UNIVERSITY OF KENTUCKY, LEXINGTON

Alluvium

lacustrine deposits

Older alluvium

terrace deposits

Terrace deposits

Sample Sandstone

Beaver Bend and Paoli

Sandstone member of

Mooretown Formation

Ste. Genevieve Limestone

St. Louis Limestone

Harrodsburg Limestone

Muldraugh Member

Nancy Member

Kenwood Siltstone

New Albany Shale

of Sellersburg Limestone

Osgood Formation

Drakes Formation

Upper part of Grant

Ashlock Formation

Lower part of Grant

Lake Limestone

Calloway Creek Formation

Clays Ferry Formation

Upper part of

Lexington Limestone

Lexington Limestone

Garrard Siltstone

Lake Limestone

**Brassfield Dolomite** 

Waldron Shale

Laurel Dolomite

Shale Member

crinoidal Is.

OLDER ALLUVIUM—Outwash in the Ohio River Valley: clay, silt, sand, and gravel. Clay and silt are as much as 10 m thick. Sand and gravel deposits are as much as 25 m thick, containing quartzite cobbles and slabs of limestone and dolomite. Unit mapped in the Fort Knox 7.5minute quadrangle. OLDER ALLUVIUM AND TERRACE DEPOSITS—Silt, clay, sand, and minor gravel. Deposits consistently present at 10 m and 25 to 30 m above floodplain. Unit is less than 7 m thick on the lower terraces Lower 2 to 3 m of unit is more gravelly, consisting of quartz and chert

uartz. Clay occurs as an upper lacustrine deposit and is silty and

calcareous; it is approximately 9 m thick, underlain by coarser alluvium

a broad flat area believed to be the slightly eroded surface of a

deposits. Alluvium occupies tributary valleys. Lacustrine deposits occupy

TERRACE DEPOSITS—Gravel, sand, silt, and clay. Gravel is primarily composed of sand, rounded to subangular pebbles and cobbles of chert, siltstone, geodes, quartzite, and silicified limestone; interbedded with sand, silt, and clay. Unit ranges from 5 to 17 m thick, commonly 15 to 35 m above normal floodplain level. In the Fort Knox 7.5-minute quadrangle, unit is as much as 116 m above present level of local river. SAMPLE SANDSTONE—Sandstone, fine-grained; occurs as unconsolidated sand capping a hill at the western edge of the quadrangle. BEAVER BEND AND PAOLI LIMESTONES—Limestone, very fine- to medium-grained, thin- to thick-bedded; oolitic in part, crinoidal in par cally argillaceous. Basal part contains chert and, locally, quartz rosettes. Unit forms moderate slopes to more resistant flaggy limestone outcrops. Generally, indistinct lower contact is placed above highest occurrence of pre-Chesterian fossils or abundant chert. SANDSTONE MEMBER OF MOORETOWN FORMATION—Sandstone. fine- to medium-grained, well-sorted, quartzose, thick-bedded, poorly o moderately cemented by quartz overgrowths and iron oxide. Unit is mainly slumped and weathered, shows southwest-dipping crossbedding locally fractured. Rests on deeply weathered clay residuum of the S Louis Limestone. In a small part of the Fort Knox 7.5-minute quadrangle the unit occupies a well-defined channel cut into the rocks that overli

gravel, carbonized plant debris, and clam shells.

the St. Louis Limestone. Channel continues toward the southwest. STE. GENEVIEVE LIMESTONE—Limestone and dolomite. Limestone, very fine- to medium-grained, thick-bedded, some layers containin rossbedding; commonly oolitic, crinoidal (Platycrinites); locally dolomitic and argillaceous. Weathers to smooth, rounded surfaces. Persistent zone of echinoid spines and plates in oolitic limestone near base. A silicified limestone bed about 10 m above Lost River Chert weathers to concentrically lavered ellipsoids. Dolomite, very fine-grained, massive locally calcareous; contains fist-size vugs filled with calcite. Lost River Chert is estimated as basal contact of unit, occurring as banded and nodular chert. Unit forms low hills and lowlands with numerous sinkholes; also commonly topped with slumped sandstone caused by dissolution

LOUIS LIMESTONE—Limestone, dolomite, and shale. Limestone, ne- to medium-grained, silty, locally carbonaceous, siliceous; thin- to hick-bedded; several zones of chert present. Lower part of unit is locally laminated, clayey, and dolomitic. Fossils include brachiopod fragments and colonial coral *Lithostrotion proliferum*. Dolomite, very fine-grained, massive: locally calcareous; contains fist-size yugs fille with calcite. Shale, calcareous, thin-bedded. Unit weathers to very thick clayey soil; forms rolling hills and abundant sinkholes.

SALEM LIMESTONE—Limestone, shale, dolomite, and siltstone. imestone, very fine- to coarse-grained, thin- to medium-bedded. Unit is highly variable, coarse-grained limestone grading laterally into finerained limestone; coarser layers contain crossbedding. Partly clastic. bundant fossils, including brachiopods, fenestrate bryozoans foraminifera, horn coral, crinoid columnals, trilobites, and blastoid calyxes. Fine-grained layers are even bedded, slightly dolomitic, contain ypsum-filled geodes. Shale, calcareous, silty, fissile, with abundant ssil fragments; makes up mainly the lower 6 m of the formation where beds. Dolomite. verv fine-grained to microgranular. thick-bedded alcareous and clayey; contains scattered fossil debris and few geodes. Siltstone, dolomitic and calcareous, slightly laminated; occurs in middle

ARGILLACEOUS LIMESTONE OF SALEM LIMESTONE—Argillaceous limestone and shale; scattered fossils, including blastoids and brachiopods; geodes common. Insolubles range from 40 to 60 percent; loss of carbonate during weathering produced rounded, gullied, barren slopes. Unit is more than 15 m thick in some areas.

LEM AND HARRODSBURG LIMESTONES—Limestone, mediumarse-grained, calcarenite, crinoidal; thin- to medium-bedded, in art crossbedded; basal bed contains disseminated quartz grains. Unit occurs on hilltops in the Gravel Switch 7.5-minute quadrangle. HARRODSBURG LIMESTONE—Limestone, coarse- to very coarsegrained with a finely crystalline calcite matrix; thin- to thick-bedded, ocally interbedded with silty dolomitic limestone: most of unit is crossbedded, stylolitic, very crinoidal. Scattered to abundant fossils ncluding crinoid columnals, fenestrate bryozoans, echinoid plates, and rachiopods. Glauconitic grains abundant. Scattered geodes as much as 22 cm in diameter. Upper part of unit is thick beds of nearly pure calcite-forming ledges: lower part of unit has thin beds with several chert layers. Sharp lower contact except where weathered. Sinkholes present; springs common at base.

BORDEN FORMATION—Unit consists of seven members, in ascending order: New Providence Shale, Nancy, Cowbell, Halls Gap, Wildie, lada, and Muldraugh Members. Most members were combined as Borden Formation for the purposes of making this map. Shale, siltstone, limestone. Shale, clayey and silty, irregular bedding; large abundant ironstone concretions. mostly unfossiliferous. Few beds with abundar crinoid columnals. Phosphatic nodules common. Plastic when we small landslides very common. Siltstone, thick-bedded, massive, quartzose; generally occurs as single beds within shale and clay shale. abular bedding, commonly discontinuous. Limestone, varies in grain size, silty, thin- to thick-bedded. Dips of 5° to 10° common. Dolomitic contains detrital crinoid stems. Unit becomes coarser-grained toward

MULDRAUGH MEMBER, BORDEN FORMATION—Siltstone, dolomite, and limestone. Siltstone, dolomitic, calcareous, micaceous, locally glauconitic; locally grades into fine-grained sandstone, complexly interbedded with other lithologies. Dolomite, very fine-grained; calcareous, silty and argillaceous in part, silicified locally, giving a mottled appearance; chert lenses and quartz geodes common. imestone, dolomitic, siliceous, sandy and silty; thin-bedded; few crinoid olumnals, few partially oxidized pyrite nodules. Basal part of member is a glauconitic zone 1 to 2 m thick

SANDSTONE BED, BORDEN FORMATION—Sandstone, fine- to very fine-grained, mainly carbonate cement, contains limonite and secondary silica. Steep crossbedding. Unit present in the southwest part of the CRINOIDAL LIMESTONE. BORDEN FORMATION—Limestone, fine-

to coarse-grained, contains abundant whole and partial crinoid columnals nin- to thick-bedded, crossbedded; occurs as discontinuous beds and lenses interbedded with siltstone; grades laterally into siltstone. Resembles reef-like deposits in south-central Kentucky. TSTONE MEMBER, BORDEN FORMATION (TURBIDITE BEDS)— Siltstone, fine-grained, quartzose; obscurely graded without lamination or with planar lamination; individual beds range from 10 cm to 5 m nick, discontinuous; occur as single beds or in a sequence of as many is 30 tabular beds interbedded with clay shale. Bottom of beds have ute, groove, and prod casts characteristic of turbidites. Unit locally fills scours cut as much as 20 m into underlying shales; beds along sides of channels dip as much as 12°.

HALLS GAP MEMBER, BORDEN FORMATION—Siltstone, quartzose, micaceous; grades laterally and is underlain by shale. Top of member marked by zone of abundant glauconite. Thin stringers of limestone and dolomite are present locally. Basal contact commonly where unit becomes more fissile, shaly. NANCY MEMBER, BORDEN FORMATION—Silty shale, quartzose,

micaceous; similar but less stable than the Halls Gap Member. Abundant

Interstate highway or parkway

Normal fault (U, upthrown side;

U.S. highway

State highway

—-—- County boundary

D, downthrown side)

Concealed contact

····· City boundary

····· Concealed fault

Inferred contact

Contact

trace fossils present, including worm marks and *Zoophycus*. Isolated beds of crinoidal limestone and dolomitic siltstone occur near the upper part of unit. Nancy is equivalent to "Upper shale member" of Borden formation on other 7.5-minute quadrangle maps. KENWOOD SILTSTONE MEMBER, BORDEN FORMATION—Siltstone and shale, interbedded. Siltstone, clayey, sandy, limonite-stained on bedding surfaces and joints; bedding obscurely graded; abundant groove sole marks and trace fossils: unit characteristic of turbidit eposits. Shale resembles that of the New Providence Shale Member.

where fresh. Weathers along iron-stained laminations and pyrite to a ery friable, iron-oxide- and sulfate-stained shale. Coalified plan remains and silicified logs as much as 1 m long are present throughout middle of unit. Contains lenses and thin layers of illitic clay shale and sandstone. Basal contact is sharp. IEW ALBANY SHALE AND BEECHWOOD LIMESTONE MEMBERale. limestone. and dolomite. Shale. carbonaceous. with numerous odules and veinlets of pyrite; laminated, massive where fresh; weathers long iron-stained laminations and pyrite to a very friable, iron-oxideand sulfate-stained shale. Unit contains spores, conodonts, brachiopods, and fish teeth. Limestone, fine- to coarse-grained: thick-bedded, calcitinatrix; fossils present crinoids (including spiked variety commonly

identified as *Dolatocrinus*), brachiopods, horn coral, and bryozoans; nodular chert present locally. Dolomite, very fine-grained, unfossiliferous, present as upper 0.5 m of Beechwood Limestone Member. Beechwood Limestone Member weathers out to resistant round slabs. SEECHWOOD LIMESTONE MEMBER OF SELLERSBURG IMESTONE—Limestone, coarse- to very coarse-grained, containing ossil fragments and whole fossils in a micritic matrix; very thin- to thinedded, locally crossbedded, stylolitic; pyrite common at top and base. ndy phosphatic layer at the base contains fish scales and other organic phosphatic debris. Unit forms ledges up to 1.5 m thick. SOYLE DOLOMITE—Dolomite, limestone, and sandstone. Dolomite, nglomeritic, with angular fragments of dolomite and chert in a finely rystalline matrix; silty and sandy near base; silicified horn coral present imestone, dolomitic, medium- to very coarse-grained; medium- to

calcareous; contains concentration of phosphatic lag debris and sandstone pebbles. Basal contact is sharp. LAUREL DOLOMITE—Dolomite, commonly divided into three parts. Upper part is very fine-grained, calcitic, dense; contains aggregate of alcite crystals and small aggregates of fine-grained pyrite; thin-bedded with few shale partings, numerous stylolites, partly oolitic. Middle part s medium- to thick-bedded, commonly blocky, forms ledges. Lower part is finely crystalline, argillaceous, thin-bedded; contains calcite pockets up to 10 cm across. Gradational with overlying dolomite and

thick-bedded; contains crinoid columnals, horn coral, and brachiopods;

contains chert lenses and blocky chert. Sandstone, fine-grained,

DUISVILLE LIMESTONE—Limestone, dolomitic limestone, and olomite. Limestone. fine- to very coarse-grained, dolomitic: contains oundant large fossil fragments; ledge-forming; weathers with a deeply itted surface. Dolomitic limestone, very fine-grained, argillaceous ii part, very thin- to thin-bedded, stylolitic; local irregular shale zone about 6 m from the base of unit. Thin veinlets of calcite present; chert rare, dolomitized fossils common as casts, including brachiopods, horn corals, colonial corals, chain corals, and algal mat remains. Dolomite contains calcite segregations as much as 5 cm in diameter; ledgeforming, beds up to 1.5 m thick, commonly obscure. Unit is gradational with underlying shale. LOUISVILLE LIMESTONE AND WALDRON SHALE—Dolomitic

limestone and shale. Dolomitic limestone, very fine-grained, argillaceous in part, very thin- to thin-bedded, stylolitic; irregular rubbly bedding ommon; local irregular shale zone about 6 m from the base of unit. Shale, silty, fissile, dolomitic, pyritic; few fossils, including crinoids, brachiopod valves. Grades laterally into overlying argillaceous dolomite. WALDRON SHALE—Shale, silty, dolomitic, nonfissile; bedding obscure. Few fossils; commonly pyritic. Weathers to gentle slopes. LOUISVILLE LIMESTONE, WALDRON SHALE, AND LAUREL

OSGOOD FORMATION—Shale and dolomite. Shale, silty, nonfissile. dolomitic, calcareous; forms gentle slopes, weathers to plastic clay. ocally suitable for construction of farm ponds; also can be unstable hen wet. Dolomite occurs as thin beds near top and base of unit. BRASSFIELD DOLOMITE—Dolomite, fine- to medium-grained, porous; thin- to thick-bedded, tabular to lumpy indistinct beds; calcareous, abundant glauconite contains scattered single crystals and irregular gregates of pyrite, scattered aggregates of large clear calcite crystal bundant nodules, and irregular beds of chert. Abundant fossil fragments nclude horn corals, colonial corals, brachiopods, and crinoid columnals; stylolites common in the middle part of unit. Unit weathers with a vuggy surface: locally may have petroliferous residue. Unit is resistant ledge ormer. Basal contact is sharp.

DRAKES FORMATION—Unit consists of three members, in ascending

crossbedded. Limestone makes up 50 to 80 percent of unit. Shale,

order: Rowland, Bardstown, and Saluda Dolomite Members. For this

nap, these members were combined into the Drakes Formation. olomite and limestone. Dolomite, fine- to very fine-grained, in part nely to coarsely crystalline, silty, porous, thin- to medium-bedded; artly obscure bedding. Calcareous. Weathers massive to platy: poorli ossiliferous except for colonial coral heads below overlying shale Limestone, fine- to medium-grained, silty; quartzose, thin- to thickedded, with minor interbeds of green calcareous shale. Weathers shaly. Fossiliferous; sparse ripple marks and mud cracks. GRANT LAKE LIMESTONE—Limestone and shale. Unit occurs above and below the Ashlock Formation. Limestone composed of abundant ossils and fossil fragments in a medium- to coarse-grained calcit matrix; thin to moderately nodular bedding; thicker beds in part

silty, calcareous; occurs as partings and thin irregular beds.

■ UPPER PART OF GRANT LAKE LIMESTONE

LOWER PART OF GRANT LAKE LIMESTONE

ASHLOCK FORMATION—Unit consists of six members, in ascending order: Tate, Gilbert, Stingy Creek, Grant Lake, Terrill, and Reba Members. or this map, these members were combined into the Ashlock Formation. Limestone and shale. Limestone, fine- to medium-grained, calcitic matrix with sparse coarse fossil fragments and sparse glauconite grains dolomitic, partly argillaceous; nodules of chert present in upper part of unit; thin- to medium-bedded, tabular and lumpy beds; few mud cracks and ripple marks. Shale, calcareous, in part carbonaceous; silty, fossiliferous; occurs as thin beds and partings. Basal contact grades into the underlying Grant Lake Limestone.

CALLOWAY CREEK LIMESTONE—Limestone, shale, and siltstone. imestone, very fine- to coarse-grained calcite matrix, fossiliferous; few nodules of gypsum, minor pyrite. Shale, calcareous, silty, contains bundant fossils, including bryozoans, brachiopods, and trilobites. Occurs as partings and thin irregular beds; makes up about 20 to 50 percent of unit. Siltstone, partly fossilferous, thin tabular bedding. GARRARD SILTSTONE—Siltstone, shale, and minor limestone. Siltstone, calcareous; thin laminated beds, interbedded with shale and mestone. Shale, silty, calcareous. Limestone, fine-grained, occurs as thin beds in middle and upper part of unit. Unit pinches out or grades laterally into Clays Ferry Formation. CLAYS FERRY FORMATION—Shale, limestone, and siltstone. Shale makes up about 50 to 55 percent of unit; clayey, calcareous, few fossils,

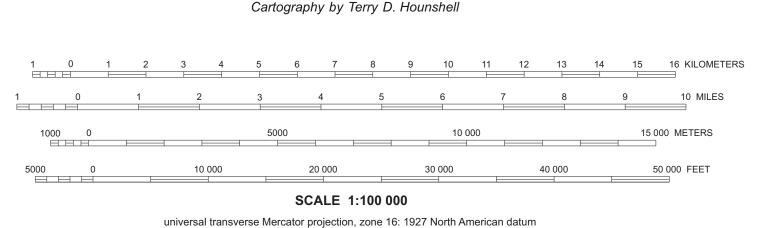
ssile, thin- to medium-bedded. Limestone, with abundant whole fossils nd fossil fragments in a micrograined to coarse-grained calcitic matrix thin-bedded; brachiopods Sowerbyella and Zygospira are most common, mainly found in lower 20 m of unit. Siltstone, fissile, calcareous, thinedded, interbedded with shale and limestone, mainly found in upper ■ LEXINGTON LIMESTONE Olu UPPER PART OF LEXINGTON LIMESTONE—Unit consists of two members, in ascending order: Perryville Limestone and Sulphur Well Member. Unit is present in few stream valleys in northeast corner of uadrangle. Limestone, medium- to very coarse-grained; thin irregular

beds, in part interbedded with shale; abundant fossils include ostracodes, achiopods, and gastropods. Upper part of unit contains abundant xplanate (leaf-like) bryozoans. BRANNON MEMBER—Limestone and shale (about 50 percent each). imestone, micrograined, occurs as thin, even beds. Shale, weakly fissile, bedding commonly deformed. Basal contact sharp. OWER PART OF LEXINGTON LIMESTONE—Unit consists of the Grier Limestone Member, exposed in the northwest corner of the uadrangle. Limestone, fine- to coarse-grained; thin-bedded, mostly regular nodular bedding; fossil fragmental. ARTIFICIAL FILL—Compacted rock debris from highway and other

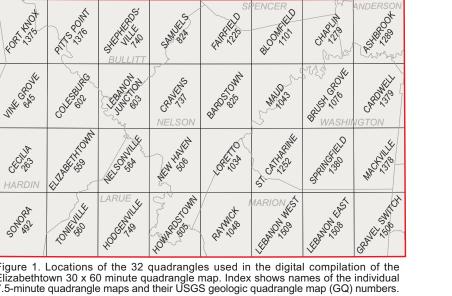
Locations of the 30 x 60 minute quadrangles covering Kentucky. The location of the Elizabethtown quadrangle

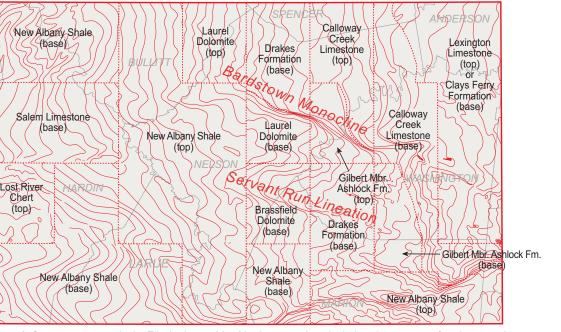
(Campbellsville quadrangle)

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



TOPOGRAPHIC CONTOUR INTERVAL 20 METERS





gure 2. Structure contours in the Elizabethtown 30 x 60 minute quadrangle. Index gives names of each mapped prizon. The horizon boundaries are shown on the geologic map as thin red dashed lines. Contour interval is 40 feet with index contours at every 200 feet.

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5tructure contour, feet

Anticline

Syncline

X Active pit; sand

X Fossil point

Datum horizon boundary

Active stone quarry or mine

Abandoned pit; sand or shale

Abandoned stone quarry or mine

0 (sea level) -

**NOTE:** cross section is diagrammatic vertical exaggeration 8x Clays Ferry Formation Clays Ferry Formation Osgood Formation Brassfield Dolomite Louisville Ls., Waldron Shale, and Laurel Dol. / Lower part of Grant Lake Ls. Clays Ferry Formation Clays Ferry Formation High Bridge Group

The geology of the Elizabethtown 30 x 60 minute quadrangle was digitally compiled from 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. The 7.5-minute guadrangles that make the Elizabethtown 30 x 60 minute quadrangle are shown on the index map. The new digital data files resulting from digitizing the GQ's are part of a comprehensive relational and spatial data set being developed by the Kentucky Seological Survey. The data files are available on CD-ROM for purchase and are available on an Internet map service on the KGS Web site. Users will have at their disposal a spatial database from which to select any map or particular map theme to create custom maps and add supplemental oil, mineral, coal,

or water information. This powerful database of information can be used in a geologic information system for analysis or manipulation of the data. Regional studies on the geology and stratigraphy of Mississippian rocks have resulted in changes in the stratigraphic nomenclature and correlation of rock units since the original GQ's were published. These changes are shown on this map, and were necessary for compilation of regional maps and for stratigraphic continuity between 7.5-minute quadrangles. The Kentucky Geological Survey's new 30 x 60 minute, 1:100,000-scale geologic map series has potential for new analysis of structural and other geologic features. The Elizabethtown 30 x 60 minute quadrangle map provides a regional perspective on erosional and depositional features, faulting, and geologic framework that may lead to new discoveries concerning mineral and energy resources.

The 7.5-minute geologic 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 correlating geologic formations and contacts across quadrangle boundaries and resolving nonuniform structure-contour datums or intervals. The metadata portion of the digital file provides detailed information about the conversion process. Formation codes were assigned to point, line, and polygon features using the American Association of Petroleum Geologists' standard stratigraphic code (Cohee, 1967), which was modified by the Kentucky Geological Survey for state-specific use. Since various authors compiled the 7.5-minute GQ's between 1960 and 1978, geologic formations and formation contacts were not mapped the same way on each map. Resolution of the differences between quadrangles was necessary for efficient topological analysis in a GIS environment. In addition, numerous thin less extensive formations and associated members mapped on individual 7 minute quadrangle maps are too small to be mapped 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. Th map is a compilation of existing maps, and no additional geologic field work took place. When there were problems in stratigraphic correlation between quadrangles, the best current data available were used to resolve these

GEOLOGIC SETTING AND STRUCTURAL GEOLOGY The geology of the Elizabethtown 30 x 60 minute quadrangle consists of mainly flat-lying sedimentary rocks of Ordovician through Mississippian age. Ordovician rocks comprise the eastern part of the quadrangle and consist of shale and limestone. Silurian and Devonian rocks are mainly limestone, shale black shale, and dolostone that crop out in a physiographic region called The Knobs. They were originally deposited as marine limestones but many have been subsequently dolomitized (Peterson, 1981). The Knobs forms a part of a ring around the flanks of the Cincinnati Arch, an elongated dome structure ominating much of the Bluegrass Region in central Kentucky. Mississippian shales, limestones, and sandstones comprise ridge- and hilltops in the central part of the quadrangle and extend to thick units toward the west. The region s characterized by hills that are erosional remnants of the once-continuous Mississippian Plateau. The often conical-shaped hills are capped with resistant sandstone or limestone, and the sharp slopes are mostly composed of shales of the Mississippian Borden Formation. The shales tend to be less resistant to erosion than the overlying sandstone and limestone, thus producing the steep-sided hills. The Knobs occur along the outcrop belt of the Devonian Mississippian contact; older Devonian and Silurian rocks make up the base of

A conspicuous feature in the Mississippian units is the Sandstone Member of the Mooretown Formation. It is a fluvial, submarine paleochannel whose northeastern part is exposed in the northwestern part of the quadrangle. merging west of the Elizabethtown guadrangle, this channel extends approx mately 30 mi to Fort Knox. In outcrop, the sandstone body creates and fills a steep-walled, narrow (0.5 to 0.8 mi wide), irregularly sinuous channel cut nto the Ste. Genevieve and St. Louis Limestones (Sedimentation Seminar, 1969). In the Elizabethtown guadrangle the Sandstone Member of the Moore town Formation forms a prominent straight ridge that rises above the surrounding rocks. Thickness varies from 50 to 100 ft, and the ridge is composed The major structural feature of the Elizabethtown quadrangle is the Bardstown

Monocline. The monocline strikes west-northwest and has a gentle southwestward ip of Upper Ordovician rocks from the central Bluegrass Region toward the ilurian-Devonian outcrop belt. Thickness variations in the Lower and Middle Silurian rocks suggest tectonic movement took place during or before deposition (Peterson, 1981). The Brassfield Dolomite thickens toward the south, corresponding with the position of the monocline, suggesting movement was during or just prior to deposition. Significant vertical offset of a basement fault below the surface location of the Bardstown Monocline suggests movement of the monocline during the Cambrian to Middle Ordovician (Andrews, 1997). The monocline is reflected in the northwest-southeast linear outcrop pattern in the central part of the quadrangle, whereas Middle Silurian Brassfield Dolomite is n contact with and at the same elevation as the Upper Ordovician Drakes The Servant Run lineation (see Figure 2) is another structural feature present

in the Elizabethtown quadrangle. The lineation is an anticlinal structure also striking west-northwest about 8 mi south of the Bardstown Monocline (Andrews, 997). The surface expression of the Servant Run Lineation can be correlated with basement structures shown in seismic lines and geophysical trends. The only named fault in the Elizabethtown quadrangle is the Brumfield Fault which runs through the Gravel Switch 7.5-minute quadrangle and is an offshoot of the Lexington Fault System. The Brumfield Fault is a normal fault downdropped to the southeast. Most of the other faults in the quadrangle occur in the Mississippian rocks in the western part of the quadrangle. ECONOMIC GEOLOGY

Limestone, dolomite, oil and gas, clay, sand, and gravel are the principal mineral resources in the Elizabethtown quadrangle. Limestone suitable for aggregate, agricultural lime, road metal, and artificial fill have been quarried om the Salem Limestone, Harrodsburg Limestone, Muldraugh Member of the Borden Formation, St. Louis Limestone, Ste. Genevieve Limestone, Louisville imestone, Laurel Dolomite, Beechwood Limestone, Drakes Formation, Ashlock ormation, and Calloway Creek Limestone. At one time, rock was quarried from the Laurel Dolomite and turbidite siltstone of the Borden Formation as imension stone used for bridges and piers. Dolomite is quarried from units in ne Silurian-Devonian outcrop belt, mainly in the central and north-central parts of the quadrangle. Five active quarries operate in the Elizabethtown quadrangle: four limestone and one dolomite.

The central Kentucky region accounts for 11 percent of the entire state's oil production, and only 1 percent of the natural gas production (Kentucky Geological survey, 2004). Of the counties comprising the Elizabethtown quadrangle, Hardin County produces fewer than 25,000 barrels of oil and less than 300 million ft of gas a year. Other counties in the quadrangle have no production records. Approximately 520 oil and gas wells have been drilled in the Elizabethtown uadrangle. Most are test wells that range from 40 to 2,500 ft deep, penetrating lississippian limestones and dolomites and the Cambrian Knox Group. The most productive zones are (1) about 50 ft below the New Albany Shale of Late Devonian age, commonly referred to as the "Corniferous," (2) the Louisville Limestone, and (3) the Laurel Dolomite. The now-abandoned Flint Hill gas storage field, located in the southwestern corner of the Sonora 7.5-minute quadrangle, was producing small quantities of oil up until the 1950's. There is potential for more oil and gas recovery in structural features present in the quadrangle. Steeply dipping synclines in the Raywick and Mackville 7.5-minute quadrangles may indicate deep fractures or fracture zones along which olomitization of underlying limestone has occurred, possibly forming hydrocarbon traps. Other features such as structural depressions, lineaments, and faults could be exploited as well. Clay, sand, and gravel have been quarried from pits mainly in the western part of the quadrangle. Clay from alluvium and lacustrine deposits, the New Providence Shale Member, and other shale members of the Borden has been used mainly for production of brick and tile. Sand and gravel have been guarried om the Sandstone Member of the Mooretown Formation and from streambed alluvium for the manufacture of glass, molding sand, brick, aggregate, and

HYDROGEOLOGY The Elizabethtown quadrangle mainly lies within the Salt River Basin with surface water flowing west-northwest toward the Ohio River. Two major karst regions are represented in the quadrangle: the Outer Bluegrass and the Western Pennyroyal. Approximately 25 percent of the population in the Elizabethtown quadrangle relies on groundwater from private wells or other nonpublic sources or domestic use (Carey and Stickney, 2004a-c, 2005). Groundwater supplies are limited; good producing wells are located in lowland valleys and larger Ohio River alluvium valleys. A few formations capping uplands and ridges yield sufficient water for domestic use. Quaternary alluvium can yield up to 5 000 gal/min; wells range in depth from 60 to 300 ft (Carey and Stickney, 2004a–c, 2005). Wells in certain bedrock units yield 100 to 500 gal/day; the wells usually penetrate no deeper than 100 ft. The Harrodsburg and Salem Limestones can yield larger amounts when wells penetrate solution openings near stream level. Springs in the Elizabethtown quadrangle can yield as much as 10 to 3,000 al/min (Carey and Stickney, 2004a-c, 2005). Many of these are in the karstic lississippian limestones and along the Muldraugh Escarpment. Water in the Elizabethtown quadrangle is considered hard. Wells drilled at depths of greater than 100 ft may contain salt or hydrogen sulfide. Because of the abundance of karst features, caves, sinkholes, and springs, groundwater pollution sensitivity in the area ranges from low-moderate to high. There is ncreasing concern about groundwater quality because it supplies a large percentage of rural drinking water and water for agricultural use (Carey and Stickney, 2004a-c, 2005).

other construction purposes.

ENGINEERING GEOLOGY AND GEOLOGIC HAZARDS The Clays Ferry Formation, New Providence Shale, Waldron Shale, and shale members in the Borden Formation are susceptible to slope failure and landslides. Steep slopes, easily weathered shale, and associated springs can all contribute to landslide potential. Shales weather to smaller pieces of loose material that eventually build up to form unstable slopes. When clayey, soft shale is wet and oversaturated, it behaves as a slippery surface, and at the same time acts as an impermeable layer, holding water from overlying permeable rock and soil, adding additional weight to the slope. Undercutting of weathered slopes for the construction of roads can also cause slope failure and landslides. Landslides on roadcuts and steep slopes intersecting alluvial valleys are common in the Clays Ferry and Borden Formations. In the Knobs Region, steep slopes of the Borden Formation often yield narrow landslide blocks and scars along the hills. Colluvium produced from landslides merges with the underlying New Albany Shale, Beechwood Limestone, or alluvial valley bottoms. High clay content in alluvium and lacustrine deposits also presents engineering problems. The high shrink-swell potential and variable compaction of these units cause older roads to push out under heavy traffic. Much of the Elizabethtown quadrangle is occupied by karst. The Western Pennyroyal Region, part of the Mississippian Plateau, and the Outer Bluegrass Region contain numerous springs, sinkholes, and caves. Two common karst related natural hazards are cover-collapse sinkholes and sinkhole flooding Cover-collapse sinkholes occur when soil overlies a void in the bedrock.

ne overlying soil is not supported, resulting in collapse. Abundant rainfall followed by dry periods causes the soil to become dislodged, collapse into the throat of the sinkhole, and then be carried off by the underlying cave conduit. Cover-collapse sinkholes range in size from 1 ft deep and wide to tens of feet deep and wide, and have the potential to damage buildings, roads, and farm ponds (Currens, 2002). Sinkhole flooding occurs when more precipitation falls than a sinkhole and associated conduits can handle. Flooding can happen when natural debris or trash clog the throat of the sinkhole, or when the diameter of the conduit is simply too small. In addition, the discharge end of the conduit may be clogged with debris, causing a backup all the way to the sinkhole. Correction and

prevention of engineering problems, karst subsidence, and flooding is possible

or existing karst geomorphic features.

by analysis of topographic maps, geologic maps, and signs of prior damage

Solution of the limestone bedrock increases the void space, and the weight of

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