KENTUCKY GEOLOGICAL SURVEY
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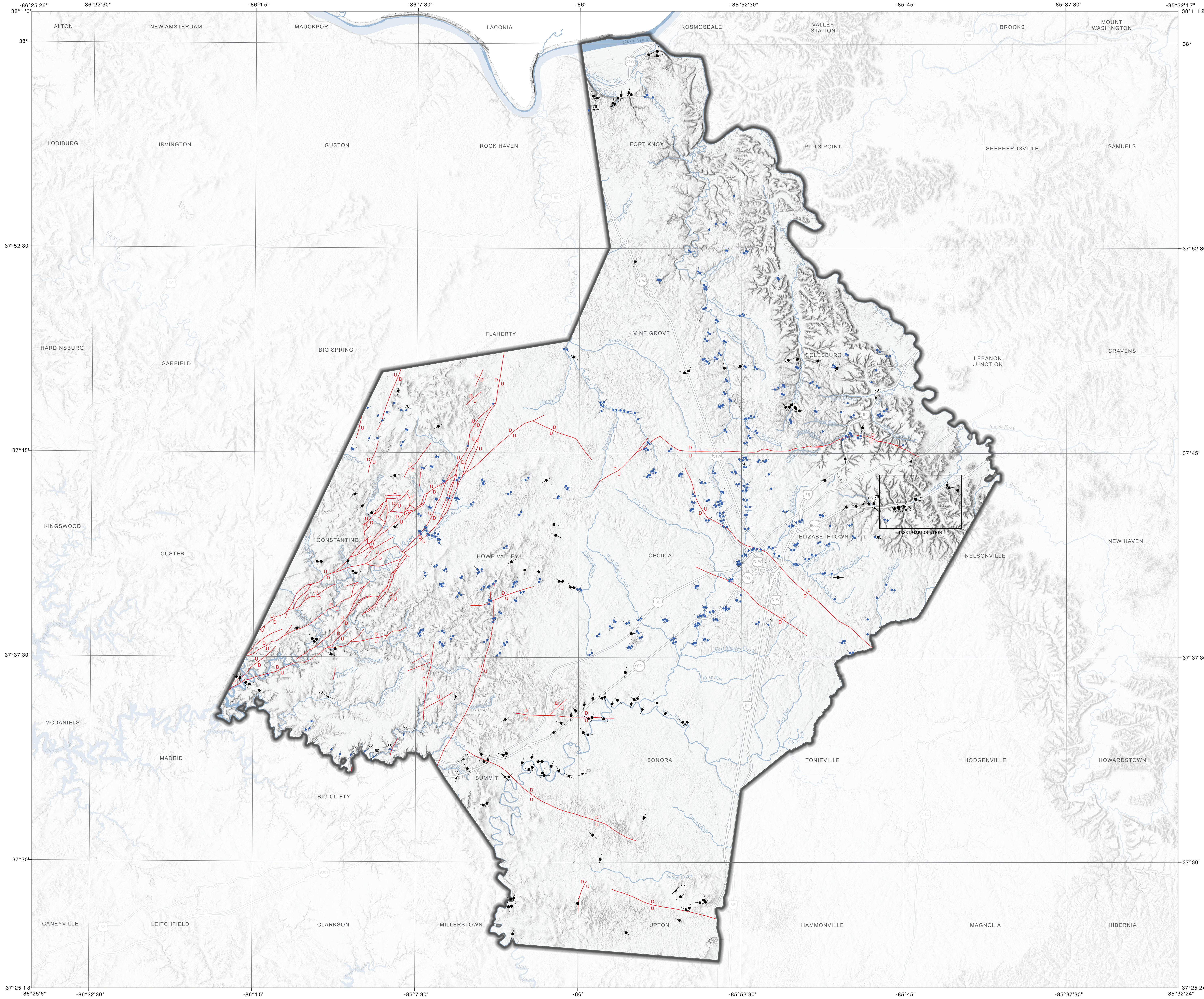
Kentucky Geological Survey
MAP AND CHART 6
Series XIII, 2024



Hillshade derived from KYAPED 5-Foot Digital Elevation Model.

Major roads from Kentucky Transportation Cabinet.

Hydrography from National Hydrography Dataset High Resolution.

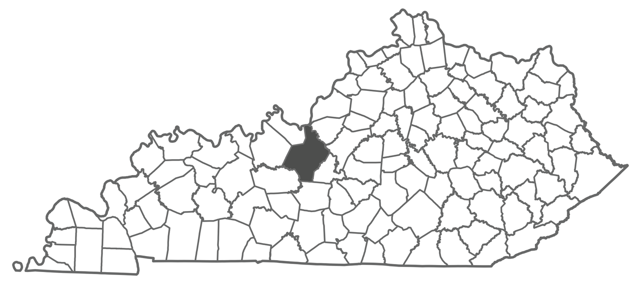
Digital data collected in Kentucky Single Zone State Plane Coordinate System. Lambert conformal projection, North American 1983 datium.

Joint Map of Hardin County, Kentucky

Steven L. Martin and Emily R. Morris
2024

SCALE 1:125,000

0 2½ 5 10 Miles
0 10,000 20,000 40,000 Feet
0 2.5 5 10 Kilometers



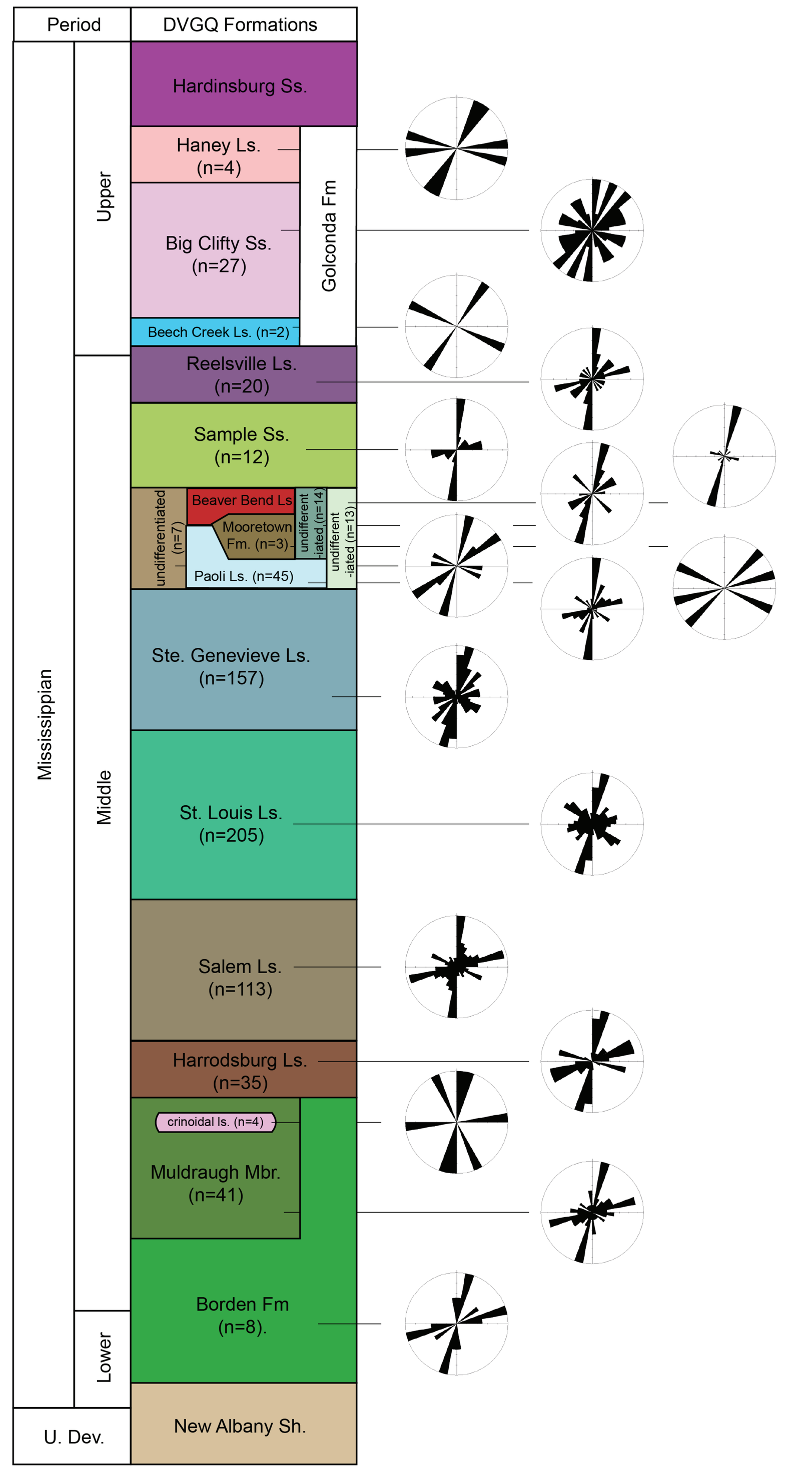
Hardin County Location

EXPLANATION

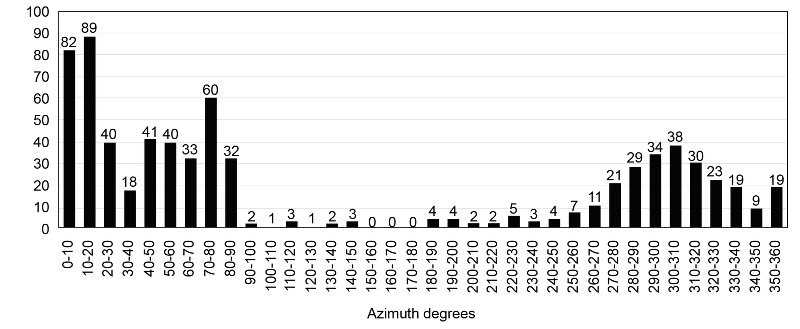
Joints (this study)
- Dipping
- Vertical
- Vertical and dipping set
- Vertical set

Joints (published geologic maps)
- Dipping
- Vertical
- Vertical and dipping set
- Vertical set

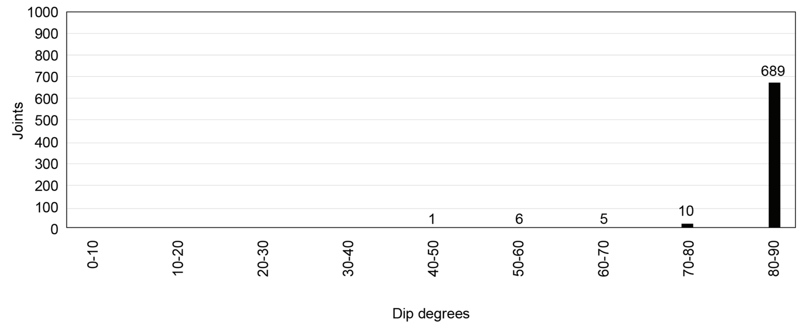
- Hardin County
- 7.5-minute quadrangle
- Fault (U, upthrown side; D, downthrown side)
- Major road
- River or stream
- Large river, stream, or creek



Stratigraphic column of Hardin County modified from Greb (2017), and Rose diagrams showing azimuth orientations for joint planes, with the number of measurements associate for each formation in parentheses. The color of the formations coincides with the inset digitally vectorized geologic map.



Histogram showing the number of joints measured per azimuth orientations from this study and published geologic maps in the study area.



Histogram showing the dip amount of joints from this study and published geologic maps in the study area.

SUMMARY

This fracture map is a compilation of joint locations and faults mapped in Hardin County, Kentucky, and provides orientations of fractures (joints and faults) for hydrological, geotechnical, slope stability and rockfall mitigation issues. The joint data includes orientations collected in 2009, and from 2022 to 2023, and those collected during the geologic mapping of the 7.5-minute quadrangles (Swadley, 1962; Swadley, 1963; Kepferle, 1963a; Kepferle, 1963b; Peterson, 1964; Kepferle, 1966; Kepferle, 1967a; Kepferle, 1967b; Kepferle and Sable, 1977). New joint orientations were measured to fill in the data gaps from the published geologic map data. Joints are fractures where there is no appreciable movement parallel and only slight movement normal to the fracture plane, whereas faults exhibit movement parallel to the fracture plane. Joints are extensional features that form due to tectonic, hydraulic, unloading, and release stresses (Engelder, 1985). Joints are symbolized on the map as either vertical or inclined (dipping). Joints intersecting at one location are symbolized as joint sets.

Hardin County is located within Mississippian Plateau and the Knobs physiographic regions of central Kentucky. The Knobs region is a narrow belt of erosional remnants, and is located in the eastern part of the county. The Knobs are underlain by Upper Devonian-age New Albany Shale and Lower to Middle Mississippian-age siltstone, and shale and are capped by resistant limestone of the Borden Formation (Greb, 2017). Most of the county is within the Mississippian Plateau region and is underlain by Middle to Upper Mississippian-age limestone. Much of the southeastern part of the county consists of sinkholes and karst topography. Faulting in the western part of the county, exposes Middle and Upper Mississippian sandstones, limestones, and shale at the surface (Greb, 2017).

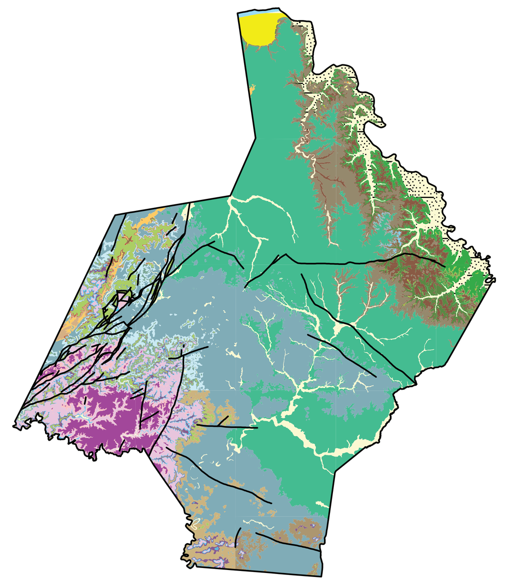
The structural geology of Hardin County consists of abundant steeply dipping, non-active, normal faults in the western part of the county that are less frequent in the eastern and southern parts of the county. The northeast-southwest trending faults in the western part of the county are offshoots of the predominantly east-west trending Rough Creek Fault System south of the county. Faulting occurred after the Late Pennsylvanian period

A Brunton compass was used to measure joint orientations of bedrock exposed along roadways in areas where there were no joint measurements from the original geologic mapping of the area. Part of the Nolin River was traversed in order to obtain joint data along the sinkhole plain in southern Hardin County. The location of rock exposures and the recording of joint data in the field was accomplished by using esriTM Field Maps. The strike and dip of these joints were measured using a quadrant system and then converted to azimuth orientations. The joint symbols on the map were created and rotated using esri™ ArcPro software, and Rose diagrams associated with the stratigraphic column were created using GEOrient© software.

Field notes for the U.S. Geological Survey quadrangle maps were not available during the digitization process. To calculate the joint orientations, a DOS-based Arcinfo script was written to determine the azimuth orientation when digitizing the "strike" of the joint symbol of the original geologic map (Conley, 2002a; Crawford, 2002a, Crawford, 2002b; Crawford, 2002c; Bhattarai, 2007a; Bhattarai, 2007b; Bhattarai, 2007c; Crawford, 2007; Toth, 2007a;). The dip angle was provided on the geologic map for inclined joints. The faults in the county were mapped by Swadley (1962, 1963), Kepferle (1963a, 1963b, 1966, 1967a, 1967b), Moore (1964, 1965) Peterson (1964), Sable (1964), Peterson (1966, 1967), Moore (1972), and digitized by Conley (2002a, 2002b, 2002c), Crawford (2002a, 2002b, 2002c, 2007), Bhattarai (2007a, 2007c), Johnson (2007a, 2007b), Nelson (2007), and Toth (2007a, 2007b).

The dominant joint orientations for all map units trend 0-20, and 70-80 degrees, with minor orientations trending 40-60 and 290-310 degrees, with many joint orientations parallel to subparallel to nearby faults which are interpreted as forming due to tectonic stresses. The present-day stress field in Kentucky trends northeast-southwest orientation since Late Devonian (Grover and Dupuis-Nouille; 1992, 1995). Most joint orientations were measured in the Middle Mississippian Salem, St. Louis, and Ste. Genevieve Limestones which are dominate map units exposed in the county.

The geologic map units for the inset county map and stratigraphic column are derived from the digitization of geologic quadrangle maps (DVGQ) and may differ from the original USGS geologic quadrangle map. The contacts between the geologic map units are omitted from this map to highlight the joints and faults in the area. The geologic map units can be viewed online on the Kentucky Geological Survey map service (https://kgs.uky.edu/kygeode/geomap/).



SCALE 1:500,000

Digitally Vectorized Geologic Quadrangle (DVGQ) map of Hardin County. Map unit colors coincide with formation colors on stratigraphic column. Map scale is 1:500,000.

REFERENCES CITED

Bhattarai, K., 2007a, Spatial database of the Colesburg quadrangle, Hardin and Bullitt Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—602.

Bhattarai, K., 2007b, Spatial database of the Fort Knox quadrangle, north-central Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—1375.

Bhattarai, K., 2007c, Spatial database of the Vine Grove quadrangle, Hardin and Meade Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—645.

Conley, T.J., 2002a, Spatial database of the Big Clifty quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—192.

Conley, T.J., 2002b, Spatial database of the Constantine quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—302.

Conley, T.J., 2002c, Spatial database of the Summit quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—298.

Crawford, M.M., 2002a, Spatial database of the Big Spring Quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—261.

Crawford, M.M., 2002b, Spatial database of the Flaherty quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—229.

Crawford, M.M., 2002c, Spatial database of the Howe Valley quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—232.

Crawford, M.M., 2007, Spatial database of the Elizabethtown quadrangle, Hardin and Larue Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—559.

Engelder, T., 1985, Loading paths to joint propagation during a tectonic cycle: an example from the Appalachian Plateau: Journal of Structural Geology, v. 7, p. 459-476.

Greb, S.F., 2017, Kentucky stratigraphy: Kentucky Geological Survey, ser. 12, Map and Chart 211.

Grover, J.E., and Dupuis-Nouille, E, 1992, Orientation of tectonic stresses in central Kentucky during U. Devonian/L. Mississippian times: evidence from quartz veins (after gypsum) in NE-trending, systematic joints in shales: Geological Society of America Abstracts with Programs, V. 24, p. A183.

Grover, J.E., and Dupuis-Nouille, E, 1995, Tectonic stress directions in the central Mid-continent and the systematic orientation of lineaments and joints: A correspondence that has endured since Devonian time: Geological Society of America Abstracts with Programs, v. 27, no. 6, p. A94-A95.

Johnson, T.L., 2007a, Spatial database of the Nelsonville quadrangle, central Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—564.

Johnson, T.L., 2007b, Spatial database of the Sonora quadrangle, Hardin and Larue Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—492.

Kepferle, R.C., 1963a, Geologic Map of the Cecilia quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—263, scale 1:24,000.

Kepferle, R.C., 1963b, Geologic Map of the Howe Valley quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—232, scale 1:24,000.

Kepferle, R.C., 1966, Geologic map of the Elizabethtown quadrangle, Hardin and Larue Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—559, scale 1:24,000.

Kepferle, R.C., 1967a, Geologic map of the Colesburg quadrangle, Hardin and Bullitt Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—602, scale 1:24,000.

Kepferle, R.C., 1967b, Geologic map of the Vine Grove quadrangle, Hardin and Meade Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—645, scale 1:24,000.

Kepferle, R.C., and Sable, E.B., 1977, Geologic Map of the Fort Knox quadrangle, north-central Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—1375, scale 1:24,000.

Moore, F.B., 1964, Geologic map of the Summit quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—298, scale 1:24,000.

Moore, F.B., 1965, Geologic map of the Sonora quadrangle, Hardin and Larue Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—492, scale 1:24,000.

Moore, F.B., 1972, Geologic map of the Upton quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—1000, scale 1:24,000.

Nelson, H.L., Jr., 2007, Spatial database of the Lebanon Junction quadrangle, central Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—603.

Peterson, W.L., 1964, Geologic map of the Big Spring quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—261, scale 1:24,000.

Peterson, W.L., 1966, Geologic map of the Nelsonville quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—564, scale 1:24,000.

Peterson, W.L., 1967, Geologic map of the Lebanon Junction quadrangle, central Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—603, scale 1:24,000.

Sable, E.C., 1964, Geologic map of the Constantine quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—302, scale 1:24,000.

Swadley, WC., 1962, Geologic map of the Big Clifty quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—192, scale 1:24,000.

Swadley, WC., 1963, Geologic map of the Flaherty quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map, GQ—229, scale 1:24,000
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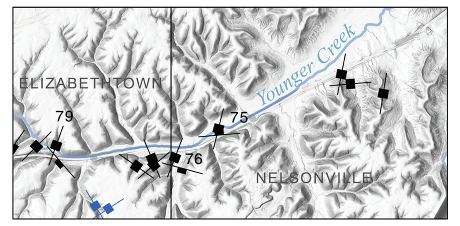
Toth, K.S., 2007a, Spatial database of the Cecilia quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle, DVGQ—263.

Toth, K.S., 2007b, Spatial database of the Upton quadrangle, central Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geological Quadrangle, DVGQ—1000.



Exposure of Borden Formation along the Bluegrass Parkway in Hardin County. A slope failure occurs at the end of this exposure when topography parallels a pervasive joint that trends 81 degrees east of north. An orange arrow points to joint surface nearest to the failed slope. Rose diagram shows orientation of 112 joint planes measured at this exposure. The LiDAR hillshade image is at a 1:24,000 scale.

A)

B)

Example of (A) dipping or inclined joints and (B) vertical sets in study area. The strike and dip of joints are shown in red text.