

SURFICIAL GEOLOGY OF THE HILLSBORO 30 X 60-MINUTE QUADRANGLE IN OHIO

by
Frank L. Fugitt, Paul N. Spahr, Richard R. Pavey, Douglas J. Aden, D. Mark Jones, and Michael P. Angle
GIS Database Administration by Joseph G. Wells
GIS Cartography by Dean R. Martin

MAPPING CONVENTIONS

This map provides a three-dimensional framework of the area's surficial geology and depicts four important aspects of surficial geology:

1. Geologic deposits, indicated by **letters** that represent the major lithologies.
2. Thicknesses of the individual deposits, indicated by **numbers and modifiers**.
3. Lateral extents of the deposits, indicated by map-unit area boundaries (solid and dashed lines).
4. Vertical sequence of deposits, shown by the stack of symbols within each map-unit area.

Figure 1 illustrates cross-section A-A' and mapping conventions. Letters, numbers, and modifiers are arranged in stacks that depict the vertical sequence of lithologic units for a given map-unit area. A single stack of symbols occurs in each map-unit area and applies only to the thickness of sediments within that particular map-unit area.

Letters represent geologic deposits (lithologic units) and are described in detail below. Lithologic units may be a single lithology, such as sand (S) or clay (C), or a combination of related lithologies that are found in specific depositional environments, such as sand-and-gravel (SG) or ice-contact (IC) deposits. The bottom symbol in each stack indicates the bedrock lithologies that underlie the surficial deposits. The detailed lithologic unit descriptions below summarize:

1. Geologic characteristics, such as range of textures, bedding, and age.
2. Engineering properties or concerns attributed to the unit.
3. Depositional environment.
4. Geomorphology or geomorphic location.
5. Geographic location within the map area, if pertinent.

Numbers (without modifiers) that follow the lithology designators represent the average thickness of a lithologic unit in feet (for example, 3 represents 30 feet [ft]). If no number is present, the average thickness is implied as 1 (10 ft). These unmodified numbers correspond to a thickness range centered on the specified value but may vary ±50 percent. For example, 14 indicates an average thickness of 14 ft, but that thickness may vary from 20 to 60 ft.

Modifiers provide additional thickness and distribution information:

1. Parentheses indicate that a unit has a patchy or discontinuous distribution and is missing in portions of that map-unit area. For example, (T2) indicates that till with an average thickness of 20 ft is present in only part of that map-unit area.
2. A negative sign (-) following a number indicates the maximum thickness for that unit in an area such as a buried valley or ridge. Thickness decreases from the specified value, commonly near the center of the map-unit area, to the thickness of the same lithologic unit and vertical position specified in an adjacent map-unit area. For example, a SG50-map-unit area adjacent to a SG3 area indicates a sand-and-gravel unit having a maximum thickness of 50 ft that thins to an average of 30 ft at the edge of the map-unit area. If the material is not present in an adjacent area, it decreases to zero at that boundary.

The small scale of this reconnaissance map generates the great local variability within surficial deposits. That variability is explained in the lithologic unit descriptions and by the use of thickness ranges. Some areas and lithologies are so small to delineate at 1:100,000 scale and have been included in adjacent areas. This map should serve only as a regional predictive guide to the area's surficial geology and not as a replacement for subsurface borings and geophysical studies required for site-specific characterization.

DATA SOURCES

Data were collected from numerous sources (see "References"). The concentration of data was greatest near the surface and decreased with depth. County soil survey maps, which describe the top 5 ft of surficial materials, provided a useful guide to map-unit areas. These areas were modified through interpretation of local geomorphic settings and other data that indicated changes of deposits at depth, including water-well logs from the Ohio Department of Natural Resources (ODNR), Division of Soil and Water Resources, oil-and-gas well logs on file at the ODNR Division of Geological Survey (e.g., test-boring logs provided by the Ohio Department of Transportation, Office of Geotechnical Engineering), and the National Geologic Map Act (NGMA) system, available online at www.dot.state.oh.us/Divisions/Engineering/Geotechnical/Pages/GeoMS.aspx#GRSR and at Ohio Environmental Protection Agency (EPA) and county engineers offices (e.g., those, and published or unpublished lithologic reports, maps, and field notes for file at the ODNR Division of Geological Survey). These data also provided the basis for lithologic unit descriptions that summarize, as accurately as possible, recognized associations of genetically related materials. Total thickness of each surficial deposit was calculated using ODNR Division of Geological Survey open-file bedrock topographic maps, and bedrock units were summarized from ODNR Division of Geological Survey bedrock geology maps, all of which are available for a 7.5-minute quadrangle in the map area. Land-surface topography was derived from LIDAR data, collected as part of the Ohio Statewide Imager Program, and then converted into a 12.5 x 12.5-ft-resolution digital elevation model (DEM) and shaded-relief model by the Ohio EPA.

KEY TO LITHOLOGIC COLORS AND UNIT DESCRIPTIONS

SURFICIAL UNITS

W	Water. Lakes generally larger than 20 acres and not appearing on base map.
M	Made land. Large areas of cut and fill, such as dams, landfills, and urban areas.
A	Aluvium (Holocene). Includes a wide variety of textures from silt and clay to boulders; commonly includes organic material, generally not compact, rarely greater than 20 ft thick. Found in floodplains of modern streams throughout entire map area. Mapped only where areal extent and thickness are significant.
Ac	Aluvium and alluvial terraces (combined). Shown in areas where insufficient space is available to delineate separate units.
Al	Alluvial terraces (Wisconsinan). Old floodplain remnants along streams that flowed into high, proglacial lakes. Highly variable textures, commonly present sets of feet above modern floodplains.
C	Clay (Wisconsinan). Massive to laminated, may contain interbedded silt and fine sand. Laminated clay commonly contains silt or sand partings. In deep buried valleys, includes till and may be older than Wisconsinan.
L	Silt (Wisconsinan). Massive or laminated, commonly contains thin sand partings. May contain localized clay, silt, or gravel layers. Clay content commonly increases with depth. Found throughout the map area in lowland surface deposits, terraces, and as deposits of glacial lakes.
S	Sand (Wisconsinan). Contains minor amounts of disintegrated gravel or thin lenses of silt or gravel; grains well to moderately sorted, moderately to well rounded; finely stratified to massive. May be cross bedded, locally may contain organic material. In deep buried valleys, may be older than Wisconsinan age. Fluvial unit found in terraces and in buried valleys primarily in the central map area.
SG	Sand and gravel (Wisconsinan). Interbedded and interbedded sand and gravel commonly containing thin, discontinuous layers of silt, clay, and till. Grains well to moderately sorted, moderately to well rounded, finely stratified to massive, may be cross bedded, locally may contain organic material. Up to 120 ft thick. In deep buried valleys, may be older than Wisconsinan. Wisconsinan fluvial deposits in terraces and buried valleys.
IC	Ice-contact deposits (Wisconsinan). Highly variable deposits of poorly sorted gravel and sand, silt, clay, and till lenses common; may be partially covered or surrounded by till. Deposited directly from stagnant ice or across or under icebergs. Found in the central western map area.
T	Loam till (Wisconsinan). Unsorted mix of silt, clay, sand, gravel, and boulders; variable carbonate content. Fracture common. May contain silt, sand, and gravel. Deposited directly from several separate ice advances. Unlaminated and non-specified age in buried valleys or where separated by intervening non-till units from an overlying deposit.
C	Clay (Illinoian). Massive to laminated, may contain interbedded silt and fine sand. Laminated clay often contains silt and sand partings. Near-surface deposits are deeply leached and have a tendency to be jointed. Clay thicknesses highly variable; deposits are commonly sorted and may exceed 225 ft in thickness. Thickest along the northern margin of the Mississippian escarpment, forming the side belt of ancestral Lake Bahrbridge. Thinner deposits, ranging from a few feet to 20 ft, occur in southeastern portions of map area.
SG	Sand and gravel (Illinoian). Properties similar to unit SG above, except upper part of unit is deeply weathered and leached where near surface. Fluvial unit found in high-level terraces and in deep buried valleys in the eastern map area.
IC	Ice-contact deposits (Illinoian). Properties similar to unit IC above, except upper part of unit is deeply weathered and leached where near surface. Found in the western map area beyond the Wisconsinan margin.
T	Loam till (Illinoian). Similar to unit T above but with more weathering. Possibly overlain by a few feet of loess where not eroded.
U	Silt (Illinoian). Similar to Wisconsinan age silt, except upper part of unit more deeply leached and greater tendency to be jointed near surface; thickness up to 50 ft. These deposits are found on high-level terraces and in buried valleys in southeastern portion of map area.
GG	Clay to gravel. Completely interbedded deposits of clay, sand, gravel, and fill in deeper parts of buried valleys; unspecified age. Unit identified from well logs, data insufficient for more detailed differentiation or age assignment. Subsurface unit only.
U	Silt (pre-Illinoian). Fine to very fine silt, highly laminated with laminations being regularly spaced and consistent throughout areas of occurrence; light gray to blue, micaceous mineral composition results in smooth group texture. Most silt occupies a greater part of valley fill in pre-Illinoian valleys and larger streams in southern Ohio. Deposits may also occur as an infilling of upper basins of smaller tributaries within the region. Some deposits are found along shallow valley walls if not eroded. Thicknesses greatest near divides where they may range from 10 to 80 ft but are normally 10 to 20 ft. Type locality for Maitland silt is exposure near town of that name in Scioto County. Evidence favors a glaciolacustrine origin. Subsurface unit only.
Ck	Clay (pre-Illinoian). Clay deposits variable in color depending on oxidation conditions where deposited, usually light buff to brownish red. May contain discontinuous clay fragments that are usually highly weathered and leached. Found within some valley settings as Maitland silt, usually as capping materials. Thickness may range from five to 40 ft with usual thickness ranging from five to 15 ft. Subsurface unit only.

BEDROCK UNITS

SSh	Sandstone and shale (Mississippian). Interbedded shale, siltstone, and sandstone and associated colluvium, with common vertical and horizontal changes.
D	Dolomite (Silurian). Dolomite, thin to massive bedded, and are dolomite shale, thin to thick bedded; contains bituminous bands; upper surface may be tabby and include thick red clay (area type paleokarst). Source of aggregate.
L-S	Limestone, dolomite, and shale (Silurian and Ordovician). Interbedded limestone, dolomite, and shale, carbonate ranges from 50% to 85% of the unit; shaly bed rock; contains solution features.
Sh	Shale (Silurian, Devonian, and/or Mississippian). Indurated, fine-grained sedimentary rock with varying organic and authigenic compositions. Silurian-age shales occur as interbedded shale and dolomite.
Ls	Limestone and dolomite (Silurian and Ordovician). Limestone and dolomite, thin to massive bedded, fossiliferous; may be cherty. Contains areas of well-developed karst topography; basal upper surface may be tabby and include thick red clay (area type paleokarst). Source of aggregate. Subsurface unit only.
S-L	Shale, limestone, and dolomite (Silurian and Ordovician). Interbedded shale, thin to thick bedded, and carbonate, thin to medium bedded, fossiliferous. Shale ranges from 50% to 85% of the unit, with minor carbonate-dominant intervals present.

The colors on the map correspond to the uppermost continuous map units and serve to assist in visualizing the geology of the area. Discontinuous units (in parentheses) and subsurface-only units are not assigned colors.

Cross-hatched patterns shown only in cross section. Units without cross-hatched patterns do not appear in cross section.

EXPLANATION OF MAP SYMBOLS

- Small area of organic deposits.
- × Quarry, floored in bedrock, may contain reclaimed areas.
- Sand-and-gravel pit. Bottom generally underlain by unconsolidated lithologic units of surrounding polydeposits. May contain reclaimed areas.
- Boundary between map-unit areas having different uppermost, continuous lithologies or significant bedrock lithology change, underlying lithologies may or may not differ.
- Boundary between map-unit areas having the same uppermost, continuous lithology but different textures or different underlying lithologies.
- Note: Boundary types reflect the relationships among uppermost continuous lithologies only, not patchy, discontinuous lithologies (in parentheses).

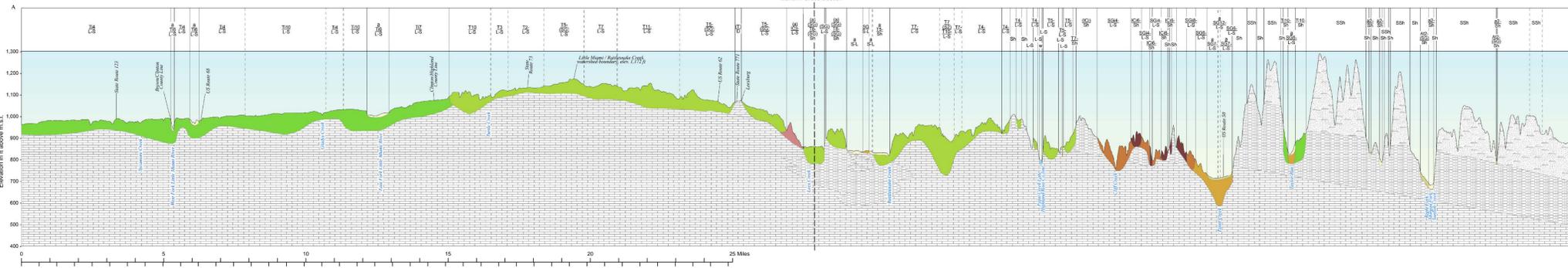
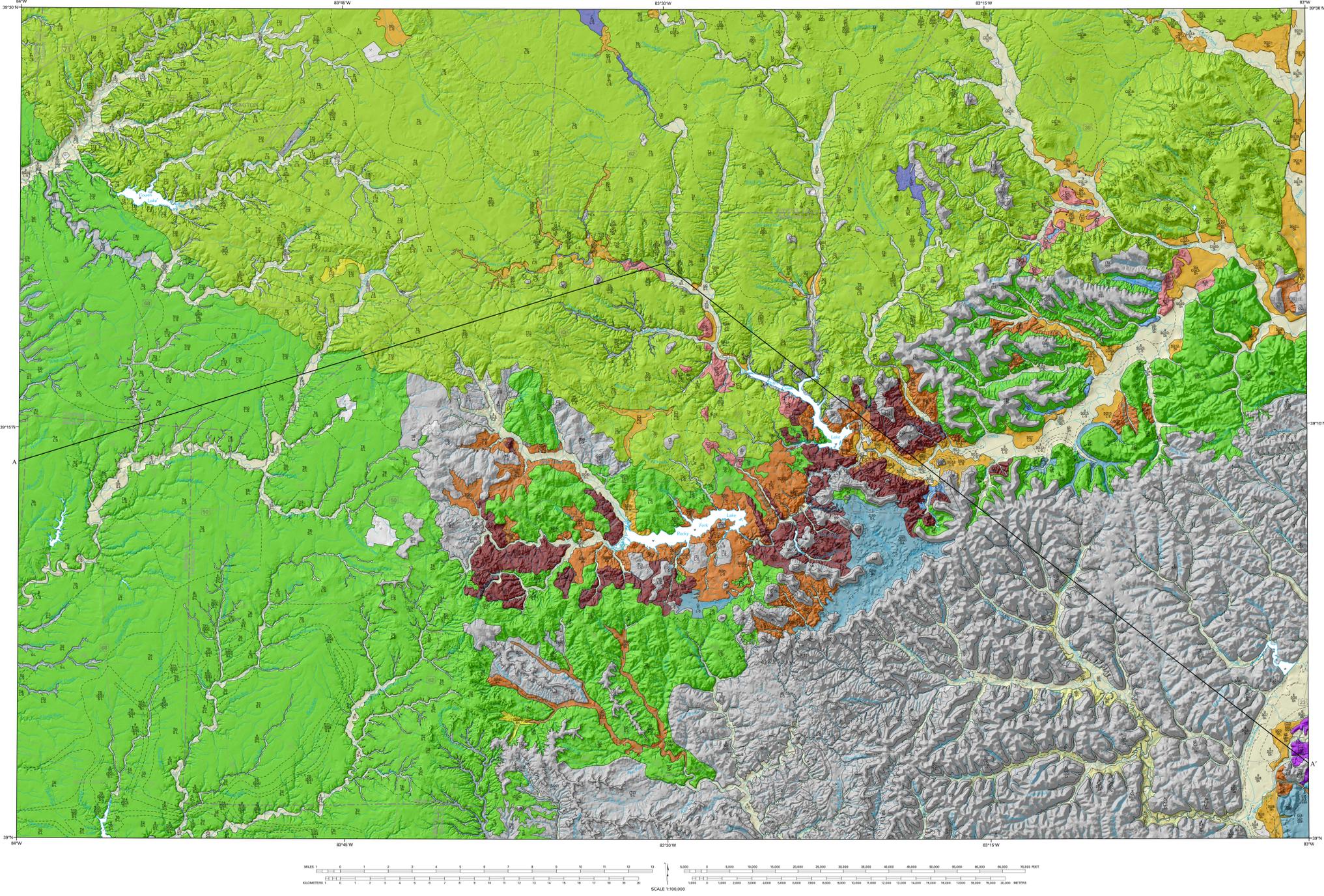


FIGURE 1—Cross section of the Surficial Geology of the Hillsboro 30 x 60-Minute Quadrangle in Ohio for explanation of symbols. Solid-line boundaries separate map-unit areas having different lithologic units at the surface; underlying lithologic units may or may not differ. Dashed-line boundaries separate map-unit areas having the same surface lithologic unit but different thicknesses or different underlying lithologies. Thickness values are in feet of feet. Values are gross averages that can vary ±50 percent, except (1) those followed by a minus sign (-) which represents the maximum thickness of a thinning trough- or wedge-shaped sediment body, or (2) units in parentheses () which indicate a discontinuous distribution of that unit. Precise surface topography can be determined from topographic maps that are available from the ODNR Division of Geological Survey at several scales; bedrock-surface topography and bedrock geology are available from the ODNR Division of Geological Survey at a 1:24,000-scale quadrangle map.

REFERENCES

Aden, D.J., and Spahr, P.N., 2010. The Hillsboro Sandstone of Ohio: Analysis of a Silurian, Sandstone Reservoir. *Journal of Geology*, v. 118, p. 209–220.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60-minute quadrangle in Ohio. *Ohio Department of Natural Resources, Division of Geological Survey, Map SG-218L*, scale 1:100,000.

Aden, D.J., Spahr, P.N., Pavey, R.R., Jones, D.M., Angle, M.P., and Fugitt, F.L., 2016. Surficial geology of the Hillsboro 30 x 60