2007

Generalized Geologic Map for Land-Use Planning: Bell County, Kentucky

Daniel I. Carey
University of Kentucky, carey@uky.edu

Kentucky Geological Survey
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

Generalized Geologic Map for Land-Use Planning: Bell County, Kentucky

Daniel I. Carey

https://doi.org/10.13023/kgs.mc181.12
MAP AND CHART 181
Series XII, 2007

Bell County Courthouse at Pineville

Bell County, 361 square miles in the Eastern Kentucky Coal Field, was formed in 1867. Mountainous topography is predominant and communities are located in stream valleys. The unique exception is the area of Middlesboro, which was created by the impact of an object from outer space sometime within the past 300 million years. The resulting crater is roughly 3 miles in diameter. The highest elevation, 3,500 feet, is near White Rock lookout tower northeast of Cumberland Gap. The lowest elevation, 975 feet, is where the Cumberland River leaves the county in the northwest. The 2006 population of 29,621 was 1.5 percent smaller than that of 2000. The deer population may be increasing (below). Photos by Dan Carey, Kentucky Geological Survey.

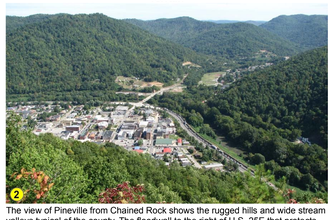
Water Resources

The Cumberland River and its tributaries provide scenic beauty, fishing, and level land for agriculture and communities. They also cause flood damage to unprotected development below the flood line. Photo by Dan Carey, Kentucky Geological Survey.

Kudzu

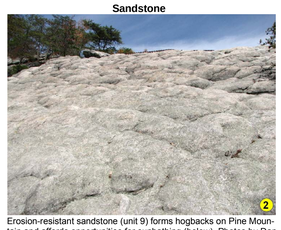
Kudzu, named after the area of its origin in Japan, grows to impressive displays throughout southeastern Kentucky. It can grow 12 inches in a day, or 60 feet in a season. The nonwoody parts are edible. Photo by Dan Carey, Kentucky Geological Survey.

Terrain



The view of Pineville from Chained Rock shows the rugged hills and wide stream valleys typical of the county. The floodwall to the right of U.S. 25E that protects the city from Cumberland River floodwaters also symbolizes the threat of flooding to development in stream valleys throughout the county. Photo by Dan Carey, Kentucky Geological Survey.

Sandstone



Erosion-resistant sandstone (unit 9) forms hogbacks on Pine Mountain and affords opportunities for sunbathing (below). Photos by Dan Carey, Kentucky Geological Survey.

Acknowledgments

Geology adapted from Conley (2003a, b), Johnson (2003a, b), Johnson and Sparks (2003), Martin (2003), Mullins (2003a, b), Mullins and Murphy (2003), Sparks and Lambert (2003), Sparks and Murphy (2003), Thompson (2003), and Toth and Sparks (2003). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for photos. Thanks to Kim and Kent Arness, Kentucky Division of Geographic Information, for base-map data. Thanks to Meg Smath, Kentucky Geological Survey, for editorial improvements. Thanks to Bart Davidson, Kentucky Geological Survey, for photo assistance.

Mapped Surface Faults

Faults are common geologic structures across Kentucky, and have been mapped in many of the commonwealth's counties. The faults shown on this map represent seismic activity that occurred several million years ago at the latest. There has been no activity along these faults in recorded history. Seismic risk associated with these faults is very low. Faults may be associated with increased fracturing of bedrock in the immediately adjacent area. This fracturing may influence slope stability and groundwater flow in these limited areas.

EXPLANATION

- School

Water wells
- Agricultural
- Domestic
- Monitoring
- Public
- Mining, industrial

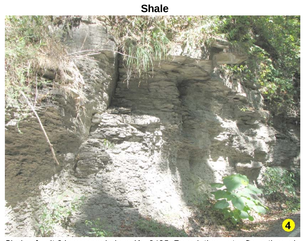
- Spring
- Wet area
- Mine or quarry
- Alluvial fan
- Gas well
- Oil well
- Railroad
- Abandoned railroad
- County line
- Watershed boundary
- Geologic fault
- Concealed geologic fault
- Scarp
- Designated flood zone* (FEMA, 2005)
- Source-water protection area, zone 1
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Incorporated city boundaries
- Quarry
- Artificial fill
- Boulders, gravel, and sand (unstable materials)
- Mine dump or spoil
- Public lands
- 200-foot contour interval
- (4) Photo location

Source-Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

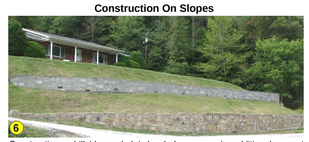
*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

Shale



Shale of unit 6 is exposed along Ky. 3485. Percolating water flows through cracks in sandstone and siltstone until it meets impermeable shale. The shale breaks down quickly when exposed to air. Roads cut into shaly hillsides often require additional support and careful drainage management to prevent pavement failure (below). Photos by Dan Carey, Kentucky Geological Survey.

Construction On Slopes



Construction on hillsides underlain by shale may require additional support to prevent slope failure. Photo by Dan Carey, Kentucky Geological Survey.

Cumberland Gap Tunnel

The Cumberland Gap Tunnel carrying U.S. 25E is a four-lane twin-bore mountain tunnel that is 4,600 feet long. It was completed in 1996 at a cost of $280 million. In addition to being a significant engineering achievement, it has provided an opportunity to learn more about how the chemistry and quantity of water flowing through the underground rocks can affect such construction. Photo by Randy Paylor, Kentucky Geological Survey (2007).

Shale (Unit 3)

Young paulownia (princess) trees, indigenous to Southeast Asia, grow at the base of a shale (unit 3) cut. Shale breaks down quickly when exposed to air and water. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

About 7,800 people in Bell County rely on private domestic water supplies: 5,900 use wells and 1,900 use other sources. Most wells drilled in valley bottoms are adequate for a domestic supply. In central and southern Bell County, fewer than half the wells drilled on hillsides meet domestic needs; on hilltops, even fewer wells are adequate. In the northern half of Bell County, and along Pine Mountain where water is more plentiful, three-quarters of the wells on hillsides and some wells on hilltops are adequate for a domestic supply. The northern half of the county may also produce high-yielding wells, deeper than 200 feet, that would provide water for small municipal or industrial supplies. Groundwater obtained from most drilled wells in this area is moderately hard and contains noticeable amounts of iron. Salty water probably will not be found at less than 200 feet below the principal valley bottoms in the southern half of the county, and at less than 300 feet in the northern half of the county.

A few high-volume springs, yielding as much as 400 gallons per minute, are found east of Middlesboro and along Pine Mountain. Most springs in the county yield less than 5 gallons per minute.

For more information on groundwater in the county, see Carey and Stickney (2002).

7.5-Minute Quadrangle Map Index

Landslides

Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

Landslides

Virtually all units containing shale on slopes are subject to landslides. Shales will break down and weather rapidly when exposed to air and water. Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the shale. Cutting into or overloading a slope with structures and fill can also be major contributing factors. The failure of the slope may be rapid, but more commonly is a slow, almost imperceptible movement, called creep, of a few inches per year. Whether rapid or slow, the end results and damage are similar and costly: broken plumbing, cracked walls and foundations, cracked streets and sidewalks, and commonly, total loss of the structures.

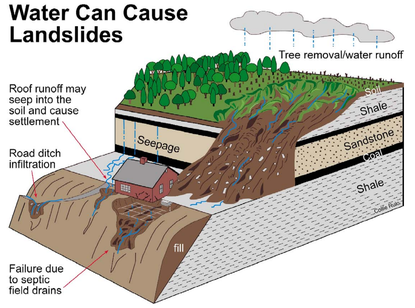
Precautions include taking care of all surface-water runoff by making certain that all runoff from roofs, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible and avoiding the use of fill; and trying to place the foundation of the structure on undisturbed bedrock. When in doubt, consult an engineering geologist or a geotechnical engineer.

What Are the Factors That Cause Landslides?

Many factors contribute to landslides. The most common in eastern Kentucky are:

1. Steep slopes: Avoid when choosing a building site.
2. Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the natural slope by creating a level area where none previously existed.
4. Poor site selection for roads and driveways.
5. Improper placement of fill material.
6. Removal of trees and other vegetation: Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.

Water Can Cause Landslides



What Are Some Ways to Prevent Landslides?

1. Seek professional assistance prior to construction.
2. Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.
3. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth-moving begins.
4. Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.
5. Household water disposal system: Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.
6. Proper water disposal: Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

Additional Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Bell County:

www.mountaingateway.com Bell County Tourism Commission
www.bellcountychamber.com Bell County Chamber of Commerce
www.kyhometown.com/middlesboro/ Middlesboro and Bell County
ces.ca.uky.edu/Bell/ University of Kentucky Cooperative Extension Service
www.cvadd.org/ Cumberland Valley Area Development District
www.thinkkentucky.com/edis/cmnty/index.aspx?cw=027 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21013.html Kentucky Atlas and Gazetteer, Bell County
quickfacts.census.gov/qfd/states/21/21013.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Clay, silt, sand, and gravel (alluvium)	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Slight to severe limitations, depending on type of activity. Subject to flooding. Refer to soil report (Childress, 1992).	Slight to severe limitations, depending on type of activity. Subject to flooding. Refer to soil report (Childress, 1992).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Childress, 1992).	Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).
2. Black, red, and green shales	Poor foundation material; easy to moderately difficult to excavate. Low strength and stability. May contain plastic clays.	Severe limitations. Thin soils and low permeability.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Not recommended.	Moderate to severe limitations, depending on activity and topography.	Severe to slight limitations, depending on activity and topography.	Slight limitations for small ponds.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.
3. Shale*, siltstone, sandstone, thin coal, underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
4. Limestone, shale, chert	Good to excellent foundation material; difficult to excavate.	Moderate to severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Slight to moderate limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Thin soils.
5. Sandstone, siltstone, shale*, limestone, coal, underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Moderate to severe limitations. Rock excavation may be required. Steep slopes.	Moderate to severe limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe to moderate limitations. Thin soils. Rock excavation.
6. Shale*, siltstone, sandstone, coal	Fair to poor foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Moderate to severe limitations, depending on activity and topography.	Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Unstable slopes.
7. Siltstone, shale*, sandstone, coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales. coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
8. Sandstone, siltstone, shale*, limestone	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
9. Sandstone, shale*	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations, depending on activity and slope.	Slight to severe limitations, depending on activity. Slight limitations for forest or nature preserve.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.

*Shales and clays in these units may shrink during dry periods and swell during wet periods and cause cracking of foundations. On hillsides, especially where seeps and springs are present, they can also be susceptible to landslides.

LAND-USE PLANNING TABLE DEFINITIONS

FOUNDATION AND EXCAVATION

The terms "earth" and "rock" for excavation are used in the engineering sense; earth can be excavated by hand tools, whereas rock requires heavy equipment or blasting to remove.

LIMITATIONS

Slight—A slight limitation is one that commonly requires some corrective measure but can be overcome without a great deal of difficulty or expense.

Moderate—A moderate limitation is one that can normally be overcome but the difficulty and expense are great enough that completing the project is commonly a question of feasibility.

Severe—A severe limitation is one that is difficult to overcome and commonly is not feasible because of the expense involved.

LAND USES

Septic tank disposal system—A septic tank disposal system consists of a septic tank and a filter field. The filter field is a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the soil.

Residences—Ratings are made for residences with basements because the degree of limitation is dependent upon ease and required depth of excavation. For example, excavation in limestone has greater limitation than excavation in shale for a house with a basement.

Highways and streets—Refers to paved roads in which cuts and fills are made in hilly topography, and considerable work is done preparing subgrades and bases before the surface is applied.

Access roads—These are low-cost roads, driveways, etc., usually surfaced with crushed stone or a thin layer of blacktop. A minimum of cuts and fills are made, little work is done preparing a subgrade, and generally only a thin base is used. The degree of limitation is based on year-around use and would be less severe if not used during the winter and early spring. Some types of recreation areas would not be used during these seasons.

Light industry and malls—Ratings are based on developments having structures or equivalent load limit requirements of three stories or less, and large paved areas for parking lots. Structures with greater load limit requirements would normally need footings in solid rock, and the rock would need to be core drilled to determine the presence of caverns, cracks, etc.

Intensive recreation—Athletic fields, stadiums, etc.

Extensive recreation—Camp sites, picnic areas, parks, etc.

Reservoir areas—The floor of the area where the water is impounded. Ratings are based on the permeability of the rock.

Reservoir embankments—The rocks are rated on limitations for embankment material.

Underground utilities—Included in this group are sanitary sewers, storm sewers, water mains, and other pipes that require fairly deep trenches.

Coal

Surface mining west of Middlesboro seen from the air in 2004. Bell County produced 302 million tons of coal from 1879 to 2004, 108 million tons by surface mining. Photo by the U.S. Department of Agriculture, Farm Services Administration, National Agricultural Imagery Program.

References Cited

Carey, D.I., and Stickney, J.F., 2002, Groundwater resources of Bell County, Kentucky: Kentucky Geological Survey, ser. 12, County Report 7, www.uky.edu/KGS/water/library/gwatlas/Bell/Bell.htm [accessed 9/14/07].

Childress, J.D., 1992, Soil survey of Bell and Harlan Counties, Kentucky: U.S. Department of Agriculture, Soil Conservation Service, 110 p.

Conley, T.J., 2003a, Spatial database of the Artemus quadrangle, Bell and Knox Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1207. Adapted from Rice, D.D., 1974, Geologic map of the Artemus quadrangle, Bell and Knox Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1207, scale 1:24,000.

Conley, T.J., 2003b, Spatial database of the Kayjay quadrangle and part of the Fork Ridge quadrangle, Bell and Knox Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1505. Adapted from Rice, C.L., and Maughan, E.K., 1978, Geologic map of the Kayjay quadrangle and part of the Fork Ridge quadrangle, Bell and Knox Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1505, scale 1:24,000.

Federal Emergency Management Agency, 2005: www.fema.gov [accessed 8/23/07].

Johnson, T.L., 2003a, Spatial database of the Frakes quadrangle, and part of the Eagan quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1249. Adapted from Newell, W.L., 1975, Geologic map of the Frakes quadrangle, and part of the Eagan quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1249, scale 1:24,000.

Johnson, T.L., 2003b, Spatial database of the Varilla quadrangle, Kentucky-Virginia: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-190. Adapted from Englund, K.J., Landis, E.R., and Smith, H.L., 1963, Geology of the Varilla quadrangle, Kentucky-Virginia: U.S. Geological Survey Geologic Quadrangle Map GQ-190, scale 1:24,000.

Johnson, T.L., and Sparks, T.N., 2003, Spatial database of the Pineville quadrangle, Bell and Knox Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1129. Adapted from Froelich, A.J., and Tazelaar, J.F., 1974, Geologic map of the Pineville quadrangle, Bell and Knox Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1129, scale 1:24,000.

Martin, S.L., 2003, Spatial database of the Balkan quadrangle, Bell and Harlan Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1127. Adapted from Froelich, A.J., and Tazelaar, J.F., 1973, Geologic map of the Balkan quadrangle, Bell and Harlan Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1127, scale 1:24,000.

Mullins, J.E., 2003a, Spatial database of the Ewing quadrangle, Kentucky-Virginia: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-172. Adapted from Englund, K.J., Smith, H.L., Harris, L.D., and Stephens, J.G., 1967, Geology of the Ewing quadrangle, Kentucky-Virginia: U.S. Geological Survey Geologic Quadrangle Map GQ-172, scale 1:24,000.

Mullins, J.E., 2003b, Spatial database of the Scalf quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1267. Adapted from Weis, P.L., 1975, Geologic map of the Scalf quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1267, scale 1:24,000.

Mullins, J.E., and Murphy, M.L., 2003, Spatial database of the Beverly quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1310. Adapted from Weis, P.L., and Rice, C.L., 1976, Geologic map of the Beverly quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1310, scale 1:24,000.

Sparks, T.N., and Lambert, J.R., 2003, Spatial database of the Middlesboro North quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1663. Adapted from Rice, C.L., and Ping, R.G., 1989, Geology of the Middlesboro North quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1663, scale 1:24,000.

Sparks, T.N., and Murphy, M.L., 2003, Spatial database of the Helton quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1227. Adapted from Rice, D.D., 1975, Geologic map of the Helton quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1227, scale 1:24,000.

Thompson, M.F., 2003, Spatial database of the Middlesboro South quadrangle, Tennessee-Kentucky-Virginia: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-301. Adapted from Englund, K.J., 1964, Geology of the Middlesboro South quadrangle, Tennessee-Kentucky-Virginia: U.S. Geological Survey Geologic Quadrangle Map GQ-301, scale 1:24,000.

Toth, K.S., and Sparks, T.N, 2003, Spatial database of the Wallins Creek quadrangle, Harlan and Bell Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1016. Adapted from Froelich, A.J., 1972, Geologic map of the Wallins Creek quadrangle, Harlan and Bell Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1016, scale 1:24,000.

U.S. Department of Agriculture, Natural Resources Conservation Service, no date, Landslide prevention in eastern Kentucky.

U.S. Fish and Wildlife Service, 2003, National Wetlands Inventory: www.nwi.fws.gov [accessed 9/4/07].

For Planning Use Only

This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand the characteristics of both the soils and the underlying rock. For further assistance, contact the Kentucky Geological Survey, 859.257.5500. For more information, visit the KGS Community Development Planning Web Site at kgsweb.uky.edu/download/kgsplanning.htm.

N

Scale = 1:63,360
1 inch = 1 mile

0 0.5 1 2 3 4 Miles

Geology of Kentucky

Learn more about Kentucky geology at www.uky.edu/KGS/geoky/