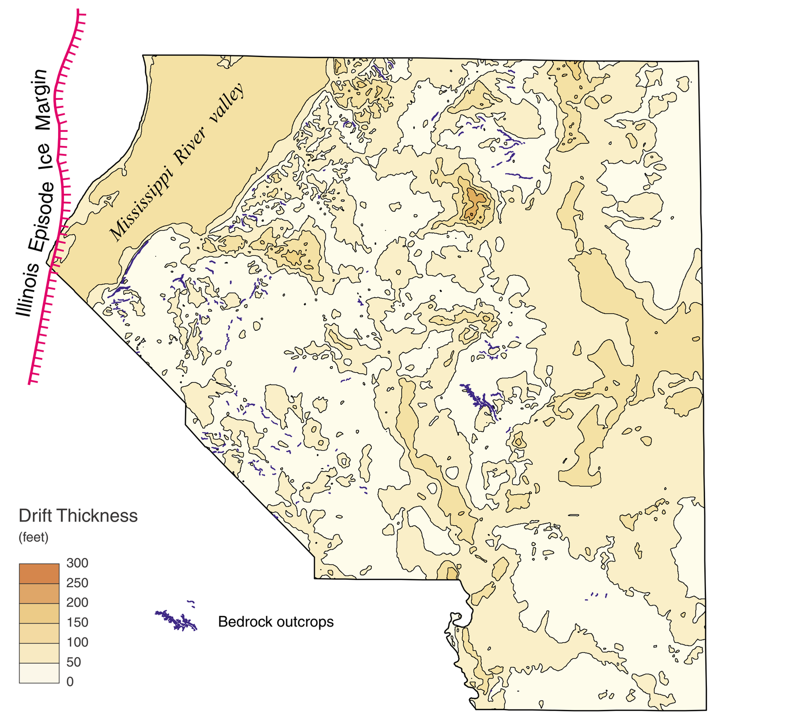

Figure 1 Thickness of unconsolidated Quaternary sediments (e.g., alluvium, loess, glacial till, ice-contact sediment, lake sediment, colluvium, outwash, residuum) that overlie Paleozoic bedrock. This inset map also shows areas of bedrock outcrop or near-surface bedrock (< 5 feet below surface, purple polygons), and the location of an Illinois Episode recessional ice margin (see Grimley and Phillips, 2011). In areas of bedrock exposure, the bedrock surface topography and ground surface topography are identical and the thickness of Quaternary deposits is zero. Map scale at 1:350,000 scale.

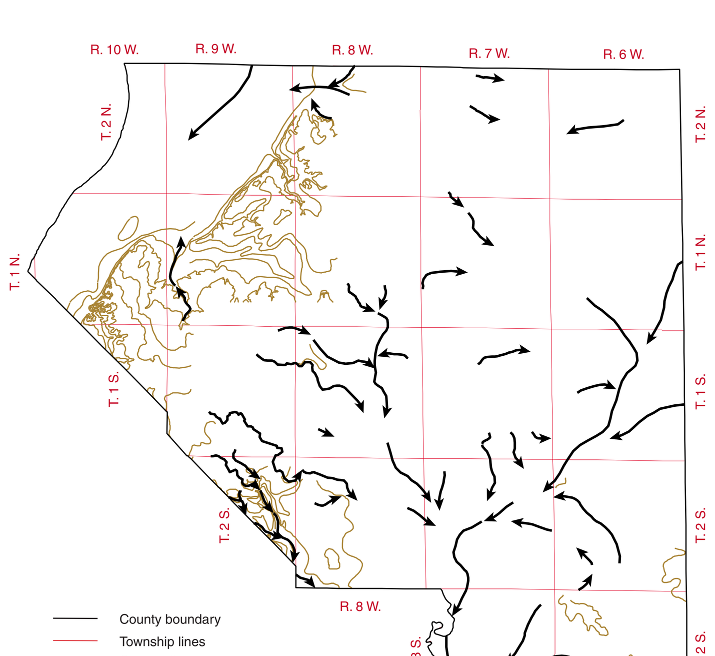

Figure 2 ArcGIS “contours” and “streams” that were used, along with data points, as inputs in constructing the bedrock topography map with the Topo to Raster Spatial Analyst tool. These inputs provide geologic and geomorphic control to the final bedrock surface topography map product. Map scale at 1:350,000 scale.

Introduction and Description

This map displays the topography of the bedrock surface in St. Clair County, in the St. Louis Metropolitan East region of southwestern Illinois. It was constructed from new and archived data compiled during ~13 years of field mapping and investigations by the primary authors (Grimley and Phillips 2011), as well as some later adjustments in association with mapping of the adjacent Monroe County (Grimley and Phillips 2021). The bedrock surface topography of St. Clair County is essentially a paleolandscape that is now buried by unconsolidated Quaternary sediments (0 to 255 ft thick, Fig. 1). Bedrock crops out in isolated areas, particularly in the southwestern highlands of the county and along the Mississippi Valley bluff line (Fig. 1).

Bedrock surface elevations range from < 275 feet (above sea level [asl]) in portions of the Mississippi River Valley to > 650 ft (asl) in bedrock highlands in southwest parts of the county. Total relief on the bedrock surface is ~390 feet (ranging from 263 to 653 feet asl). Bedrock highlands in the county trend northwest-southeast to north-south, following the regional strike of the bedrock on the west flank of the Illinois Basin (Kolata 2005), and are underlain mainly by more resistant Mississippian or Pennsylvanian limestones or sandstones. In contrast, the ancient Kaskaskia Valley and Silver Creek Valley on the east side of the county tend to be underlain by less resistant Pennsylvanian shale or siltstone (Kolata 2005). Some bedrock highlands, such as those underlying Freeburg, Lenzburg, and Marissa in the southeastern part of the county, represent preglacial cuestas underlain by Pennsylvanian sandstone or limestone units that dip east or northeast. Southeast trending valleys tributary to the ancient Kaskaskia Valley formed between the bedrock highlands and include the broad, ancestral Silver Creek Valley, underlying the towns of Lebanon and Mascoutah, and also ancestral Richland Creek Valley between the towns of Smithton and Freeburg. These ancestral valleys are typically now filled with 75 to 150 feet of Quaternary unconsolidated sediments, including alluvial, lacustrine, and glacial deposits. Elevations of the bedrock surface are 275 to 350 feet asl under much of the Kaskaskia River Valley and its major tributaries. Bedrock surface elevations typically range from 265 to 300 feet in the Mississippi Valley, which is superposed on the buried preglacial valley. The narrowing of the buried Mississippi Valley to the south (near Dupo) reflects the constraint of Mississippian limestone bluffs.

The bedrock surface topography that now exists mainly reflects a preglacial (early Pleistocene) landscape, but with minor modification during glaciation. It is suspected that some areas above ~450 ft. elevation (asl) may have been eroded or scoured by glaciers flowing to the southwest and west during the pre-Illinois and Illinois Episode glaciations (Grimley and Phillips 2011). Bedrock lowlands or valleys do not appear to be glacially scoured since they contain relatively undisturbed preglacial Pleistocene alluvium (Canteen member of the Banner Formation) or proglacial lake sediments (Petersburg Silt and/or Harkness Silt Member of the Banner Formation) below till deposits in some locations (Grimley and Phillips 2011, 2015). Bedrock surface topography maps were previously published for the French Village Quadrangle at the 1:24,000 scale (Grimley and Denny 2004) and for several other quadrangles at the 1:100,000 scale as inset figures associated with 1:24,000 scale surficial geology maps (e.g., Grimley 2010; Phillips 2008; Phillips and Aper 2006).

Methods

The bedrock topography map was constructed using the Topo to Raster tool implemented in ArcGIS (ESRI). The Topo to Raster tool is designed to create hydrologically reasonable digital elevation models (Hutchinson 1989; Hutchinson et al. 2011) and can integrate inputs of point data along with inputs of “contours” and virtual “streamlines”, among other options. The input contour data (lines of equal bedrock surface elevation) help provide spatially accurate information, particularly along bedrock bluffs, bedrock exposure, or abrupt changes in bedrock elevation. In the context of this map, the “streamlines” helped define and connect the thalweg of paleovalleys according to geologic models in areas of limited point data. Without the use of contour and streamline data in the digital model, a number of bulls-eye patterns around sparsely distributed data points would exist. The contour and stream inputs provide a means to digitally incorporate geologic and geomorphic insights that are not captured by computer generated models of point data. The following is the general process used for construction of this bedrock surface map (source data avilable upon request):

- **Data points** yielding bedrock surface elevations were interpreted from oil and gas, water well, coal, and engineering boring records (in order of increasing reliability) or were directly observed in stratigraphic test holes, outcrops, sample sets or cores samples archived at the Illinois State Geological Survey (ISGS). The quality of data point locations and descriptive logs varies considerably. To the extent possible, data locations were verified during prior mapping projects (e.g., Grimley and Webb 2009; Grimley 2010; Phillips and Aper 2006; Phillips 2008; Phillips 2010) using water well permits, plat maps, address checking and elevation comparisons on topographic maps. A large number of available oil and gas logs were unreliable or unusable for identifying the bedrock surface, yet some with higher quality driller’s descriptions were useful. Problematic data, either in location or subsurface information, was reevaluated and either corrected or removed from the dataset; however, the majority of available data were utilized. All acceptable point data was tabulated in GIS software (ArcMap/ArcGIS) with bedrock surface elevations calculated by subtracting depth to bedrock from assigned surface elevation.
- **“Contour” and “stream” input lines** (Fig. 2), based on geologic and geomorphic models, were constructed based on inferences from bedrock outcrop areas, topographic features (karst, bedrock bluffs), and interpretations of data point patterns. The “streams” were used mainly to connect envisioned buried valley thalwegs where point data was sparse.
- **Regional and county data compilation** (of points, “contour”, and “stream” inputs) was accomplished mainly as part of county-wide surficial geologic mapping projects in the St. Louis Metro East region (Grimley and Phillips 2006, 2011, 2021) and as part of an earthquake hazards mapping project (Bauer et al. 2012). Point data, “contours”, and “streams” were each merged into a single regional dataset (including Madison, St. Clair, and Monroe counties), with some adjustments and reevaluation of the data in light of edge matching and the regional geologic picture.
- **Bedrock surface map construction**. Once the data points, contours and streams were merged and finalized, the final bedrock surface map was a result of several process steps:
    a. A grid of the bedrock surface map with 40 m horizontal resolution was made from the three data inputs (points, contours, and streamlines) using the Topo to Raster tool, with settings of 4 feet Vertical Standard Error and 4 feet for Tolerance 1.
    b. The thickness of unconsolidated sediments (Fig. 1) was determined by subtraction of the final bedrock topography map from a 10 m resolution surface digital elevation map of Illinois.
    c. Areas in the grid with modeled bedrock elevation above the land surface elevation (i.e., thickness of unconsolidated sediments impossibly < 0, Fig. 1) were digitally reassigned with the surface elevation (from 10 m resolution surface digital elevation map) using a conditional statement in ArcGIS.
    d. Focal statistics (setting = 3 cells) were used to smooth the grid surface (*bt71_con_foc3*).
    e. As an output for the published map product, contours and polygons at a 25 foot interval were created for St. Clair County from the smoothed grid in ArcGIS.
    f. For cartographic legibility at 1:62,500 scale, polygons < 2000 m^2 were merged into larger polygons. Other small polygons, not appropriate at 1:62,500 scale, were likewise merged at the authors’ discretion.

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Geology based on field work and data compilation by David A. Grimley, Andrew C. Phillips, 1997–2006, 2021-2022.

Digital cartography by Katie Mandera, Deette Lund, and Emily Bunse, Illinois State Geological Survey.

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This map has not undergone the formal Illinois County Geologic Map (ICGM) review process. Whether or when this map will be formally reviewed and published depends on the resources and priorities of the ISGS.

Base map compiled by Illinois State Geological Survey from digital data (2013, 2021 TIGER/Line Shapefiles) provided by the United States Census Bureau. Universal Transverse Mercator Projection, zone 16. North American Datum of 1983. North American Vertical Datum of 1988.

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