KENTUCKY GEOLOGICAL SURVEY
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UNIVERSITY OF KENTUCKY, LEXINGTON

GEOLOGIC MAP 2
Series XII, 2002

GEOLOGIC MAP OF THE LEXINGTON 30 x 60 MINUTE QUADRANGLE, CENTRAL KENTUCKY

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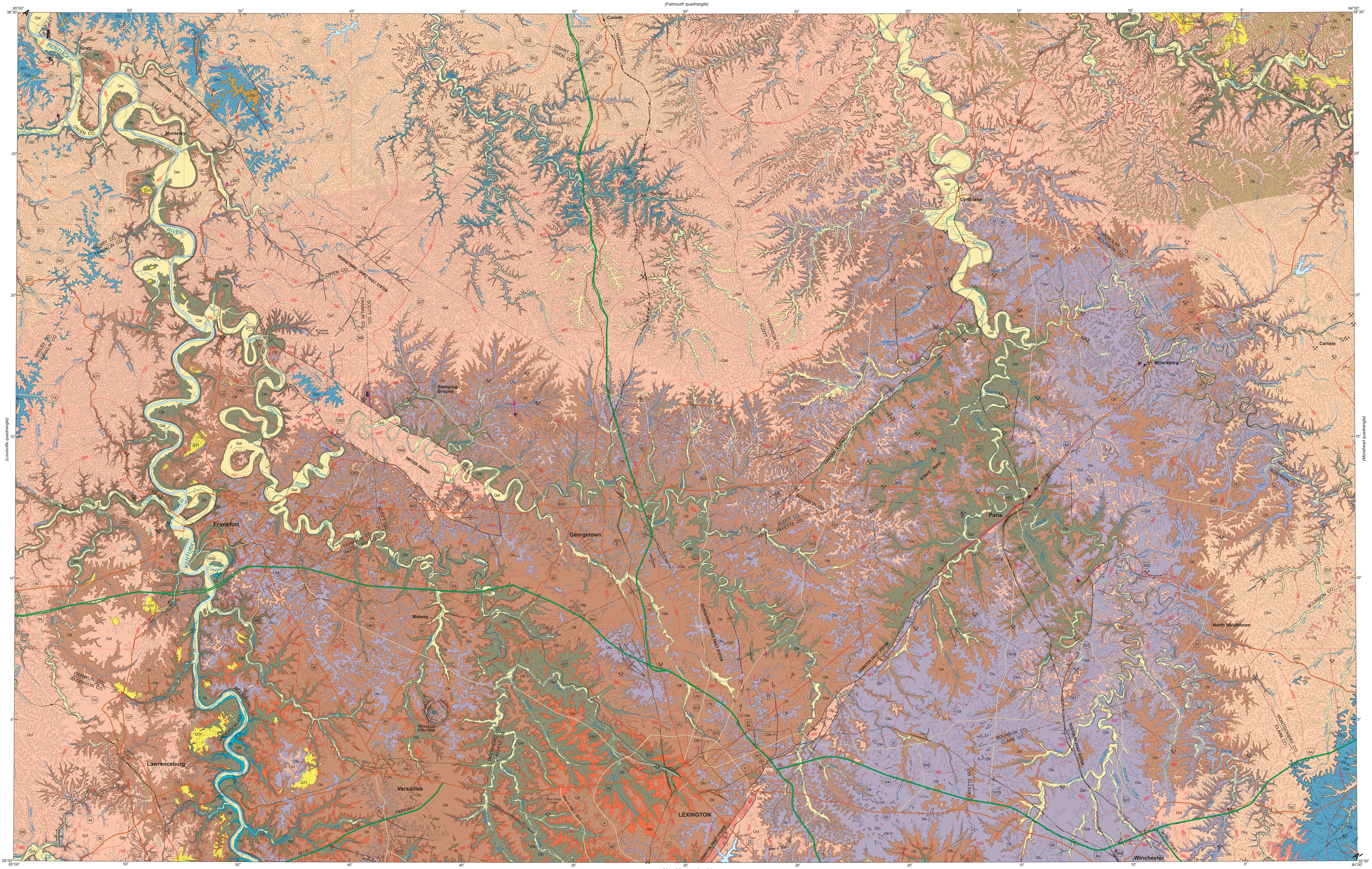
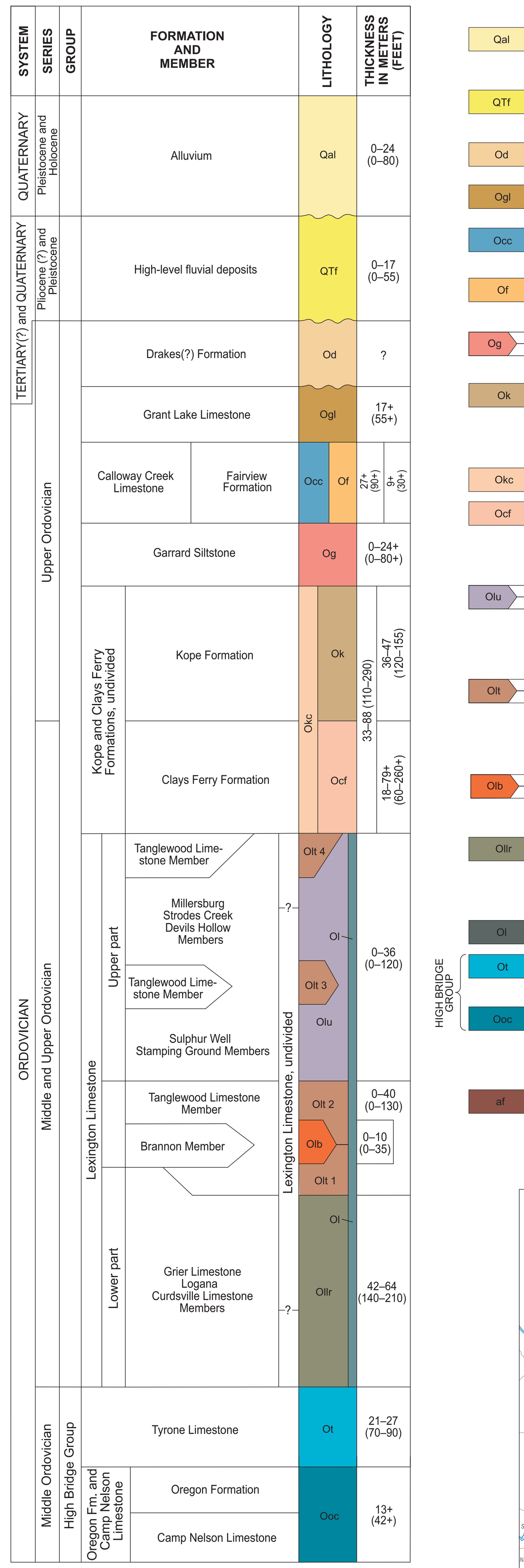
Cartography by Terry D. Hounshell





DESCRIPTION OF MAPPED UNITS

Qal — ALLUVIUM—Silt, sand, clay, and gravel. Silt, commonly clayey, partly sandy. Sand, very fine- to coarse-grained, commonly composed of limonite, limestone, and phosphate; partly quartzose. Clay, partly silty. Gravel composed of limestone, with lesser amounts of siltstone and shale; partly composed of quartz, chert, sandstone, and geodes derived from high-level fluvial deposits.

QTf — HIGH-LEVEL FLUVIAL DEPOSITS—Gravel, sand, silt, and clay. Gravel composed of quartz, quartzite, chert, sandstone, and geodes. Sand, very fine- to medium-grained. Clay, silty. Deposits occur on uplands along Kentucky and Licking Rivers and their tributaries.

Od — DRAKES(?) FORMATION—Dolomite and mudstone. Dolomite, microcrystalline to medium crystalline, interbedded with dolomitic mudstone. Unit occurs in graben in southwestern part of quadrangle.

Ogl — GRANT LAKE LIMESTONE—Limestone and shale. Limestone, argillaceous, very fossiliferous, with shaly partings. Unit occurs in northwestern part of quadrangle.

Occ — CALLOWAY CREEK LIMESTONE—Limestone, shale, and siltstone. Limestone, micrograined to coarse-grained, bioclastic, fossiliferous, partly argillaceous. Shale, calcareous, sparsely fossiliferous; in partings and interbeds. Siltstone, quartzose, calcareous in lower part of formation.

Of — FAIRVIEW FORMATION—Limestone and shale. Limestone, micrograined to coarse-grained, partly silty, sparsely to abundantly fossiliferous. Shale, calcareous in partings and interbeds; partly sandy to silty in lower part of formation. Unit occurs in northeastern part of quadrangle.

Og — GARRARD SILTSTONE—Siltstone, shale, and limestone. Siltstone, quartzose, calcareous. Shale, partly calcareous and silty; interbedded with siltstone. Limestone, micrograined to medium-grained, argillaceous, partly silty, sparsely fossiliferous. Unit occurs in southern part of quadrangle.

Ok — KOPE FORMATION—Shale and limestone. Shale, commonly calcareous and silty, sparsely fossiliferous; interbedded with lesser amounts of limestone. Limestone, micrograined to coarse-grained, fossiliferous. Locally dolomitized near fault in northern part of quadrangle. Unit intertongues and intergrades with Clays Ferry Formation. Kope Formation mapped in northeastern part of quadrangle; combined with Clays Ferry Formation as undivided unit in northern and eastern parts of quadrangle.

Okc — KOPE AND CLAYS FERRY FORMATIONS, UNDIVIDED

Ocf — CLAYS FERRY FORMATION—Limestone, shale, and siltstone. Limestone, micrograined to coarse-grained, partly bioclastic, partly silty, sparsely to abundantly fossiliferous; interbedded with about equal amounts of shale. Shale, calcareous, partly fissile, partly platy, sparsely fossiliferous. Siltstone, quartzose, calcareous. Unit intertongues with Lexington Limestone; intertongues and intergrades with Kope Formation. Clays Ferry combined with Kope Formation as undivided unit in northern and eastern parts of quadrangle.

Olu — UPPER PART OF LEXINGTON LIMESTONE—Unit consists of five members, in approximate ascending order: the Stamping Ground, Sulphur Well, Devils Hollow, Strodes Creek, and Millersburg Members. Limestone and shale. Limestone, micrograined to very coarse-grained, fossiliferous, partly bioclastic, partly argillaceous, partly cherty; commonly with partings and interbeds of shale. Shale, fissile, partly calcareous, sparsely fossiliferous. In parts of quadrangle, unit intertongues and intergrades with Clays Ferry Formation and Tanglewood Limestone Member of Lexington Limestone.

Olt — TANGLEWOOD LIMESTONE MEMBER OF LEXINGTON LIMESTONE—Limestone and minor shale. Limestone, very fine- to very coarse-grained, bioclastic, phosphatic, sparsely to abundantly fossiliferous, partly argillaceous, rarely cherty; with minor partings and interbeds of shale. In parts of quadrangle, unit intertongues and intergrades with Brannon Member and upper and lower parts of Lexington Limestone, and Clays Ferry Formation. Four subunits of Tanglewood delineated on quadrangle, in ascending order: lower tongue (no. 1), main body (no. 2), and upper tongues (nos. 3 and 4).

Olb — BRANNON MEMBER OF LEXINGTON LIMESTONE—Limestone and shale. Limestone, micrograined to medium-grained, argillaceous, partly silty, partly cherty, sparsely fossiliferous; with interbedded shale. Shale, fissile, partly calcareous, sparsely fossiliferous. Unit intertongues with Tanglewood Limestone Member of Lexington Limestone, and pinches out in parts of quadrangle.

Ollr — LOWER PART OF LEXINGTON LIMESTONE—Unit consists of three members, in ascending order: Curdsville Limestone, Logana, and Grier Limestone Members. Limestone and shale. Limestone, micrograined to coarse-grained, fossiliferous, commonly argillaceous, partly bioclastic, sparsely cherty, locally slightly phosphatic; interlayered with partings and beds of shale. In parts of quadrangle, unit intertongues and intergrades with Tanglewood Limestone Member of Lexington Limestone.

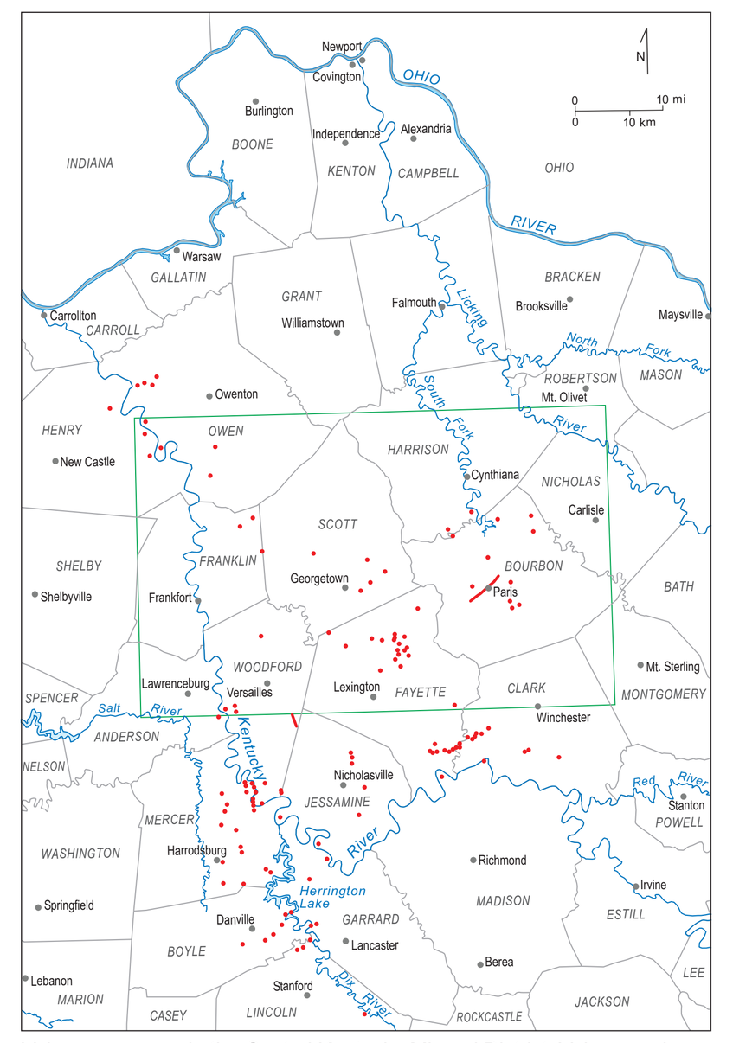
Ol — LEXINGTON LIMESTONE, UNDIVIDED

HIGH BRIDGE GROUP

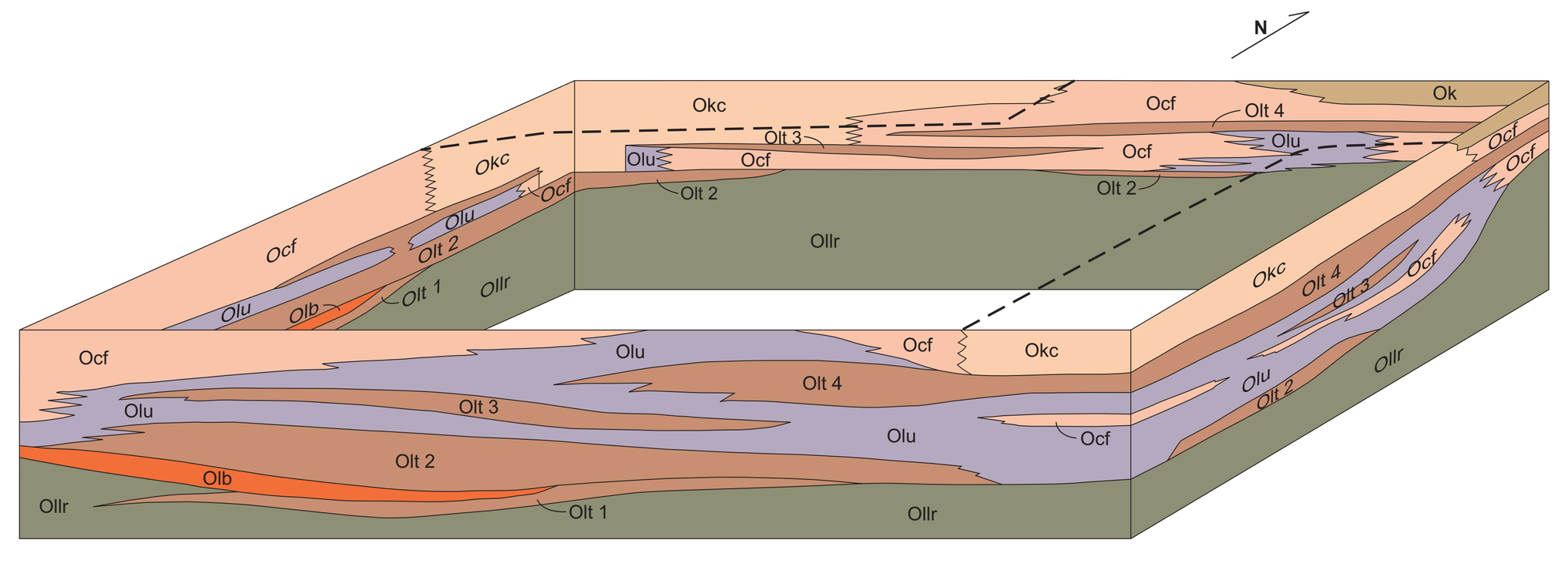
Ot — TYRONE LIMESTONE—Limestone and bentonite. Limestone, micrograined, with scattered stringers and blebs of crystalline calcite, partly shaly, sparsely fossiliferous. Bentonites at about 6 m below top and locally at or near top of formation.

Ooc — OREGON FORMATION AND CAMP NELSON LIMESTONE—Mapping unit consists of two formations, in ascending order: Camp Nelson Limestone (1.5+ m thick) and Oregon Formation (11.5 m thick). Dolomite and limestone. Oregon Formation mainly composed of dolomite, very finely crystalline, calcareous; interbedded with micrograined limestone in lower part of formation. Camp Nelson Limestone composed of limestone, micrograined, mottled with irregular bodies of very finely crystalline dolomite.

af — ARTIFICIAL FILL—Compacted rock debris from highway and railroad construction.



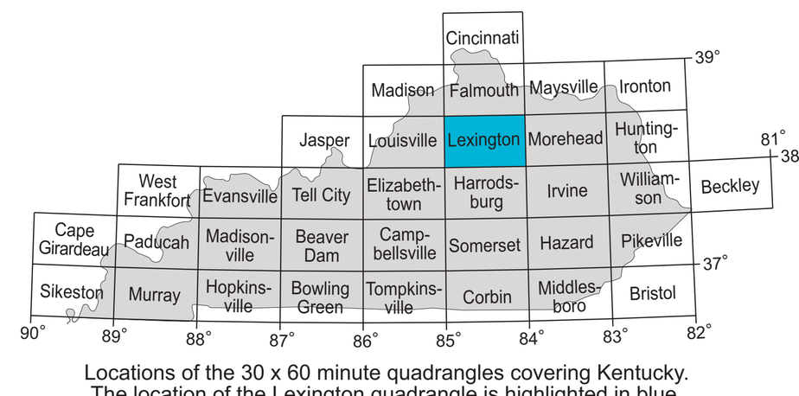
Vein occurrences in the Central Kentucky Mineral District. Veins are shown by red dots and lines; area of Lexington 30 x 60 minute quadrangle map is indicated by the green outline.



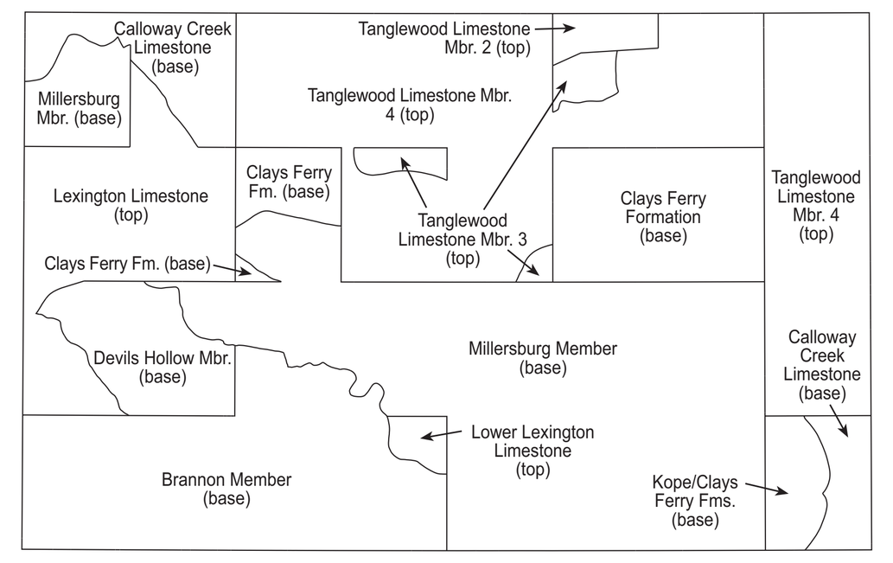
Generalized fence diagram illustrating stratigraphic relationships between the tongues of the Tanglewood Limestone Member, the upper and lower Lexington Limestone, the Clays Ferry Formation, and the Kope Formation in the mapped area. The dashed line represents the mapped stratigraphic boundary of the Kope and Clays Ferry Formations, undivided (Okc) at the surface.

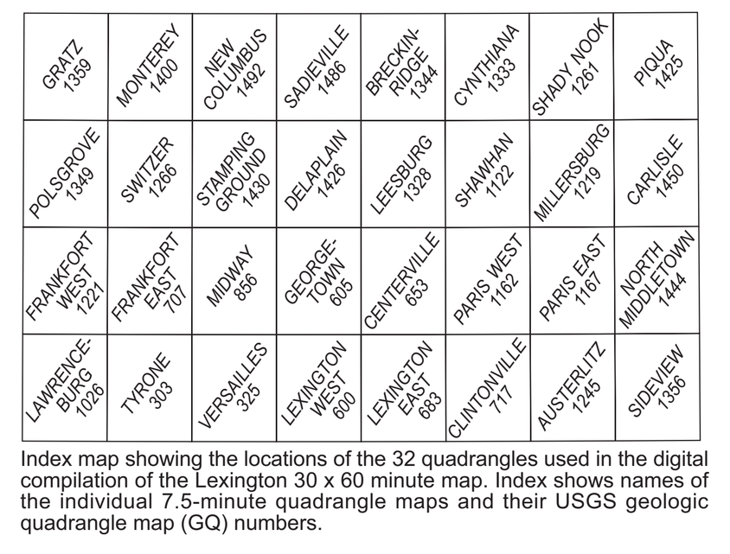
EXPLANATION

- Interstate highway or parkway
- U.S. highway
- State highway
- County boundary
- City boundary
- Railroad
- Normal fault (U, upthrown side; D, downthrown side)
- Concealed fault
- Structure contour, feet
- Concealed contact
- Active stone quarry or mine
- Abandoned stone quarry or mine
- Abandoned sand or clay pit
- Mineral vein
- Mineral prospect or outcrop
- Abandoned vein-mineral mine shaft
- Abandoned vein-mineral mine adit



Locations of the 30 x 60 minute quadrangles covering Kentucky. The location of the Lexington quadrangle is highlighted in blue.



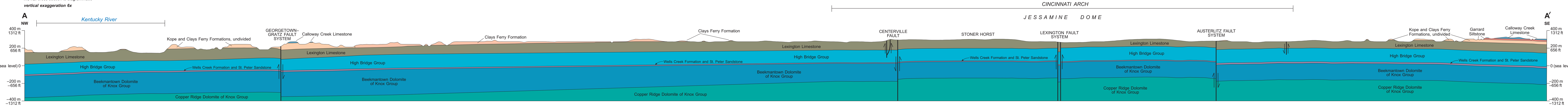


SCALE 1:100 000

ACKNOWLEDGMENTS: This map was digitally generated from 1:24,000-scale geologic maps under the STATEMAP Program authorized by the National Geologic Mapping Act of 1992, Grant No. 99HQAG0035, and was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program.

NOTE: cross section is diagrammatic

vertical exaggeration 6x



INTRODUCTION

This map of the geology of the Lexington 30 x 60 minute quadrangle was compiled mostly from digital U.S. Geological Survey 7.5-minute geologic quadrangle maps (GQ's), as cited in the references. The GQ's are products of a cooperative mapping project between the U.S. Geological Survey and the Kentucky Geological Survey from 1960 to 1978. Several regional geologic studies on mapping and stratigraphy (Cressman, 1973; Cressman and Noger, 1976; Dever, 1980), structure (Drahovzal and Noger, 1995), minerals (Anderson and others, 1982; Anderson, 1994), and karst (Currens and Ray, 1996) have resulted in new publications since the original geologic quadrangle maps were completed. This new information led us to make changes on the new digital 7.5-minute maps. These changes are shown on this map, and were necessary for updating and compiling regional maps and for stratigraphic continuity between quadrangles. The 7.5-minute quadrangles that make up the Lexington 30 x 60 minute quadrangle are shown in the index map.

The digital geologic map data files are part of a comprehensive relational and spatial data set (Anderson and others, 1999) being developed by the Kentucky Geological Survey that will be available via the Internet in the near future. Users will have at their disposal a spatial database from which to select any map or particular map themes to create custom maps and add supplemental oil, mineral, coal, or water information. This powerful database of geologic information can be used in a geographic information system (GIS) for analysis or manipulation of the data.

PROCEDURE

The 7.5-minute quadrangle maps were digitally compiled using a semi-automated data-capture technique to convert hard-copy geologic maps into digital format. Compiling 7.5-minute maps into a 30 x 60 minute map required the resolution of significant problems, such as (1) correlating geologic formations across quadrangle boundaries, (2) resolving nonuniform structure-contour datums or intervals, and (3) resolving discrepancies in Quaternary alluvium boundaries and inferred contacts. The metadata portion of the digital file provides detailed sources of data and information about the conversion process. Formations and formation boundaries were not mapped the same way on each of the 7.5-minute quadrangle maps as they were compiled between 1960 and 1978. Resolution of the differences between quadrangles was necessary for topological analysis in a GIS environment. In addition, numerous small members mapped on individual 7.5-minute quadrangle maps are too small to be mapped at a scale of 1:100,000 on a 30 x 60 minute quadrangle map. These problems were resolved by adhering to geologic, cartographic, and GIS standards appropriate for the scale of the map.

This map is a compilation of existing maps, and no additional field work took place. When there were problems in stratigraphic correlation between quadrangles, the best current data available were used to resolve these differences.

GEOLOGIC SETTING AND STRUCTURAL GEOLOGY

The geology of the Lexington 30 x 60 minute quadrangle consists of flat-lying sedimentary rocks of Ordovician age, which occur along the north-trending Cincinnati Arch, a structural feature that extends from Ohio through Kentucky to Tennessee. The Jessamine Dome, a regional domal structure, lies along the Cincinnati Arch in the central Kentucky area. The Ordovician rocks consist of limestones, shales, and siltstones. The Tanglewood Limestone Member of the Lexington Limestone has the most complex facies relationships and consists of intertonguing beds of phosphatic limestone (see fence diagram).

The crest of the Cincinnati Arch trends north across the quadrangle, and the apex of the Jessamine Dome occurs in the adjacent Harrodsburg 30 x 60 minute quadrangle (Sparks and others, 2001). The northern part of this dome is reflected in the semicircular outcrop pattern of the Upper Ordovician units in the center of the map. Two major fault systems transect the quadrangle: (1) the Lexington Fault System, between Lexington and Paris, and (2) the Georgetown-Gratz Fault System, herein defined as the northwest-trending fault segments from their bifurcation at the Lexington Fault System to the northwestern terminus near Gratz in Owen County. The Switzer Graben is a major component of the Georgetown-Gratz Fault System in Scott and Franklin Counties. An unnamed horst, herein named the Stoner Horst, extends northeastward, bounded on the southeast by the Lexington Fault System and on the northwest by the Centerville Fault. The Versailles Structure is a circular faulted structure in Woodford County. Mapped by Black (1964), it was originally interpreted as a meteorite impact structure, but Black (1986) subsequently described possible hydraulic diapiric events, "point source explosions," as a potential cause for the Versailles Structure.

ECONOMIC AND ENGINEERING GEOLOGY

Limestone, vein minerals, and oil and gas are the principal mineral resources for the Lexington quadrangle. Limestone suitable for construction aggregate and agricultural products is being quarried and mined from the Lexington Limestone in Scott, Bourbon, and Henry Counties and mined from the High Bridge Group in Anderson, Fayette, Franklin, and Scott Counties (Dever, 1980; Anderson and Dever, 2001). Cumulative production from these mines is estimated at about 7 million tons per year. Several of these mines operate in urban areas, and many quarry operations have decided to mine deeper horizons because of the difficulty of obtaining surface-mine permits.

The Lexington quadrangle is in the heart of the Central Kentucky Mineral District, in which approximately 70 known mineral veins contain barite, galena, sphalerite, and minor amounts of fluorite and calcite (Anderson and others, 1982) (see map on left side of map sheet). Several of the veins in Fayette, Scott, Owen, Bourbon, and Harrison Counties were mined in the early 1900's, and the Gratz veins in Owen County were mined during World War II. Most veins are too small to be mined economically unless they are mined as a by-product of a limestone mining operation. All mines are now abandoned, and urban encroachment and industrial development are preventing many of these veins from being considered for future mining or geologic examination. These veins are usually north-trending, vertical, 1 to 8 ft in width, and extend for several thousand feet along strike. There have been several stratigraphic tests in the search for deeper mineral occurrences in the subsurface of the quadrangle. Drilling and core analysis in Owen, Bourbon, and Clark Counties showed traces of galena, barite, and sphalerite in the Knox Group (Cambrian–Ordovician).

Two minor oil and gas fields occur in this quadrangle (Wilson and Sutton, 1976). The Corinth and Plum Lick Fields produced gas from the shallow Sunnybrooke zone in the Lexington Limestone, at a depth of less than 500 ft. These wells were drilled in 1950 (Corinth) and 1915 (Plum Lick), and some of the wells at Corinth had an initial production of 350,000 cubic feet of gas per day. Cumulative production is not known, but the wells were only open for a few years. Other wells in the area have had shows of oil or gas or produced small amounts, but no other major production is known. A few wells penetrated the Knox Group, but no production was ever recorded.

More than 100,000 tons of phosphate were mined in parts of central Kentucky during the early 1900's near Wallace in Woodford County. Phosphate occurs in several quadrangles in the Tanglewood Limestone Member of the Lexington Limestone, and is concentrated during weathering.

Limestone provides a satisfactory foundation for moderate to heavy loads where the bedrock is unaffected by dissolution from groundwater. Groundwater moving along vertical fractures, or joints, will dissolve limestone. The resulting void may be identified as a sinkhole, or not recognized at all. Unconsolidated rock debris and soil may fill or bridge the void, making the affected area prone to sudden collapse or foundation failure. Because of these potential hazards, building sites should be carefully investigated prior to construction.

Slope instability in thick sequences of shale in the Kope and Clays Ferry Formations affects construction and engineering projects. Landslides or slumps could occur when developed slopes on the Kope Formation are saturated with water.

HYDROGEOLOGY

The Lexington quadrangle covers parts of regions 5, 6, 7, and 8 of the Kentucky River Basin watershed (Carey and others, 1994). The availability and quality of groundwater in this area is discussed in Palmquist and Hall (1960, a–c), Currens and Graham (1993), Currens and Ray (1996), and Kipp (1997). During the drought of 1999, this area was severely affected by the lack of surface water, and many near-surface springs and wells went dry. Sections of the Kentucky River were very low, and part of the Licking River was dry during this drought. Sources of groundwater may be found in deeper horizons such as the Knox Group (Kipp, 1997). This deeper aquifer may have farm or agricultural use.

Most groundwater in the Lexington quadrangle is obtained from wells less than 100 ft deep in shallow alluvial or bedrock regolith. Wells in alluvium near the Kentucky River or other major streams may provide adequate water (up to 500 gallons per day) for farms or commercial operations at shallower depths. Shallow carbonate aquifers in the southern part of the quadrangle are karstic. Groundwater in karst aquifers occurs in solution-enlarged joints, bedding planes, and limestone caves. The limestone rocks beneath the high-level fluvial deposits along the ancestral Kentucky River may have induced karst-related features in these areas. These features provide a relatively small target for water-well drilling, so several dry holes may be drilled before a well producing an adequate supply for domestic use is found. Where favorably located, springs provide a more predictable supply. Water from all wells and springs in karst aquifers should be sanitized before human consumption.

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