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SURFICIAL GEOLOGY OF THE OHIO PORTIONS OF THE CINCINNATI AND FALMOUTH 30 X 60 MINUTE QUADRANGLES

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INTRODUCTION

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

1) the geologic deposits, indicated by letters which represent the major lithologies;
2) the thickness of the individual deposits, indicated by numbers and modifiers;
3) the lateral extent of the deposits, indicated by map-unit area boundaries;
4) the vertical sequence of deposits, shown by the stack of symbols within each map-unit area.

In effect, each stack represents a generalized cross section for each 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 deposits (IC). 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 designator represent the average thickness of a lithologic unit in tens of feet (for example, 3 represents 30 feet). If no number is present, the average thickness is assumed to be 1 (10 feet). These unmodified numbers correspond to a thickness range centered on the specified value, but may vary up to 50 percent. For example, T4 indicates the average thickness of till in a map-unit area is 40 feet, but thickness may vary from 20 to 60 feet.

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 feet is present in only part of that map-unit area.

2) A minus sign following a number indicates the maximum thickness for that unit in areas 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, an SG9- map-unit area adjacent to an SG3 area indicates a sand and gravel unit having a maximum thickness of 90 feet that thins to an average of 30 feet 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.

These **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 volume of sediments within that particular map-unit area. Figure 1 illustrates mapping conventions.

The small scale of this reconnaissance map generalizes 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 too small to delineate 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 characterizations.

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 described the top 5 feet of surficial materials, provided an initial guide to map-unit areas. These areas were modified through field mapping and the interpretation of local geomorphic settings as well as the use of other data which indicated change of deposits at depth, such as Ohio Department of Natural Resources water-well logs, Ohio Department of Transportation and Ohio EPA test-boring logs, theses, and published or unpublished geologic reports, maps, and field notes. These data also provided the basis for lithologic unit descriptions, which summarize, as accurately as possible, recognized associations of genetically related materials. The total thickness of surficial deposits was calculated from Division of Geological Survey open-file bedrock-topography maps, which are available for each 7.5-minute quadrangle in the map area. The bedrock units were summarized from Division of Geological Survey open-file bedrock-geology maps, also available for each 7.5-minute quadrangle. Land-surface topography shown on the basemap was prepared largely from data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing).

LITHOLOGIC UNIT DESCRIPTIONS

SURFICIAL UNITS

w — Water, lakes generally larger than 20 acres and not appearing on basemap.

m — Made land. Large cut and fill areas.

a — Alluvium, Holocene-age. Includes a wide variety of textural classes from silt to boulders with disseminated or concentrated organics; generally not compact; rarely greater than 20 feet thick. Found within floodplains of modern streams throughout the entire map area. Mapped only where areal extent and thickness are significant.

C — Clay, generally Wisconsinan-age. Massive to laminated; may contain thin interbedded silt, fine sand, and minor gravel; clay content may exceed 80%. Laminated clay commonly contains thin silt or sand partings. May contain joints/fractures 6 to 12 inches apart and disseminated organics, fossil snails and clams. Unit may contain areas of modern alluvium. In deep buried valleys, includes till and may be older than Wisconsinan-age. Generally less than 30 feet thick; landslide-prone. Lacustrine deposit on lowland surfaces, low-level terraces, and buried valley-fills throughout the map area.

Cl — Clay, Illinoian-age. Properties similar to unit C above except upper part of unit deeply leached and more deeply jointed where near surface; up to 30 feet thick. Unit found in high-level terraces and buried valleys in the central and eastern map area.

Ck — Clay, Pre-Illinoian-age (Kansan-age in old terminology). Properties and deposition mode similar to unit C above with exceptions: Ck generally oxidized and entirely leached; may contain thin, laterally discontinuous, bedded, calcareous concretions in near-surface exposures; joints/fractures may contain linear concretions. Unit 10 to 20 feet thick, landslide-prone, found between elevations 650-870 feet in the southwestern map area.

CA — Clay and silt, pre-Wisconsinan-age, with Sangamon-age paleosol developed in upper few feet of the unit. Patchy distribution of paleosol. Upper part of unit leached with loess and abundant organics, lower part of unit may contain till. Up to 100 feet thick. Lacustrine unit, restricted to the subsurface, formerly exposed to surface soil processes; limited to the New Haven Trough and Mill Creek Valley.

CB — Clay and silt similar to unit CA, but with paleosol (Yarmouthian?-age) developed in Early Illinoian or Pre-Illinoian loess and lacustrine deposits. Unit coarsens downward, but does not contain till as does unit CA. Unit 10 feet thick, found in buried valley-fill east of Newtown.

CS — Interlayered very fine grained materials, unspecified age. Clay and silt predominate with interbeds of fine sand, gravel is rare; may include till at depth. Variable thickness and sequence of lithologies. Unit identified from well logs; up to 150 feet thick. Deposited as fine overbank sediments or in lacustrine settings as lake bottom and distal deltaic facies. Found in area's largest valleys including Norwood Trough and Mill Creek Valley.

G — Gravel, generally Wisconsinan-age. Contains minor amounts of disseminated sand and thin, discontinuous lenses of silt and thicker, more continuous beds of sand; unit well to poorly sorted, angular to well rounded; may be massive, cross bedded, or horizontally bedded. Clasts vary in lithology and in some areas are exclusively limestone derived from the immediate area. Up to 60 feet thick. Some stable slope exposures are locally cemented by calcium carbonate. In deep buried valleys, may be older than Wisconsinan-age. Fluvial deposit in low-level terraces and buried valleys throughout the map area.

Gi — Gravel, Illinoian-age. Properties similar to unit G above except upper part of unit more deeply weathered and leached where near surface; up to 20 feet thick. Unit found in high-level terraces and buried valleys in the eastern part of the map area.

IC — Ice-contact materials, highly variable deposits of poorly sorted sand and/or gravel, with common lenses of till, silt and clay, Wisconsinan-age. Generally high-angle bedding; 10 to 30 feet thick. Unit differs from SGB and Til in containing less till and clay. Deposited in northern half of map area as kames, eskers or ice-contact deltas, partially covered or surrounded by till.

IM — Till and water laid deposits juxtaposed near valley walls and the ice margin, Wisconsinan-age. Till in low-relief swells and swales and stratigraphically underlying other units. Till-swales are partially infilled with debris-flow material, lacustrine silt, clay, fine sand, and fluvial or ice-contact sand and gravel; fluvial units may be stratigraphically over and/or under lacustrine units. Up to 70 feet thick; unit thickness reflects maximum thickness of till. Mapped along the Mill Creek and Great Miami Valleys where individual units cannot be shown separately due to map scale. Deposited in ablational swales or lowlands of till on which meltwater was initially ponded (lacustrine deposition), until free-flowing conditions were established (fluvial conditions).

L — Silt, generally Wisconsinan-age. Contains localized clay, sand, or gravel layers. Laminated to massive; disseminated organics commonly present, may contain fossil snails, clams, and small branches or logs. Carbonate-cemented concretions in finer silt. Up to 100 feet thick, but generally thinner. Fine silts develop shallow angle slumps; coarse silts prone to piping, may be thixotropic ("quick sand"). Lacustrine deposit found in low-level slackwater terraces and buried valley-fills throughout the map area.

Li — Silt, Illinoian-age. Unit similar to L above except upper part of unit deeply leached and more deeply jointed where near surface; up to 50 feet thick. Unit found in high-level terraces and in buried valleys in the eastern part of the map area.

LA — Silt, clay, sand and gravel as distinct interbeds 10 or more feet thick, Wisconsinan-age. Sequence of lithologies variable; 30 to 40 feet thick. Deposited in buried valleys, which alternated between free-draining and ponded conditions. Mapped where individual units cannot be shown separately due to map scale and insufficient data. Unit limited to valleys upstream of numerous bedrock narrows along the Little Miami River.

S — Sand, generally Wisconsinan-age. Contains minor amounts of disseminated gravel and thin lenses of silt and gravel; grains well to poorly sorted, moderately to well rounded with high quartz percentage; finely laminated to massive, may be cross bedded; locally may contain organics as disseminated particles or sticks and logs. Beds may be lithified by calcium carbonate in stable valley-side exposures; concretions may be present with varying degrees of cementation. In deep buried valleys, may be older than Wisconsinan-age; up to 50 feet thick. A fluvial unit in low terraces and buried valleys throughout the map area.

Si — Sand, Illinoian-age. Properties similar to unit S above except upper part of unit more deeply weathered and leached where near surface; usually less than 20 feet thick. Unit found in high-level terraces and buried valleys in the eastern part of the map area.

Sk — Clayey to pebbly sand, Pre-Illinoian-age (Kansan-age in old terminology). Overlain by up to 5 feet of loess. Weathered and leached; B-horizon soil-clay accumulation greater than 10 feet thick. Sand to pebble-size nodules of iron oxide and manganese oxide concentrate near loess/sand contact. Sand mostly quartz and other resistant lithologies; pebble beds uncommon. Up to 30 feet thick; erodes easily when vegetation removed. Unit both fluvial (deposited in high-level "Teays-age" paleovalleys), and aeolian (loess and sheet sands in uplands). Limited to hilltops and slopes above 620 feet elevation in southwestern part of the map area.

SC — Interlayered medium-fine to fine grained materials, unspecified age. Fine sand predominates and includes clay, silt, and thin gravel interbeds. Variable thickness and sequence of lithologies. Unit identified from well logs and is similar to unit CS above but coarser; up to 150 feet thick. Deposited as lacustrine and proximal deltaic facies as well as overbank sediments within the area's largest valleys.

SG — Sand and gravel, generally Wisconsinan-age. Intermixed and interbedded sand and gravel with thin, discontinuous layers of silt, clay, and till. Grain size, bedding, cementation, and distribution characteristics similar to units S and G above; up to 250 feet thick. In deep buried valleys, may be older than Wisconsinan-age. Widespread fluvial deposit in low-level terraces and in buried valleys.

SGi — Sand and gravel, Illinoian-age. Properties similar to unit SG above except upper part of unit more deeply weathered and leached where near surface; up to 30 feet thick. On stable slopes, more of unit may be cemented by calcium carbonate than other SG-related units. Found in high-level terraces and buried valleys in the eastern part of the map area.

SGA — Sand and gravel, pre-Wisconsinan-age, similar to unit SG above but with Sangamon-age paleosol developed in upper portions. Patchy distribution of paleosol. Paleosol red brown to green gray, clay to clayey gravel, 15 feet or thicker, found between elevations 530-550 feet. Below paleosol, unweathered sand and gravel of Illinoian-age, generally coarser than any overlying SG unit. Unit may also include sand and gravel overlying paleosol. Up to 190 feet thick. A fluvial unit generally limited to the New Haven Trough in the southwestern map area.

SGB — Sand and gravel, generally Wisconsinan-age, similar to unit SG above, but including discontinuous, thick interbedded till or clay. Up to 100 feet thick. Differs from unit Til in having a higher proportion of sand and gravel to till or clay. In deep buried valleys, may be older than Wisconsinan-age. Found in lowlands near valley sides where it was deposited as outwash receiving periodic flow-till deposition from the uplands. Unit associated with Great Miami River Valley, Mill Creek Valley and Turtle Creek Valley.

SGC — Sand and gravel, Wisconsinan-age, similar to unit SG above, but included clay and silt interbeds are limited to the upper part of the unit, and concentrated just upstream of junctions with major tributaries. From 60 to 100 feet thick. Unit resulted as coarse-textured fans and deltas formed at the mouths of tributaries that were fed by a melting ice margin. Clay and silt accumulated in localized slackwater upstream of the tributaries. Unit found in the Little Miami River gorge between South Lebanon and Loveland.

TA — Loam till, generally Wisconsinan-age. Overlain by up to 3 feet of loess; loess generally thin or absent on slopes. Till may contain silt, sand, and gravel lenses. Average sand/silt/clay percentages of till 25/45/30 percent, ranging from 15/50/35 percent to 30/45/25 percent (Wentworth classification). Clasts larger than medium pebbles average about 5% of total volume of till but vary from 1% to 20%. Flat, well-drained areas leached to a depth of about 3 feet, including loess cap. Joints/fractures common. Averages 20 to 30 feet thick and ranges to 90 feet thick in buried valleys and end moraines. In deep buried valleys includes pre-Wisconsinan till and may include clay and silt beds. Stratigraphic name: Shelbyville Till. Local relief is low and landslides are generally limited to valley walls. Deposited by glacial ice. Common surficial unit in the central and northern part of the map area.

Ti — Loam till, Illinoian-age. Generally overlain by up to 3.5 feet of loess, but loess may be 10 feet thick along bluffs bordering major rivers. Till may contain silt, sand, and gravel lenses. Sand/silt/clay percentages of till vary widely averaging 25/47/28 percent and range from 8/43/49 percent to 34/41/25 percent (Wentworth classification). Upland areas leached to 6 feet, including loess cap. Joints/fractures common. Averages 20 to 30 feet thick and ranges to 90 feet thick in buried valleys. Stratigraphic names: Richmond and Centerville Tills approximately west of the Great Miami River, Rainsboro Till east of the river. Landsliding may occur in oversteepened, wet areas. Deposited by glacial ice. Most common surficial unit in the southeastern part of the map area.

Til — Flow-till with fine to coarse clastic interbeds, Illinoian-age. Flow-till, with characteristics of Ti above, in thin to moderately thick beds, interbedded with lesser amounts of horizontal to high angle layers of sand, gravel, fine sand, silt, and clay, inches to many feet thick. Unit averages 30 feet thick. Differs from unit SGB, which contains more sand and gravel, and unit IC, which contains less till. Stratigraphic name: Rainsboro Till. Found in high-level terraces near the Illinoian-ice margin, along the southern Mill Creek Valley. May have been deposited as till-derived debris-flows from a stagnant or drowned ice tongue in lowland trough, with some drift contribution from uplands.

Tk — Clay-loam till, Pre-Illinoian-age (Kansan-age in old terminology). Overlain by well-weathered loess, 5 to 10 feet thick, entirely leached. Till highly weathered, leached, brown to strong brown color; thin to absent on slopes; clay averages 50%, with sand and pebbles of resistant lithologies only; sand to 20% but generally less than 10%; pebbles less than 1% by volume. Sand-size voids common. Unit less than 30 feet thick. Informal stratigraphic name: Cincinnati till. Unit has a large shrink-swell capacity from a high percentage of mixed-layer clays; foundation problems may result where water has been removed from the unit. Deposited from glacial ice. The unit remains on a relatively small upland plateau and nearby narrow ridge tops surrounded by bedrock slopes; southwestern part of the map area.

BEDROCK UNITS

Ls — Limestone bedrock and limestone-derived colluvium, Silurian-age. Limestone, tan to reddish-tan, coarse-crystalline, medium to thin bedded; hard; Brassfield Formation. Present as a single, small outlier in the northeast portion of the study area.

L-S — Limestone-dominant bedrock and bedrock-derived colluvium, Ordovician-age. Interbedded limestone, medium gray, thin to medium bedded, fossiliferous, and shale, gray, thin to medium bedded. Limestone ranges from 50% to 85% of the unit, although shale-rich beds are present. Includes Point Pleasant, Fairview, Grant Lake, Arnheim, Liberty and Whitewater Formations. On side-slopes and toe-slopes, unit is colluvium, predominantly clay with downslope-oriented limestone slabs and organic matter. Colluvium has relatively low shear strength and is the source of numerous landslides, especially on steep slopes.

S-L — Shale-dominant bedrock and clay-rich, bedrock-derived colluvium, prone to landsliding, Ordovician-age. Interbedded shale, gray, thin to thick bedded, and limestone, medium gray, thin to medium bedded, fossiliferous. Shale ranges from 50% to 85% of the unit, although minor limestone-rich beds are present. Unit associated with the shale-rich Kope Formation, on steep slopes near Cincinnati and north of Cincinnati, and with the Waynesville Formation on uplands in the northern part of the map area. On side-slopes and toe-slopes, unit is clay-rich colluvium with downslope-oriented limestone slabs and organic matter. Colluvium has relatively low shear strength and is the source of numerous landslides, especially on steep slopes. Landslides commonly form at the colluvium-bedrock interface.

EXPLANATION

Sand and gravel pit. Pit bottom generally underlain by unconsolidated lithologic units of surrounding map-unit area(s). May contain reclaimed areas.

Boundary between map-unit areas having **different** uppermost continuous lithologies; underlying lithologies may or may not differ.

Boundary between map-unit areas having the **same** uppermost continuous lithology but different thickness or different underlying lithologies.

note: Boundary types reflect the relationships among uppermost **continuous** lithologies only, not patchy, discontinuous lithologies (in parentheses).

KEY TO LITHOLOGIC COLORS*

Surficial Units

- w — Water
- m — Made land and pits
- a — Alluvium
- C — Clay, Wisconsinan-age
- Cl — Clay, Illinoian-age
- Ck — Clay, Pre-Illinoian-age (Kansan-age in old terminology)
- G — Gravel, Wisconsinan-age
- IC — Ice contact deposits, Wisconsinan-age
- IM — Till and water laid deposits, Wisconsinan-age
- L — Silt, Wisconsinan-age
- Li — Silt, Illinoian-age
- LA — Silt, clay, sand and gravel, Wisconsinan-age
- S — Sand, Wisconsinan-age
- Si — Sand, Illinoian-age
- Sk — Clayey to pebbly sand, Pre-Illinoian-age
- SC — Fine sand, clay, and silt, unspecified age
- SG — Sand and gravel, Wisconsinan-age
- SGi — Sand and gravel, Illinoian-age
- SGA — Sand and gravel with paleosol, Pre-Wisconsinan-age
- SGC — Sand and gravel, Wisconsinan-age with clay and silt interbeds
- TA — Loam till, Wisconsinan-age
- Ti — Loam till, Illinoian-age
- Tk — Clay-loam till, Pre-Illinoian-age

- Ls — Limestone
- L-S — Limestone and Shale
- S-L — Shale and Limestone

* The colors on this map depict the uppermost continuous unit and are intended to assist in visualizing the geology of the area. Discontinuous units (in parentheses) and subsurface-only units are excluded in color assignments.

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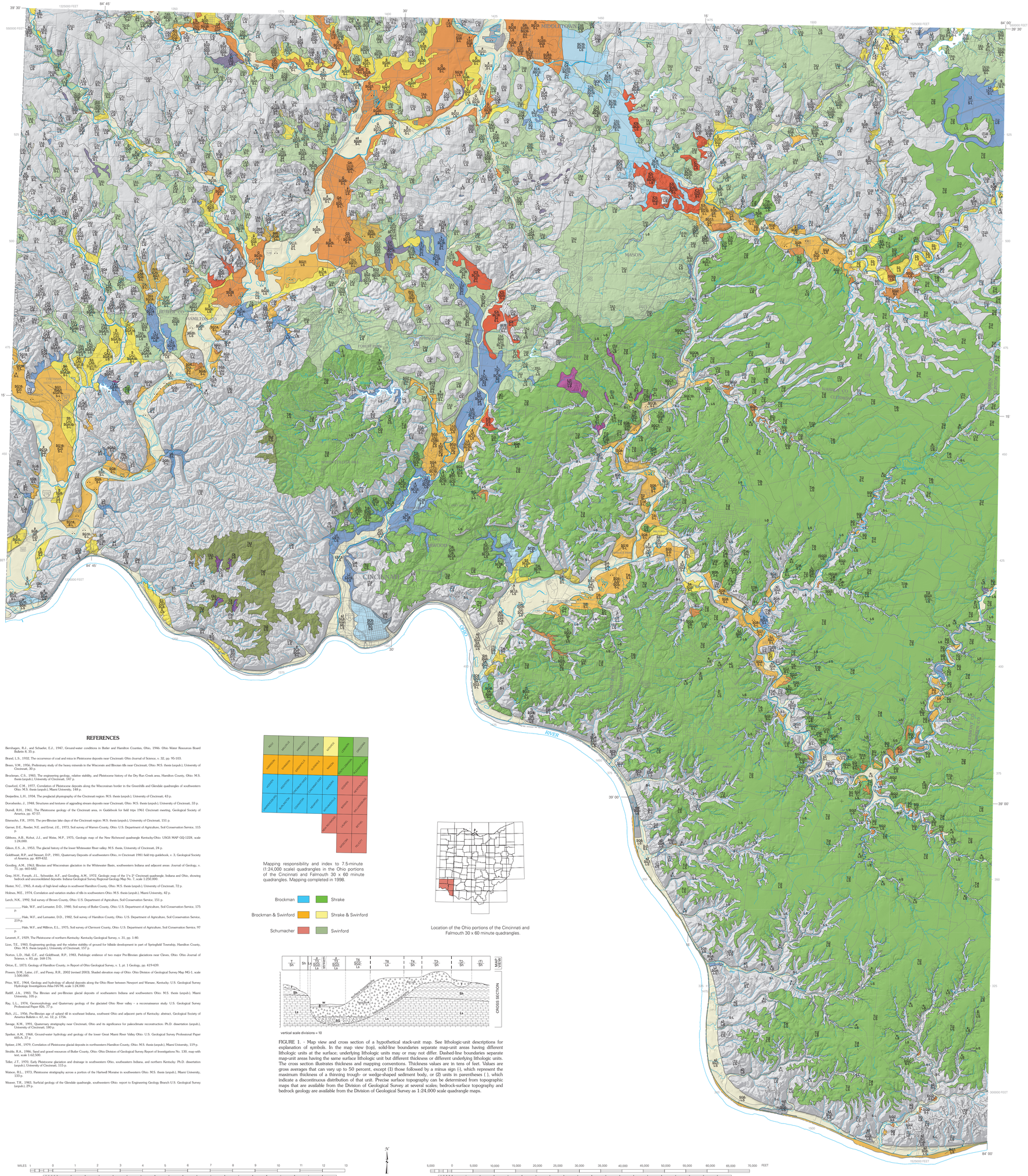

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