2018

Surficial Geologic Map of the Newport 7.5-Minute Quadrangle, Kentucky

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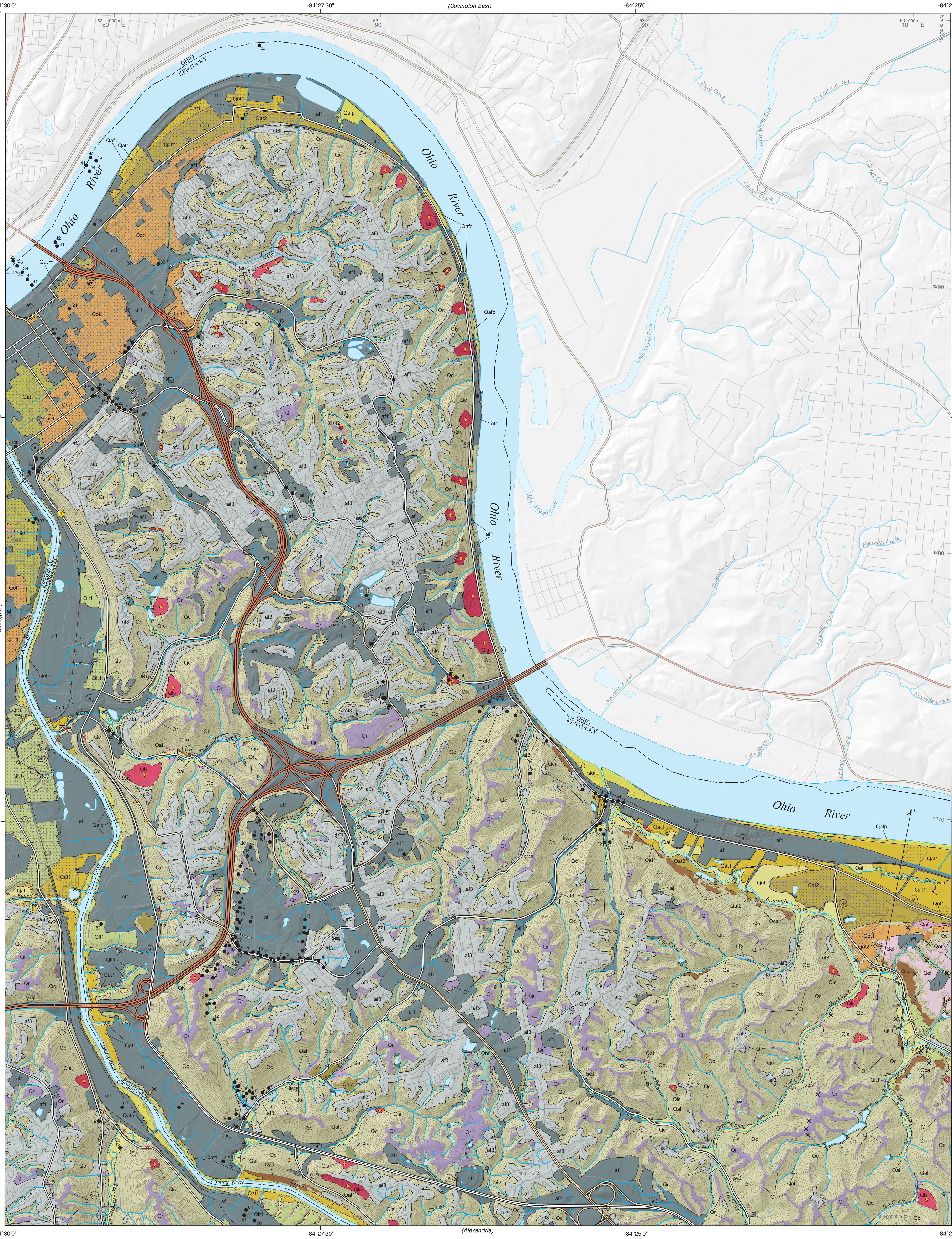
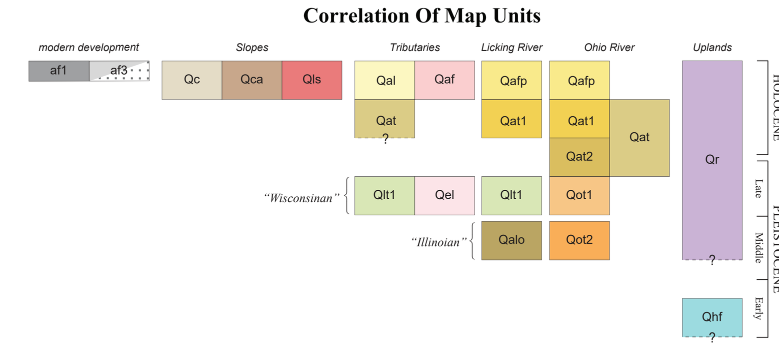


Correlation Of Map Units



Description of Map Units

af1 — **Artificial fill, engineered (modern)**
Engineered fill that includes compacted material used for road embankments, roadway interchanges, dams, levees, and major urban development. Narrow areas of fill along railroads and most highways are not differentiated.

af3 — **Artificial fill, other (modern)**
Disturbed sediment associated with the development of densely populated neighborhoods and urban areas, or areas where original topography has been drastically modified; transparent overlay is used in valley bottoms where underlying deposits are significantly thicker.

Qafp — **Alluvium, river floodplain (Holocene)**
Silt, sand, and gravel, brown to dark brown. Regionally derived limestone, siltstone, and igneous and metamorphic rocks from glacial deposition (Figs. 1, 2A). Modern river floodplain. Unit is up to 20 ft thick. Silt, clay, sand, gravel, and boulders, dark brown, dark yellowish brown, and brown, moderately to poorly sorted; angular slabs of locally derived limestone and shale and subrounded gravels of exotic sandstone, siltstone, quartz, and chert deposited in the modern floodplain of the Licking River (Fig. 2A). Flooding results in some backwash deposition in mouths of smaller tributaries. Depth to bedrock in the Ohio River has been reported at 60 ft or greater (Gibbons, 1973), and 0–80 ft along the Licking River, and likely includes underlying outwash.

Qal — **Alluvium, small creek floodplain (Holocene)**
Silt, clay, sand, gravel, and boulders, brown, dark yellowish brown, and dark brown. Imbricated slabs of locally derived limestone and shale deposited in small tributaries and associated floodplains (Figs. 1, 2A). Sediment provenance is local, but can include quartz, chert, and igneous and metamorphic rocks that have been reworked from sediments with regional provenance. Thickness of alluvium is up to 20 ft, and bedrock is commonly exposed in stream bottoms.

Qaf — **Alluvial fan (Holocene)**
Silt, sand, gravel, and boulder deposits; sediment is locally derived; poorly sorted. Successive water-dominated and -deposited debris flows and sheet-wash erosion. Present in watersheds where smaller streams enter a larger tributary; alluvial fans are usually associated with lobe-shaped contours and generally are in the shape of a fan. Thickness is variable from 5–20 ft and gradually thins downslope to the fan margin. Fans present in the outwash terraces are very sandy and composed of sediments from outwash.

Qc — **Colluvium, undifferentiated (Holocene)**
Clay, silt, sand, gravel, and boulders, dark yellowish brown to dark olive brown. Consists of locally derived residuum, glacial drift, and bedrock fragments (slabs of limestone and shale), commonly with scattered bedrock exposure. Soil horizons are not distinguishable; contacts inferred from LiDAR-derived slope angles greater than 12° and hummocky contours; deposits on Kope Formation mapped from slope angles greater than 10–12°. Locally developed along terrace risers and steep banks along rivers and streams; deposits occur along slopes of stream valleys and artificial cuts along roadways. Thickness is variable, but averages 9 ft. Contact with residuum and glacial drift on hilltops is gradational, and generally sharp with alluvium.

Qca — **Colluvium, accumulation zone (Holocene)**
Clay, silt, sand, gravel, and boulders, poorly sorted. Unit includes local areas of windblown sand and silt deposited on hillslopes, margins of lake deposits, and possible overlap with outwash and alluvial terraces. Wedge-shaped accumulations of colluvium at base of slopes characterized by inclined angles of slope less than 12° and local hummocky topography. Up to 26 ft thick.

Qls — **Landslide deposit (Holocene)**
Clay, silt, sand, gravel, and boulders. Gravel and boulders are locally derived from limestone, shale, and unconsolidated Qr and Qc resulting from active or recently active landslides (Fig. 3). Poorly sorted. Mapped by Crawford (2014) and Roenker and others (2018) and primarily based on the recognition of head and lateral scarps, with or without associated toe accumulation zones. Landslides are prevalent in the Kope Formation throughout the quadrangle, but most prevalent along the Ohio River. Unit does not include local creep and failure of road embankments.

Qat1 — **Alluvium, fluvial terrace generation 1 (Holocene)**
Silt, sand, and clay, brown to dark brown; reworked material of higher glacial deposits (Figs. 1, 2A). First regional terrace system above the Ohio River floodplain. Terrace tread is approximately 480 ft elevation. Well exposed along the Ohio River, near the confluence with Fourmile Creek. Silt, clay, and sand, yellowish brown to dark yellowish brown, associated with first benched terrace immediately above the modern Licking River floodplain (Fig. 2A). Qat1 of both the Ohio and Licking Rivers have similar tread elevations and are interpreted to be contemporaneous features. Mostly obscured by artificial fill and urbanization along and near the Licking River.

Qat2 — **Alluvium, fluvial terrace generation 2 (Late Pleistocene? – Holocene)**
Alluvium, fluvial terrace generation 2 (Late Pleistocene?–Holocene)
Silt, sand, and clay, brown to dark brown; reworked material of higher glacial deposits. Second regional terrace system above the Ohio River floodplain; terrace tread is approximately 490 ft elevation (Figs. 1, 2A).

Qat — **Alluvium, fluvial terrace undifferentiated (Pleistocene?–Holocene)**
Undifferentiated terraces consisting of Qat1 and/or Qat2 of the Ohio River; obscured by artificial fill and urbanization.

Qel — **Eolian, loess (Late Pleistocene)**
Silt, sand, and clay, dark yellowish orange. Mapped on slopes and ridges along the east side of the mouth of Fourmile Creek (Gibbons, 1973). Overlies glacial outwash and bedrock near mouth of Fourmile Creek. Thickness is variable, but up to 25 ft.

Qlt1 — **Lacustrine, terrace generation 1 (Late Pleistocene)**
Silt and clay, gray to light olive brown mottled with yellowish brown. Small, dark manganese (?) nodules are common and locally abundant. Comprises the most expansive terrace landform along the Licking River (Figs. 1, 2A). Thickness is 80 ft or more. Terrace tread elevations are consistently 530–535 ft elevation, similar to the elevation of Qot1 deposited at the mouth of the Licking River. Well exposed in the southern part of the quadrangle, but mostly obscured by urbanization to the north.

Qot1 — **Outwash, terrace generation 1 (Late Pleistocene)**
Sand, gravel, silt, and clay, gray to yellowish brown. Gravel consists of limestone, igneous and metamorphic rocks, chert, quartz, and coal. Commonly displays stratified layering and crossbedding. Associated with regional terrace system along the Ohio River in northern Kentucky (Figs. 1, 2A). Up to 170 ft thick near Newport (Price, 1964) and greater than 75 ft near Silver Grove.

Qot2 — **Outwash, terrace generation 2 (Middle Pleistocene)**
Silt, clay, sand, gravel, and conglomerate, olive gray to yellowish brown. Gravels include local limestone and scattered rocks of igneous and metamorphic origin. Associated with high terrace along the Ohio River and near the confluence with Fourmile Creek (Figs. 1, 2A). Intermixing of bedded outwash and nonbedded till suggests a glacial margin setting (Gibbons, 1973).

Qalo — **Alluvium, old (Middle Pleistocene?)**
High terrace and abandoned meander of the Licking River at approximately 600 ft elevation near Highland Heights; material interpreted to be alluvial, based on geomorphologic setting. Obscured by urbanization and development.

Qhf — **High-level fluvial (Pliocene? – Early Pleistocene)**
Clay, silt, sand, and gravel, reddish brown to brown. Mapped by Gibbons (1973) in the upland region near the southern quadrangle boundary. Deeply weathered, not presently exposed or preserved because of development.

Qr — **Residual soil (Pleistocene? – Holocene)**
Silt and clay, dark brown to yellowish brown. In-situ weathering of bedrock, in some areas. Thin glacially derived loess integrated into unit. Unconsolidated. Found overlying bedrock in uplands throughout the quadrangle (Fig. 2B); thickness is less than 13 ft. Contact with adjacent colluvium and glacial drift is gradational. Marked by well-developed soil horizons. in the field. Typically less than 13 ft thick.

Geologic Summary

The Newport 7.5-minute quadrangle is located in the Outer Bluegrass physiographic province (McFarlan, 1943) in the Greater Cincinnati metropolitan area of northern Kentucky and includes parts of Kenton and Campbell Counties. Topography is characterized by a relatively broad expanse of upland with moderate relief that is bounded by the Ohio River Valley, Licking River Valley, and Fourmile Creek. Gibbons (1973) mapped the bedrock geology of this quadrangle, which was later digitized by Sparks (2002). The entire quadrangle is underlain by horizontal Ordovician limestone and shale, consisting of the Point Pleasant Formation, Kope Formation, Fairview Formation, Bellevue Tongue of the Grant Lake Limestone, and Bull Fork Formation.

Multiple advances and retreats of the Laurentide ice sheet throughout the Pleistocene continuously adjusted the landscape of the central United States, including the Covington quadrangle. Pre-Illinoian glaciation in the Early Pleistocene impounded the Teays River system, causing widespread avulsion of the Teays and its tributaries (Teller, 1973; Ray, 1974; Andrews, 2004). Deep incision of bedrock valleys, headward erosion of tributaries, and development of a prominent weathering horizon throughout the region characterized the Yarmouth interglacial stage that followed the pre-Illinoian glaciations (e.g., Durrell, 1961; Ray, 1974). The present day course of the Ohio River was broadly in place before Illinoian glaciation in the Middle Pleistocene, which then served as the approximate limit of Illinoian ice and a drainage for outwash (Ray, 1974; Andrews, 2004; Potter, 2007). The Sangamon interglacial marked another period of Ohio River degradation, incising and removing much of the Illinoian deposits (Ray, 1974; Andrews, 2004; Potter, 2007). Late Pleistocene Wisconsinan ice did not reach Kentucky, but the Ohio River was used to transport high volumes of outwash (Ray, 1974; Andrews, 2004; Potter, 2007). The Holocene has been marked by relatively continuous period of erosion, river degradation, and soil development.

Surficial Geology

This map was generated using new field mapping, sample analysis, LiDAR elevation data (5-ft average horizontal spacing), aerial imagery, and compilation of data from water-well logs and Kentucky Transportation Cabinet geotechnical reports, landslide inventory mapping from Crawford (2014) and Roenker and others (2018), and outcrop information from Gibbons (1973). Previously published reports by Gibbons (1973), Price (1964), and Weisenberger and others (1973) were also used for interpretation. The map units described here reflect natural processes operating as an integrated dynamic geomorphic system (Newell, 1978). The primary mechanisms of sediment transport and deposition in this area are flowing water (fluvial processes), ice (glacial processes), and gravity/mass movement (colluvial processes), which can be complexly interrelated. Residual soils are interpreted to have accumulated as a result of in-situ chemical weathering of underlying bedrock, soil production, and erosion.

The large majority of low-relief land in the Newport quadrangle (upland and river valleys) has been modified by human development (af1 and af3) associated with the Cincinnati metropolitan area. In the high-elevation uplands, disturbance associated with af1 and af3 is interpreted to reach bedrock. Locally preserved areas of undisturbed, unconsolidated sediments in the uplands are characterized by residual soil (Qr) derived from in situ chemical weathering of the underlying limestone and carbonate shale (Fig. 2B). Depth to bedrock is approximately 13 ft, based on field observations, geologic relationships, water well data, and Kentucky Transportation Cabinet geotechnical borings. Gibbons (1973) mapped high-level fluvial silt and sand deposits (Qhf) that have been included here where not obscured by development. Gibbons (1973) interpreted these as fluvial in origin and correlative to fluvial and lacustrine deposits to the south in the Alexandria quadrangle (Gibbons, 1971). Given the high elevation (>820 ft), if these are fluvial deposits they must be older than 1.5 million years (unpublished data of KGS).

Areas of development (af1 and af3) and Qr in the uplands are mantled by colluvium (Qc) on hillsides and valleys with slopes generally greater than 12°. Qc is predominantly composed of actively eroding (gravity-driven) af1, af3, and Qr, along with detached slabs and scattered outcrops of bedrock (Fig. 3). Qc is also present below terraces associated with the Ohio and Licking Rivers, and the colluvial material is derived from the surficial material directly upslope. Accumulation zones of colluvium (Qca) are commonly found at the toes of steep slopes throughout the quadrangle; alluvial fans (Qaf) are similar in appearance to accumulation zones, but the fan-shaped landforms are deposited at the mouths of streams, gullies, and V-shaped valleys, presumably as a combination of episodic debris flows and regular sheet erosion. Landslides (Qls) have been mapped by Crawford (2014) and Roenker and others (2018) using a topographic signature and field investigations; Qls is located along steep slopes of Qc, especially along the Ohio River in the Newport quadrangle (Fig. 3).

Alluvial deposits with sediments of local provenance (Qal) are located in all active streams, which are tributary to the Ohio and Licking Rivers. Depth of Qal to bedrock ranges from 0 ft (bedrock pavements exposed in streambeds or along banks) up to 20 ft. In contrast, sediments in the Ohio and Licking Rivers and associated floodplains are derived from regional sources (Fig. 2A). Alluvial sediments of the Ohio River (Qafp, Qat1, and Qat2) are interpreted as Wisconsinan outwash that filled the Ohio River Valley (Qot1) and was later reworked by progressive incision of the river (Figs. 1 and 2A). Qat1 and Qat2 of the Ohio River are distinguished only by landforms and elevations of tread surfaces. Wisconsinan outwash (Qot1) is poorly exposed along Fourmile Creek (Fig. 1); however, borings (Price, 1964; Kentucky Transportation Cabinet), LiDAR elevation data, and regional observations indicate its presence beneath af1 and af3 at the mouth of the Licking River and beneath a relatively extensive layer of eolian (windblown) loess (Qel) east of Fourmile Creek. Fourmile Creek also presents evidence for the Illinoian glacial Episode (Qot2), where distinct terrace landforms are identified (higher in elevation than Qot1) and where Gibbons (1973) described outcrops of his "Illinoian" drift (Fig. 1).

Regional generations of alluvial terraces (Qat1 and Qat2) are also exposed along the Licking River (Fig. 2A). Qat1 of the Licking River has a similar tread elevation as Qat1 of the Ohio River and both are interpreted to have developed contemporaneously; however, the tread elevation of Qat2 along the Licking River is significantly higher (560 ft versus 490 ft) than Qat2 of the Ohio River and must be older. Lacustrine sediments (Qlt1) have been deposited along the Licking River and Fourmile Creek downstream from Qot1 at their confluences with the Ohio River. Qlt1 is located within well-defined terraces that are characterized by very consistent, aerially extensive tread elevations similar to the elevation of Qot1. The relationships between Qlt1 and Qot1 lead to the interpretation that the Licking River and Fourmile Creek were impounded by Wisconsinan outwash (Qot1), which created a slackwater depositional environment for Qlt1 to accumulate. It is possible that Illinoian glaciation and outwash (Qot2) created a similar environment, but we see no evidence of that in this quadrangle. An abandoned meander of the Licking River incised the eastern edge of the valley near the southern boundary of the Newport quadrangle. Remnant alluvial deposits remain in the meander and at elevations over 600 ft (Qalo) and must be older than Qat2 (Licking River).

Geologic Hazards

Landslides and flooding are the most common geologic hazards in the Covington quadrangle. Multiple landslide scarps are recognized on steep slopes of colluvium found throughout the quadrangle (Fig. 3; Crawford, 2014; Roenker and others, 2018). Creep and failure of roadways (af1) commonly occurs within or on top of steep colluvial slopes. Most landslides have been identified in Kenton and Campbell Counties by Crawford (2014) and Roenker and others (2018) using LiDAR elevation data. Flooding along the Ohio and Licking Rivers is common, with annual floods breaching the banks; in 1964 and again in early spring of 1997, flooding reached the city of Covington, as high as Qlt1 and Qot1 (concealed).

Areas in Kentucky underlain by limestone are commonly associated with high radon levels; however, the threat in Campbell and Kenton Counties is low (Overfield and others, 2016; BREATHE, no date a, b). Karst potential is also low, although one sinkhole has been identified near Edgewood close to the southern boundary of the quadrangle (Paylor and others, 2004; http://kgs.uky.edu/kgsweb/download/karst/sinkpick.htm [accessed 06/05/2018). Seismicity is rare, but has been reported; the earthquake of July 27, 1980, had an epicenter near Sharpsburg (Reagor and others, 1981). Mechanical properties of surficial materials likely plays a role in the development of these geologic hazards, but their significance has not been assessed.

Disclaimer

Acknowledgments

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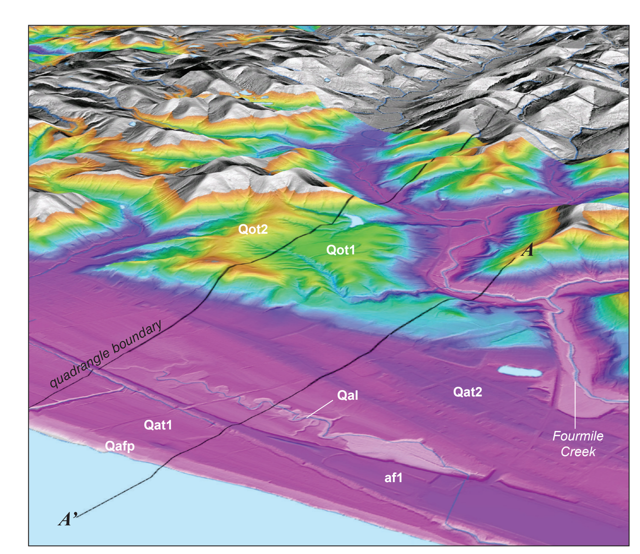


Figure 1. Three-dimensional hillshade image of the Ohio River Valley at the confluence with Fourmile Creek in the Newport quadrangle. Relative elevation model is shown by colored scale that represents feet above water level of the Ohio River. Notice the presence of multiple terraces along the Ohio River and Fourmile Creek (Qat1, Qlt1, and Qot1), fluvial incision (Qal) of these terraces by Fourmile Creek, urbanization of Silver Grove (af1 and af3), and prominent railroad embankment (af1). Short black line is cross section A-A'; long black line is eastern boundary of Newport quadrangle.

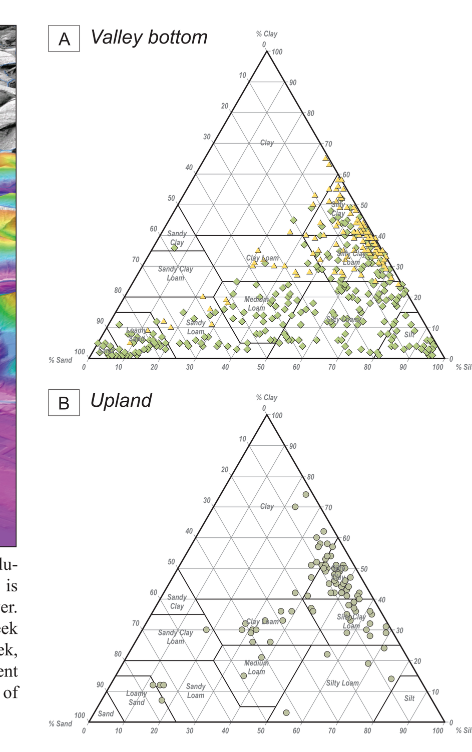
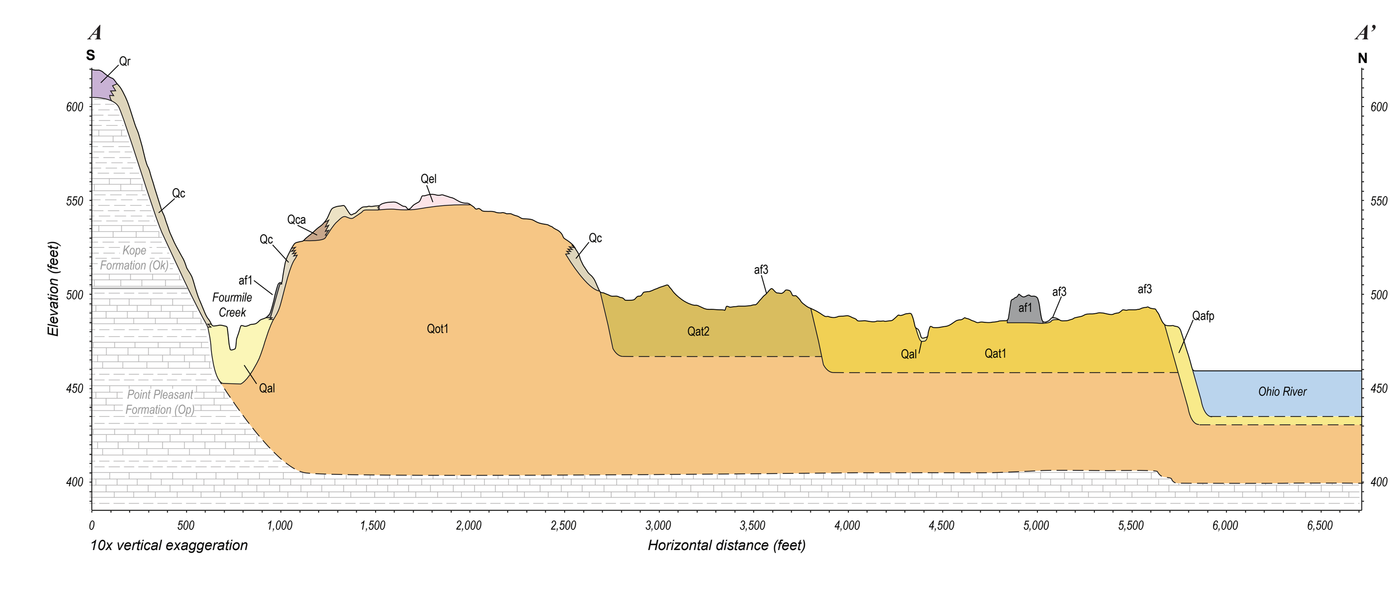


Figure 2. Sand-silt-clay ternary diagram of samples (Kentucky Geological Survey hand probe samples and Kentucky Transportation Cabinet geotechnical borings). USDA soil classification fields shown and labeled for reference. A. Valley bottom map units. Green diamonds, Ohio River outwash (Qot1; green diamonds); Yellow triangles, Licking River (Qafp, Qat1, Qlt1) and tributaries (Qal). B. Residual soil (Qr; green circles) from the upland.

Figure 3. Recent slope failure (Qls) within bedrock (Kope Formation) along Licking Pike northeast of Austinburg along the eastern slope of the Licking River.



Topographic lines and hillshading derived from KYAPED 5 Foot Digital Elevation Model and USGS 3DEP 1/3 arc-second digital elevation model.

Highways and roads from Kentucky Transportation Cabinet (KYTC) and Ohio Department of Transportation (ODOT). Railroads from OpenStreetMap.

Hydrography from National Hydrography Dataset High Resolution.

Digital data collected in Kentucky Single Zone State Plane Coordinate System. Lambert conformal projection, North American 1983 datum.

Topographic contours and hillshading may not be current within areas of artificial fill.

SURFICIAL GEOLOGIC MAP OF PART OF THE NEWPORT 7.5-MINUTE QUADRANGLE, NORTHERN KENTUCKY

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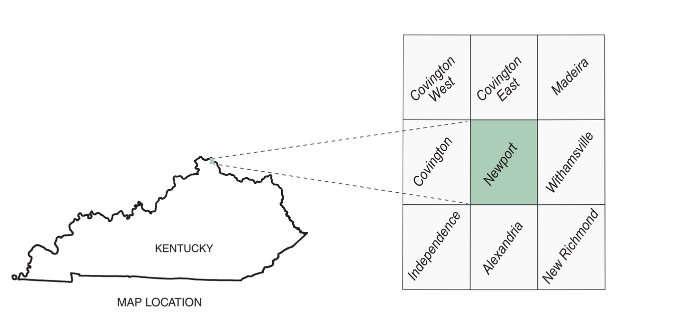
MN
GN
5°55´
105 MILS
0°48´
14 MILS
KY SINGLE ZONE GRID AND 2018 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOUR INTERVAL 20 FEET
SCALE 1:24,000

1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER



Explanation of Map Symbols

- State boundary
- County boundary
- Interstate
- U.S highway
- State highway
- Local road
- Railroad
- Topographic contour
- Small stream or creek
- River or large stream or creek
- Water body; pond or lake
- Contact
- Approximate contact
- Inferred contact
- Concealed contact
- Gradational contact
- Gradational approximate contact
- Drillhole data (Kentucky Transportation Cabinet; KGS water well database; Price, 1964); number indicates depth to bedrock in feet
- Sample (Kentucky Geological Survey; Kentucky Transportation Cabinet); numbers indicate silt+clay percentages
- Outcrop (Kentucky Geological Survey)
- Outcrop (Gibbons, 1973)
- Landslide (Crawford, 2014)
- Photograph Location