Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

Bedrock Topography of Madison County, Illinois

David A. Grimley and Andrew C. Phillips
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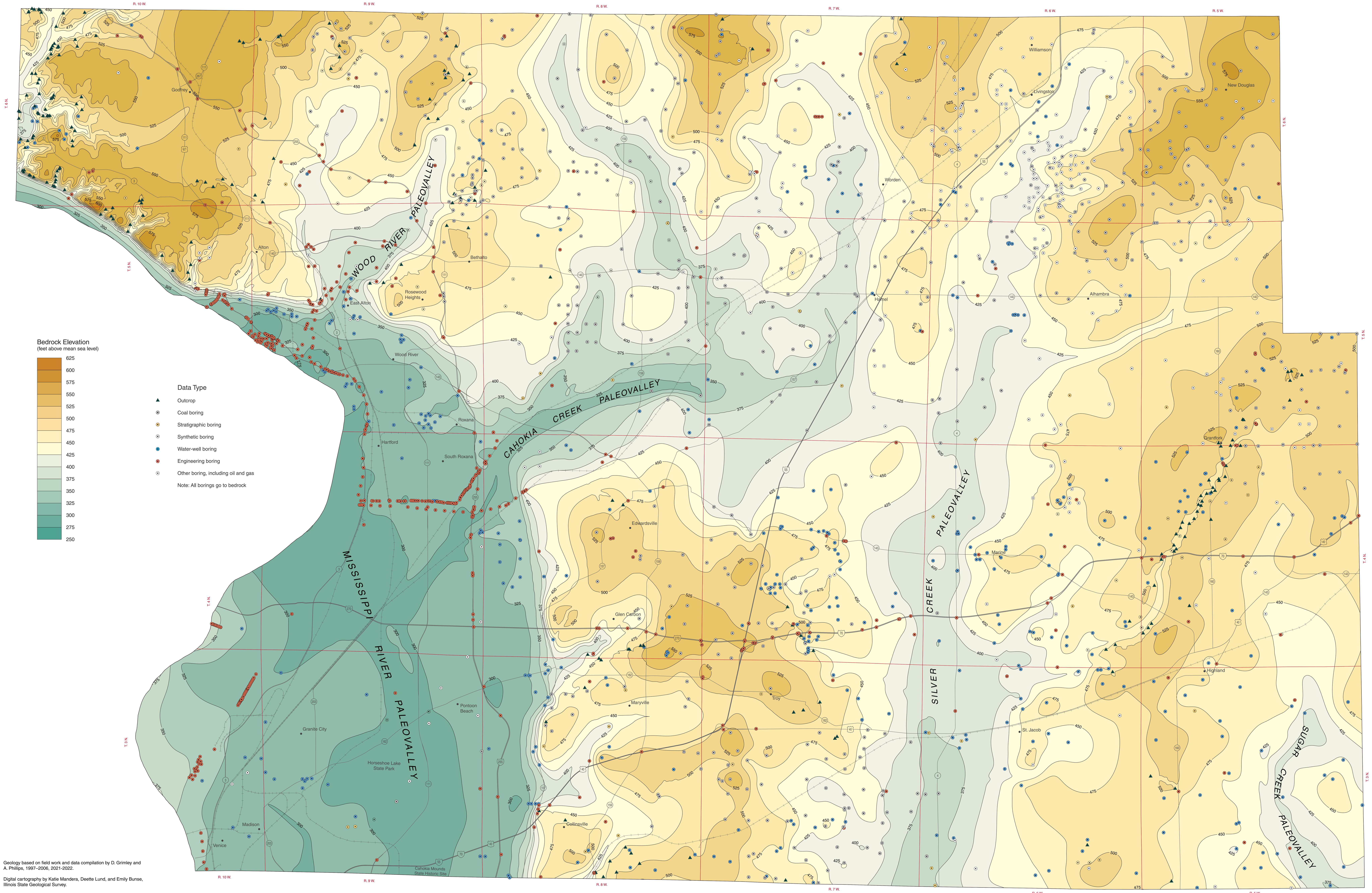

Introduction and Description

This map displays the topography of the bedrock surface in Madison County, in the St. Louis Metropolitan East region of southwestern Illinois. It was constructed from new and archived data compiled during about 9 years of field mapping (1997–2006) and investigations by the authors (Grimley and Phillips 2006), as well as some later adjustments in association with mapping of the adjacent St. Clair County (Grimley and Phillips 2011). The bedrock surface topography of Madison County is essentially a paleolandscape that is now buried by unconsolidated Quaternary sediments (0 to 225 ft thick, Fig. 1). Paleozoic bedrock is near-surface and exposed in many areas in the northwestern part of the county, west of Alton (Fig. 1 and Grimley and Phillips 2006). Bedrock is exposed in this area along the Mississippi River bluffs and along nearby tributaries (Grimley 1999, 2002). The bedrock west of Alton is Mississippian Subsystem, and east of Alton is Pennsylvanian Subsystem (Kolata 2005). Bedrock is also exposed sporadically along ravines and lakeshores in other parts of the county. One of the few areas of significant Pennsylvanian bedrock exposure in the eastern part of Madison County exists along and near Highland Silver Lake, south of Grantfork (Grimley and Phillips 2005).

Bedrock surface elevations range from 275 feet (above sea level [asl]) in portions of the Mississippi River Valley to > 600 ft (asl) in isolated bedrock highlands in northwestern parts of the county. Total relief on the bedrock surface is ~ 325 feet. Bedrock highlands in the county trend north-northeast to south-southwest, following the regional strike of the bedrock on the west flank of the Illinois Basin (Kolata 2005), and are generally underlain mainly by more resistant Mississippian or Pennsylvanian limestones or sandstones. In contrast, preglacial bedrock valleys tend to be underlain by less resistant Pennsylvanian shale or siltstone. Some bedrock highlands may represent preglacial cuestas underlain by Pennsylvanian sandstone or limestone units that dip east to southeast. The ancestral valleys, in many cases, generally follow the modern valleys. For instance, the ancestral Silver Creek Valley extends north-south in the Marine and St. Jacob Quadrangles in the south-central part of Madison County. However, in the upper portions of some drainage basins, the ancestral bedrock valleys and modern valleys may be offset, such as in the Prairietown and Worden Quadrangles. The buried bedrock valleys are typically now filled with 50 to 100 feet of Quaternary unconsolidated sediments, including alluvial, lacustrine, and glacial deposits. Elevations of the bedrock surface are typically between 275 to 315 feet asl under much of the Mississippi River Valley where the modern valley is superposed on the ancestral preglacial valley. Large tributary valleys with low bedrock surface elevations occur along the lower portions of Cahokia Creek valley (Phillips 2003) and Silver Creek valley (Phillips 2004b).

The bedrock surface topography that now exists mainly reflects a preglacial (early Pleistocene) landscape, but with minor modification during glaciation. Some areas above ~ 500 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. The preglacial bedrock lowlands or valleys do not appear to be glacially scoured as many buried valleys contain relatively undisturbed preglacial Pleistocene alluvium (Canteen member, Banner Formation) or proglacial lake sediments (Petersburg Silt) below till deposits (e.g., Grimley 2004; Grimley and Phillips 2006, 2010). Bedrock surface topography maps for some quadrangles were previously produced at the 1:100,000 scale as inset figures associated with 1:24,000 scale surficial geology maps (Grimley 2004, 2005a, 2005b; Phillips 2003, 2004a, 2004b, 2005; Grimley and Phillips 2005).

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 available on request):

- **Data points** yielding bedrock surface elevations (2255 points in total) 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 some prior mapping projects (e.g., Grimley 2004; Phillips 2004a, 2005) using water well permits, plat maps, address checking and elevation comparisons on topographic maps. However, water wells were largely not verified in some of the earlier mapping projects. 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 used. 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. The vertical accuracy of the bedrock elevation data is estimated to typically range from 0.5 to 3 meters, depending on the locational and description accuracy. To minimize edge effects, data located at least 1 km beyond the county boundary was also utilized.
- **"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. Contours were used extensively in the Alton and Elsah quadrangle due to the higher relief and more shallow bedrock. 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 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. The horizontal accuracy of the lines is estimated to be ~100 m, for most areas.
  f. For cartographic legibility at the 1:62,500 scale, polygons < 2000 m^2 were removed by merging into surrounding polygons. Polygons ranging from 2000–7000 m^2 area, were in some cases removed or connected to nearby polygons at the authors' discretion. Polygons > 7000 m^2 were not modified. Contours were adjusted accordingly.

Acknowledgments

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Geology based on field work and data compilation by D. Grimley and A. 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 Geologic County 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 and 1:100,000-scale Digital Line Graph data provided by the United States Geological Survey. Universal Transverse Mercator Projection, zone 16. North American Datum of 1983. North American Vertical Datum of 1988.

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ILLINOIS
Illinois State Geological Survey

Prairie Research Institute
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6918
(217) 244-2414
http://www.isgs.illinois.edu

SCALE 1:62,500
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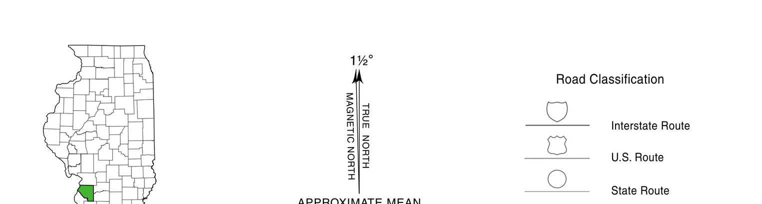

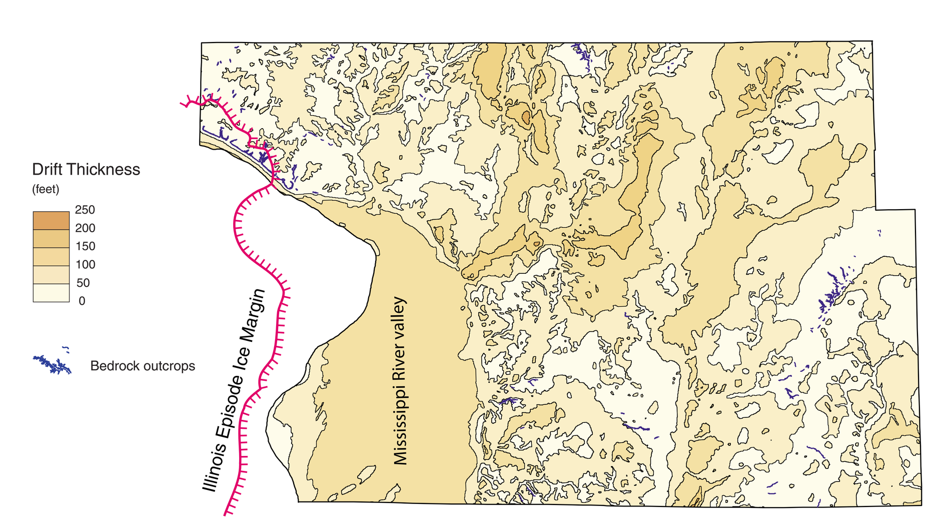

Figure 1 Thickness of unconsolidated Quaternary sediments (e.g., alluvium, loess, glacial till, ice-contact sediment, lake sediment, colluvium, outwash, residuum) that overlie Paleozoic bedrock. This inset map also shows areas of bedrock outcrop or near-surface bedrock (< 5 feet below surface, purple polygons), and the location of the Illinois Episode ice margin (see Grimley and Phillips 2006). 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.

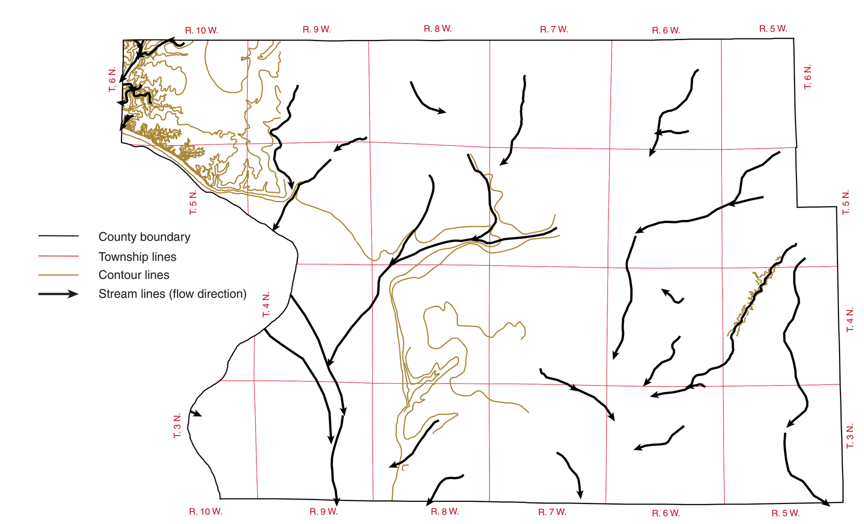

Figure 2 ArcGIS "contours" and "streams" that were used, along with data points, as inputs in constructing the bedrock topography map with the Topo to Raster Spatial Analyst tool. These inputs provide geologic and geomorphic control to the final bedrock surface topography map product. Map scale at 1:350,000.