U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Buffalo National River

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Buffalo National River

buff_geology.pdf

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Geologic Resources Inventory Ancillary Map Information Document for Buffalo National River

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Geologic Resources Inventory Map Document

Buffalo National River, Arkansas

Document to Accompany Digital Geologic-GIS Data

buff_geology.pdf

Version: 9/14/2018

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Buffalo National River, Arkansas (BUFF).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1)**About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2)**GRI Digital Maps and Source Map Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3)**Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4)**Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5)**Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviation.

6)**Joint Frequency Diagrams & Structural Data -** Rose diagrams, bedding and fault measurements, and other structural data.

7)**Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

8)**GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document

production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Buffalo National River, Arkansas (BUFF):

Digital Geologic-GIS Map of Buffalo National River and Vicinity, Arkansas (*GRI MapCode BUFF*)

In addition to the above map the GRI also produced several 7.5' quadrangle component maps that collectively comprise the above park and vicinity map. Unless noted the full extent of each quadrangle source map (listed below) was used and all geologic features present on each map including all mine point features (e.g., gravel pits, quarries, wells) were captured. In addition, prominent map components present on each source map (e.g., unit colors, unit descriptions, geologic cross sections and other ancillary map graphics and text) were also incorporated into this GRI digital geologic-GIS dataset and product. For maps where source map SIM-3314 is listed, this source map was the primary source for geologic features, and the other source map listed was only used for additional features not present on SIM-3314, plus provide cross sections, unit descriptions and additional ancillary source map information.

Component maps that comprise the park and vicinity map and their source map citations.

Digital Geologic-GIS Map of the Big Flat Quadrangle, Arkansas (*GRI MapCode BIFL)*

Chandler, A.K., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2011, Geologic Map of the Big Flat Quadrangle, Baxter, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00075, scale 1:24,000. (Big Flat Quadrangle). (*GRI Source Map ID 74688*).

Digital Geologic-GIS Map of the Boxley Quadrangle, Arkansas (*GRI MapCode BOXL*)

Hudson, M.R., and Turner, K.J., 2007, Geologic Map of the Boxley Quadrangle, Newton and Madison Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2991, scale 1:24,000. (Boxley Quadrangle). (*GRI Source Map ID 74842*).

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Digital Geologic-GIS Map of the Buffalo City Quadrangle, Arkansas (*GRI MapCode BFCI*)

Chandler, A.K., Nondorf, L.M., Johnson, T.C., and Traywick, C.L., 2011, Geologic Map of the Buffalo City Quadrangle, Baxter and Marion Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00111, scale 1:24,000. (Buffalo City Quadrangle). (*GRI Source Map ID 74674*)..

Digital Geologic-GIS Map of the Cozahome Quadrangle, Arkansas (*GRI MapCode COZA*)

Ausbrooks, S.A., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2012, Geologic Map of the Cozahome Quadrangle, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00187, scale 1:24,000. (Cozahome Quadrangle). (*GRI Source Map ID 74675*)..

Digital Geologic-GIS Map of the Eula Quadrangle, Arkansas (*GRI MapCode EULA*)

Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Eula Quadrangle, Newton and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00269, scale 1:24,000. (Eula Quadrangle). (*GRI Source Map ID 62271*).

Digital Geologic-GIS Map of the Harriet Quadrangle, Arkansas (*GRI MapCode HRRT*)

Smart, E.E, and Hutto, R.S., 2008, Geologic Map of the Harriet Quadrangle, Searcy County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00374, scale 1:24,000. (Harriet Quadrangle). (*GRI Source Map ID 75408*).

Digital Geologic-GIS Map of the Hasty Quadrangle, Arkansas (*GRI MapCode HSTY*)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Hudson, M.R., and Murray, K.E., 2004, Geologic Map of the Hasty Quadrangle, Boone and Newton Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2847, scale 1:24,000. (Hasty Quadrangle). (*GRI Source Map ID 68982*).

Digital Geologic-GIS Map of the Jasper Quadrangle, Arkansas (*GRI MapCode JSPR*)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Hudson, M.R., Murray, K.E., and Pezzutti, Deborah, 2001, Geologic Map of the Jasper Quadrangle, Newton and Boone Counties, Arkansas: U.S. Geological Survey, Miscellaneous Field Studies Map, MF-2356, scale 1:24,000. (Jasper Quadrangle). (*GRI Source Map ID 3807*).

Digital Geologic-GIS Map of the Marshall Quadrangle, Arkansas (*GRI MapCode MRSH*)

Hutto, R.S., and Smart, E.E., 2008, Geologic Map of the Marshall Quadrangle, Searcy County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00532, scale 1:24,000. (Marshall Quadrangle). (*GRI Source Map ID 75407*).

Digital Geologic-GIS Map of the Maumee Quadrangle, Arkansas (*GRI MapCode MAUM*)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Turner, K.J., and Hudson, M.R., 2010, Geologic Map of the Maumee Quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3134, scale 1:24,000. (Maumee Quadrangle). (*GRI Source Map ID 74689*).

Digital Geologic-GIS Map of the Mt. Judea Quadrangle, Arkansas (*GRI MapCode MOJU*)

Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Mt. Judea Quadrangle, Newton County, Arkansas: Arkansas Geological Commission, Digital Geologic Quadrangle Map, DGM-AR-00590, scale 1:24,000. (Mt. Judea Quadrangle). (*GRI Source Map ID 60913*).

Digital Geologic-GIS Map of the Murray Quadrangle, Arkansas (*GRI MapCode MRAY*)

Hudson, M.R., and Turner, K.J., 2016, Geologic Map of the Murray Quadrangle, Newton County, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3360, scale 1:24,000. (Murray Quadrangle). (*GRI Source Map ID 76081*).

Digital Geologic-GIS Map of the Osage SW Quadrangle, Arkansas (*GRI MapCode OSGS*)

Hudson, M.R., and Turner, K.J., 2018, Geologic Map of the Osage SW Quadrangle, Newton, Madison, and Carroll Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map,

SIM-3400, scale 1:24,000. (Osage SW Quadrangle). (*GRI Source Map ID 76151).*

This source data is unpublished and preliminary.

Digital Geologic-GIS Map of the Parthenon Quadrangle, Arkansas (*GRI MapCode PART*)

Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Parthenon Quadrangle, Newton County, Arkansas: Arkansas Geological Commission, Digital Geologic Quadrangle Map, DGM-AR-00680, scale 1:24,000. (Parthenon Quadrangle). (*GRI Source Map ID 4176*).

Digital Geologic-GIS Map of the Ponca Quadrangle, Arkansas (*GRI MapCode PNCA*)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Hudson, M.R., and Murray, K.E., 2003, Geologic Map of the Ponca Quadrangle, Newton, Boone, and Carroll Counties, Arkansas: U.S. Geological Survey, Miscellaneous Field Studies Map, MF-2412, scale 1:24,000. (Ponca Quadrangle). (*GRI Source Map ID 4854*).

Digital Geologic-GIS Map of the Rea Valley Quadrangle, Arkansas (*GRI MapCode REVA*)

Ausbrooks, S.A., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2011, Geologic Map of the Rea Valley Quadrangle, Marion County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00730, scale 1:24,000. (Rea Valley Quadrangle). (*GRI Source Map ID 74687*).

Digital Geologic-GIS Map of the St. Joe Quadrangle, Arkansas (*GRI MapCode SAJO*)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Hudson, M.R., and Turner, K.J., 2009, Geologic Map of the St. Joe Quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3074, scale 1:24,000. (St. Joe Quadrangle). (*GRI Source Map ID 75172*).

Digital Geologic-GIS Map of the Snowball Quadrangle, Arkansas (*GRI MapCode SNWB*)

Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Snowball Quadrangle, Searcy County, Arkansas: Arkansas Geological Commission, Digital Geologic Quadrangle Map, DGM-AR-00800, scale 1:24,000. (Snowball Quadrangle). (*GRI Source Map ID 62287*).

Digital Geologic-GIS Map of the Western Grove Quadrangle, Arkansas (*GRI MapCode WEGR*)

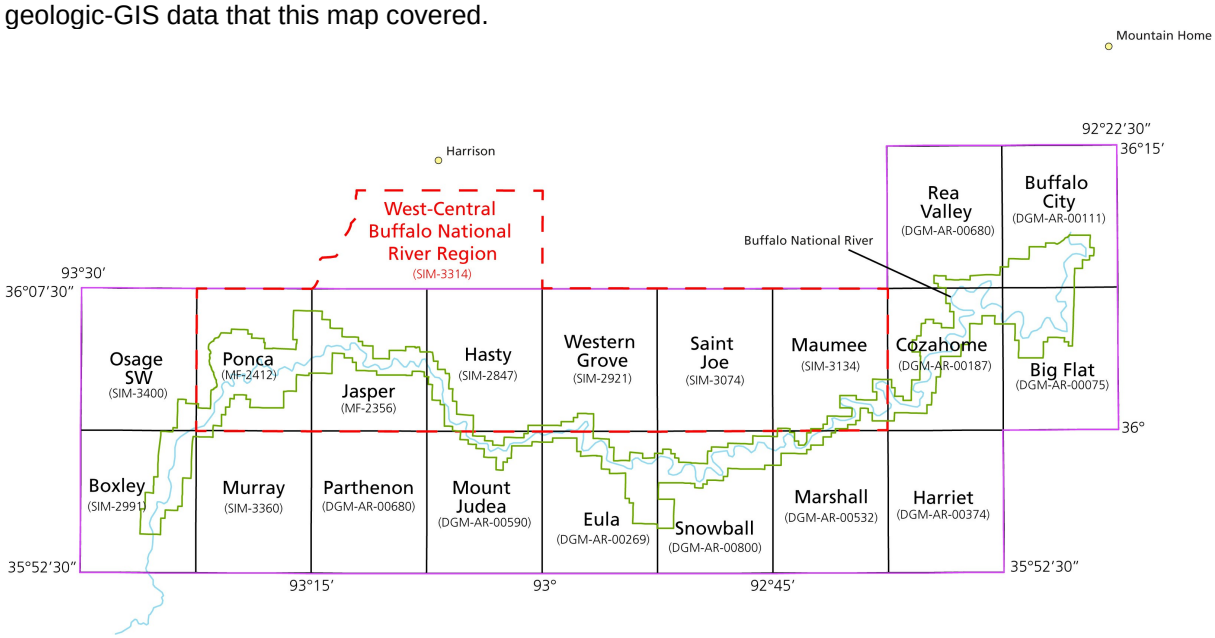
Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000. (West-Central Buffalo National River Region). (*GRI Source Map ID 75962*).

Hudson, M.R., Turner, K.J., and Repetski, J.E., 2006, Geologic Map of the Western Grove Quadrangle, Northwestern Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2921, scale 1:24,000. (Western Grove Quadrangle). (*GRI Source Map ID 74478*).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (BUFFMAP) table included with the GRI geologic-GIS data.

Index Map

The following index map displays the extent of GRI digital geologic-GIS data for Buffalo National River. The 7.5' quadrangles that comprise the extent of the data is also presented. The boundary of Buffalo National River (in dark green, as of September 2018), as well as quadrangle source maps used (map series numbers in parenthesis (e.g., DGM-AR-00075) in blue) is also displayed. The dashed red outline represents the extent of the West-Central Buffalo National River Region (SIM-3314) source map. This source map was the primary source for quadrangles within the GRI digital geologic-GIS data that this map covered.



Index map produced by James Winter (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Buffalo National River, Arkansas (BUFF) are listed below. Units are listed with their assigned unit symbol and unit name (e. g., Qat - Alluvium and terrace deposits). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (BUFFUNIT) table included with the GRI geology-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qat - Alluvium and terrace deposits
Qal - Alluvium deposits
Qty - Young terrace and active channel deposits
Qc - Colluvial deposits
Qls - Landslide deposits
Qtm - Medial terrace and alluvial deposits
Qto1 - Old terrace and alluvial deposits
Qbx - Remnant block deposits
Qto2 - Very old terrace and alluvial deposits

Paleozoic Era

Pennsylvanian Period

PNa - Atoka Formation
PNbu - Bloyd Formation, upper part
PNbm - Bloyd Formation, "middle Bloyd sandstone"
PNbl - Bloyd Formation, lower part
PNw - Witts Springs Formation
PNhp - Hale Formation, Prairie Grove Member
PNhc - Hale Formation, Cane Hill Member

Mississippian Period

Mi - Imo interval
Mp - Pitkin Limestone
Mf - Fayetteville Shale, undivided
Mfw - Fayetteville Shale, Wedington Sandstone Member
Mfmb - Fayetteville Shale, main body
Mbv - Batesville Sandstone/ Formation
Mm - Moorefield Formation
Mbu - Boone Formation, undivided
Mbmb - Boone Formation, main body
Mbsco - Boone Formation, Short Creek Oolite
Mbsj - Boone Formation, St. Joe Limestone Member

Silurian Period

Su - Silurian Limestone, undifferentiated

Ordovician Period
Ocs - Cason Shale
Ocsf - Cason Shale and Fernvale Limestone
Ocsfk - Cason Shale, Fernvale Limestone and Kimmswick Limestone
Of - Fernvale Limestone
Ofp - Fernvale Limestone and Plattin Limestone
Opl - Plattin Limestone
Oplj - Plattin Limestone and Joachim Dolomite
Osp - St. Peter Sandstone
Oe - Everton Formation, undivided
Oeu - Everton Formation, upper part
Oel - Everton Formation, lower part
Op - Powell Dolomite
Opblc - Powell Dolomite, black ledge chert
Ou - Lower Ordovician rocks, undivided
OCu - Lower Ordovician and Cambrian rocks, undivided
Oc - Cotter Dolomite

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. As mentioned in the Map Unit Listing section some source map unit symbols may have been changed. Unit descriptions and ancillary figures from the older component maps are included with this report because they contain more detailed descriptions of geologic features and processes than the West-Central Buffalo National River Region compiled map.

Qat - Alluvium and terrace deposits (Quaternary)

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel including deposits on one or more terrace levels in small streams and tributaries to the Buffalo River. Approximately 5-8 feet (1-2 meters) is exposed in gravel bars along creeks and tributaries to the Buffalo River. Exposed terraces along Big Creek range from 10-30 feet (3-9 meters) thick. (Description from source map: Big Flat Quadrangle).

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel including deposits on one or more terrace levels in small creeks and tributaries to the Buffalo and White Rivers. Approximately 5-20 feet (1.5-6 meters). (Description from source map: Buffalo City Quadrangle).

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated deposits of clay, silt, sand and gravel including deposits on one or more terrace levels in small creeks and tributaries to the Buffalo River. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source maps: Cozahome Quadrangle and Rea Valley Quadrangle).

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel including deposits on one or more terrace levels. (Description from source maps: Eula Quadrangle, Harriet Quadrangle, Mt. Judea Quadrangle, and Parthenon Quadrangle).

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel including deposits on one or more terrace levels. These deposits are only shown in areas where they do not overlap the Silurian and Ordovician units in Bear and Brush Creek to more clearly show the structure of those units. (Description from source map: Marshall Quadrangle).

Qat - Alluvium and terrace deposits (Quaternary)
Unconsolidated clay, silt, sand, and gravel including deposits on one or more terrace levels in small streams and tributaries to the Buffalo River. Approximately 5-20 ft. (1-6 m) is exposed in gravel bars along creeks and tributaries to the Buffalo River. (Description from source map: Snowball Quadrangle).

Qal - Alluvium deposits (Quaternary)

Qal - Alluvial deposits (Quaternary)
Unconsolidated alluvial deposits of Sweden Creek (northwest map area). Light-brown fine sand underlies smooth land surfaces that are 10-15 ft above level of creek. Deposits as thick as 15 ft. (Description from source map: Boxley Quadrangle).

Qal - Alluvium deposits (Quaternary)
Unconsolidated deposits of clay, silt, sand and gravel within the active channel and sandy/gravel point bar deposits along Water Creek and the Buffalo River. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source map: Cozahome Quadrangle).

Qal - Alluvial and active channel deposits of tributary drainages (Quaternary)
Tributaries to the Buffalo River include Tomahawk, Dry, and Water Creeks. Active-channel deposits include gravel deposits, composed of subangular to rounded Paleozoic rock clasts of predominantly chert and sandstone, and sandy point bar deposits composed mostly of rounded fine sand. Low terraces and active flood plain composed of light-brown, fine sand are locally present adjacent to creeks and extend up to about 20 ft above creek level. Unmapped bedrock exposures are interspersed along channels. As thick as 10 ft. (Description from source map: Maumee Quadrangle).

Qal - Alluvial deposits (Quaternary)
Unconsolidated alluvial deposits of Henson Creek (northeast map area). Light-brown fine sand underlies smooth land surfaces that are 10 to 15 ft above level of creek. Deposits as thick as 15 ft. (Description from source map: Murray Quadrangle).

Qal - Alluvium (Quaternary)
Unconsolidated deposits of clay, silt, sand and gravel within the “active channel” and sandy/gravel point bar deposits along Crooked Creek and the Buffalo River. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source map: Rea Valley Quadrangle).

Qal - Alluvial deposits (Quaternary)
Unconsolidated sand and gravel of Tomahawk, Mill, and Dry Creeks. Active-channel gravel deposits composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages are interspersed with bedrock exposures (not mapped). Low terraces of light-brown, fine sand are locally present adjacent to creeks. As thick as 10 ft. (Description from source map: St. Joe Quadrangle).

Qal - Alluvial deposits (Quaternary)
Unconsolidated channel and valley-fill deposits of Clear Creek. Channel deposits are subangular to rounded gravel of Paleozoic chert and sandstone and lesser sand and silt; small areas of unmapped bedrock are interspersed in the channel. Alluvial deposits filling valley bottom are composed of reddish-brown fine sand, siltstone, and claystone and contain subrounded to subangular fragments of weathered chert and sandstone. Valley-fill deposits underlie smooth land surfaces that are 10–15 ft above base-flow level of creek. Deposits are as thick as 15 ft. (Description from source map: Western Grove Quadrangle).

Qal - Alluvial deposits (Quaternary)
Unconsolidated silt, sand, and gravel. Active-channel gravel deposits are composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages, and interspersed with bedrock exposures (not mapped). Low terraces of light-brown, fine sand to reddish-brown silt are present adjacent to streams and underlie smooth land surfaces that are 10–15 ft above base-flow level of streams. As thick as 15 ft. (Description from source map: West-Central Buffalo National River Region).

Qty - Young terrace and active channel deposits (Quaternary)

Qty - Young terrace and active channel deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel in gravel bars and sandy point bar deposits along the Buffalo River. Primarily clay, silt and sand in youngest terrace above the river. The tops of terraces are generally flat but can be hummocky and dissected by tributaries. Approximately 20-30 feet (6-9 meters) thick. (Description from source map: Big Flat Quadrangle).

Qty - Younger terrace and active-channel deposits (Quaternary)
Unconsolidated sand and gravel of Buffalo River and tributaries. Terrace deposits are principally composed of light-brown fine sand; smooth upper surfaces are about 20ft above river. Gravel deposits of active channel are composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages and are interspersed with bedrock exposures to small to show at map scale. Low-

lying parts of deposit subject to periodic flooding. As thick as 20 ft. (Description from source map: Boxley Quadrangle).

Qty - Young terrace and active channel deposits (Quaternary)
Unconsolidated sand and gravel in gravel bars and sandy point bar deposits along the Buffalo and White Rivers. Primarily clay, silt and sand in youngest terrace above the river. The tops of the terraces are generally flat but can be hummocky and dissected by local side streams. Approximately 20-40 feet (6-12 meters). (Description from source map: Buffalo City Quadrangle).

Qty - Young terrace deposits (Quaternary)
Unconsolidated deposits of primarily clay, silt and sand in youngest terrace approximately 20-60 feet above the river. The tops of the terraces are generally flat but can be hummocky and dissected by smaller streams. This terrace may correspond with the terrace portion of Turner and Hudson's (2010) young terrace. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source map: Cozahome Quadrangle).

Qty - Young terrace and active channel deposits (Quaternary)
Unconsolidated clay, silt, sand and gravel in gravel bars and sandy point bar deposits along the Buffalo River. Primarily clay, silt, and sand in youngest terrace above the river. The tops of terraces are generally hummocky and tree-covered but can be flat and commonly dissected by tributaries. Approximately 20-30 ft. (6-9 m.) thick. (Description from source map: Eula Quadrangle).

Qty - Younger terrace and active-channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of Buffalo River. Terrace deposits are principally composed of light-brown, fine sand; smooth upper surfaces are about 20 ft above base-flow level of river. Active-channel gravel deposits are composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages, and they are interspersed with bedrock exposures (not mapped). As thick as 20 ft. (Description from source map: Hasty Quadrangle).

Qty - Younger terrace and alluvium deposits (Quaternary)
Unconsolidated sand and gravel of the Buffalo and Little Buffalo River and their major tributaries. Terrace deposits are principally composed of fine sand and have smooth upper surfaces that are about 20 ft (6 m) above the base-flow level of the rivers. Gravel deposits mostly line recent drainages and are composed of subrounded to rounded clasts of mixed lithology. (Description from source map: Jasper Quadrangle).

Qty - Young terrace and active channel deposits (Quaternary)
Unconsolidated clay, silt, sand, and gravel in gravel bars and point bar deposits along the Buffalo River. Primarily clay, silt and sand in youngest terrace above the river. The tops of terraces are generally hummocky and tree-covered but also common are flat tops dissected by tributaries. Approximately 20-30 ft. (6-9 m) thick. (Description from source map: Marshall Quadrangle).

Qty - Young terrace and active channel alluvial deposits (Quaternary)
Active channel deposits consist of gravel bar and sandy point bar deposits of the Buffalo River. Gravel bar deposits composed of rounded to subrounded pebble- to cobble-sized clasts of Paleozoic chert, dolostone, and sandstone, and sandy point bar deposits composed of fine to medium, rounded to well-rounded sand grains. Terrace deposits are principally light-brown, fine sand with lesser interspersed silt and have smooth upper surfaces that are about 20–40 ft above the base-flow level of river. Unmapped bedrock exposures are located along channel. Deposits are as thick as 20 ft. (Description from source map: Maumee Quadrangle).

Qty - Young terrace and active channel deposits (Quaternary)
Unconsolidated clay, silt, sand, and gravel in gravel bars and sandy point bar deposits along the Buffalo River. Primarily clay, silt, and sand in youngest terrace above the river. The tops of terraces are generally hummocky and tree-covered but can be flat and commonly dissected by tributaries. Approximately 20-30 ft. (6-9 m) thick. (Description from source maps: Mt. Judea Quadrangle and

Snowball Quadrangle).

Qty - Younger terrace and active-channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of Buffalo River, Little Buffalo River, and tributaries. Terrace deposits are principally composed of light-brown fine sand; smooth upper surfaces are about 20 feet (ft) above the river. Gravel deposits of the active channel are composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages and are interspersed with bedrock exposures too small to show at map scale. Low-lying parts of deposit are subject to periodic flooding. As thick as 20 ft. (Description from source map: Murray Quadrangle).

Qty - Younger terrace and active-channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of the Buffalo River. Terrace deposits are principally composed of light brown fine sand and have smooth upper surfaces that are as much as 20 ft (6 m) above the base-flow level of the river. Active-channel gravel deposits are composed of subangular to rounded Paleozoic rock clasts of mixed lithology along drainages and they are interspersed with bedrock exposures (not mapped). Deposits are as thick as 20 ft (6 m). (Description from source map Osage SW Quadrangle).

Qty - Younger terrace and active-channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of the Buffalo River and tributaries to the Kings River that include Sweden Creek, Dry Creek, Dry Fork, and Kenner Creek. Terrace deposits are principally composed of light-brown fine sand; smooth upper surfaces are about 20 ft above base flow. Gravel deposits of the active channels are composed of subangular to rounded Paleozoic rock clasts of mixed lithology, which are interspersed with bedrock exposures too small to show at map scale. Low-lying parts of deposit subject to periodic flooding. As thick as 20 ft. (Description from source map Ponca Quadrangle).

Qty - Young terrace deposits (Quaternary)
Unconsolidated deposits of primarily clay, silt and sand in the youngest terrace approximately 20-40 feet above Crooked Creek and the Buffalo River. The tops of the terraces are generally flat but can be hummocky and dissected by smaller streams. This terrace may correspond with the terrace portion of Turner and Hudson's (2010) young terrace. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source map: Rea Valley Quadrangle).

Qty - Younger terrace and channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of Buffalo River. Terrace deposits are principally light-brown fine sand and have smooth upper surfaces that are about 20 ft above the base-flow level of river. Channel gravel is subangular to rounded and composed of Paleozoic sandstone, chert, dolostone, and limestone; unmapped bedrock exposures are interspersed along channel. Deposits are as thick as 20 ft. (Description from source map: Western Grove Quadrangle).

Qty - Younger terrace and channel alluvial deposits (Quaternary)
Unconsolidated sand and gravel of Buffalo River. Terrace deposits are principally light-brown fine sand and have smooth upper surfaces that are about 20 ft above the base-flow level of river. Channel gravel is subangular to rounded and composed of clasts of Paleozoic sandstone, chert, and sparse dolostone and limestone; unmapped bedrock exposures are interspersed along channel. As thick as 20 ft. (Description from source map: West-Central Buffalo National River Region).

Qc - Colluvial deposits (Quaternary)

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of subrounded to angular blocks as large as 20 ft in diameter, commonly in an orange-brown silty clay matrix. Blocks are mostly derived from the basal sandstone of the upper part of the Bloyd Formation (PNbu) and the Cane Hill Member (PNhc) of the Hale Formation. Deposits have fan-like morphology and were mapped where sufficiently thick to mask typical ledge-flat

topography of underlying bedrock. Smaller, thinner colluvial deposits elsewhere were not mapped. Thickness uncertain but probably more than 10 ft. (Description from source maps: Boxley Quadrangle and Murray Quadrangle).

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of angular blocks as large as 20 ft (6 m) in diameter that are mostly derived from the basal sandstone of the upper Bloyd Formation. Thickness of deposit is variable but exceeds 60 ft (18 m) along Boulder Creek. Thinner colluvial deposits present elsewhere are not mapped. (Description from source map: Jasper Quadrangle).

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of subrounded to angular blocks as large as 20 ft in diameter, commonly in an orange-brown, silty clay matrix. Blocks are mostly derived from the basal sandstone of the upper part of the Bloyd Formation (*bu) and the Cane Hill Member (*hc) of the Hale Formation. Deposits have fan-like morphology and were mapped where sufficiently thick to mask typical ledge-flat topography of underlying bedrock. Smaller, thinner colluvial deposits elsewhere were not mapped. Thickness probably 10 ft or more. (Description from source map Osage SW Quadrangle).

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of angular blocks as large as 20 ft (6 m) in diameter that are mostly derived from the basal sandstone of the upper Bloyd Formation. Colluvium in southeast corner of map is a continuation of a thick deposit centered on Boulder Creek in adjacent Jasper quadrangle (Hudson and others, 2001). Colluvium deposit in east-central part of map (sec. 13, T. 16 N., R. 22 W.) conceals probable erosional truncation of Pitkin Limestone and Wedington Sandstone Member of the Fayetteville Shale beneath Cane Hill Member of the Hale Formation. Colluvial deposits present elsewhere are not mapped. Thickness uncertain but probably more than 10 ft (3 m). (Description from source map: Ponca Quadrangle).

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of subrounded to angular blocks as large as 20 ft in diameter, commonly in an orange-brown silty clay matrix. Blocks are mostly derived from basal sandstone of upper part of Bloyd Formation (PNbu) and Cane Hill Member (PNhc) of the Hale Formation. Deposits have fan-like morphology and were mapped where sufficiently thick to mask typical ledge-flat topography of underlying bedrock. Smaller, thinner colluvial deposits elsewhere were not mapped. Thickness uncertain but probably more than 10 ft. (Description from source map: St. Joe Quadrangle).

Qc - Colluvial deposits (Quaternary)
Unconsolidated deposits of subrounded to angular blocks as large as 20 ft in diameter, commonly in an orange-brown silty clay matrix. Blocks are mostly derived from the basal sandstone of the upper part of the Bloyd Formation (PNbu) or the Cane Hill Member (PNhc) of the Hale Formation. Deposits have fan-like morphology and were mapped where sufficiently thick to mask typical ledge-flat topography of underlying bedrock. Smaller, thinner colluvial deposits elsewhere were not mapped. Thickness as great as 60 ft. (Description from source map: West-Central Buffalo National River Region).

Qls - Landslide deposits (Quaternary)

Ql - Landslide (Quaternary)
Large slide blocks of limestone, sandstone, and shale derived from the Pennsylvanian Bloyd Formation (PNb) through the Mississippian Fayetteville Shale (Mf). Upper parts of slides are semi-coherent stratigraphic sequences back tilted into hillsides and down-dropped relative to bedrock. Lower parts of slides root in deformed lower part of Fayetteville Shale. (Description from source map: Boxley Quadrangle).

Qls - Landslide deposits (Quaternary)

Large blocks of St. Peter Sandstone scattered across a hummocky surface of unconsolidated material along Panther Creek. Thickness is variable. (Description from source map: Cozahome Quadrangle).

Qls - Landslide deposits (Quaternary)
Mostly blocks of sandstone derived from the Morrowan units. Also contains shale slumps from Morrowan and upper Mississippian units. (Description from source maps: Eula Quadrangle and Snowball Quadrangle).

Ql - Landslide (Quaternary)
Large slide blocks of limestone, sandstone, and shale derived from the Pitkin Limestone (Mp) and the Wedington Sandstone Member (Mfw) and main body of the Fayetteville Shale (Mf); generally back tilted into hillside on north side of Sulphur Mountain. Blocks moved over middle and lower parts of the Fayetteville Shale. (Description from source map: Hasty Quadrangle).

Qls - Landslide deposits (Quaternary)
Slump block of shale from main body of Fayetteville Shale (Mf) and minor sandstone blocks derived from Wedington Sandstone Member (Mfw) of Fayetteville Shale in west central part of map. Generally back-tilted into hillside and forms hummocky terrain. Probably no more that 60–80 ft thick. (Description from source map: Maumee Quadrangle).

Qls - Landslide deposits (Quaternary)
Blocks of sandstone derived from the Morrowan units. Along roads, the landslides are mostly in shale units either in the Fayetteville Shale or Cane Hill Member of the Hale Formation. (Description from source maps: Mt. Judea Quadrangle, Parthenon Quadrangle).

Qls - Landslide (Quaternary)
Slide blocks of limestone, sandstone, and shale derived from the Pennsylvanian Bloyd Formation (PNbu and PNbl) through the Prairie Grove and Cane Hill Members of the Hale Formation (Phf and Phc, respectively). Upper parts of slides are semi-coherent stratigraphic sequences back tilted into hillsides and down-dropped relative to bedrock. (Description from source map: Murray Quadrangle).

Ql - Landslide (Quaternary)
Large slide blocks of limestone, sandstone, and shale derived from the Lower Pennsylvanian Bloyd Formation through the Upper Mississippian Fayetteville Shale. Upper parts of slides are semi-coherent stratigraphic sequences that are back tilted into hillsides and down-dropped relative to bedrock. Lower parts of slides root in deformed lower part of Fayetteville Shale. (Description from source map: West-Central Buffalo National River Region).

Qtm - Medial terrace and alluvial deposits (Quaternary)

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt and sand in a higher terrace along the Buffalo River. It is approximately 40 feet (12 meters) above the river and ranges in thickness from 20-40 feet (6-12 meters). (Description from source map: Big Flat Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt and sand in higher terrace above the Buffalo and White Rivers. Ranges in thickness from 20-30 feet (6-9 meters). (Description from source map: Buffalo City Quadrangle).

Qtm - Medial terrace deposits (Quaternary)
Unconsolidated deposits of clay, silt and sand in higher (older) terraces approximately 40-80 feet above Water Creek and the Buffalo River. This terrace may correspond with Turner and Hudson's (2010) medial terrace. Thickness is variable and may reach up to 20 feet (0-6 meters). (Description from source map: Cozahome Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt, sand, gravel, and cobbles located approximately 40 ft. (12 m.) above the Buffalo River. The contact with the underlying young terrace is located at a riser that is approximately 15-20 ft. (4-6 m.) high and usually coincides with the edge of the riparian zone along the river. Ranges in thickness from 20-60 ft. (6-18 m.). (Description from source map: Eula Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated sand deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally brown-weathered, fine sand as high as 40 ft above base-flow level of river. Includes deposits within abandoned channel of Buffalo River east of Lost Hill. Thickness uncertain but probably as much as 20 ft. (Description from source map: Hasty Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt, sand, gravel, and cobbles along the Buffalo River. The contact with the underlying young terrace is located at the base of a riser that is approximately 15-20 ft. (4-6 m) high and usually coincides with the edge of the riparian zone along the river. This terrace is located approximately 40 ft. (12 m) above the river and ranges in thickness from 20-60 ft. (6-18 m). (Description from source map: Marshall Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated sand deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally brown-weathered, fine sand. Terrace surfaces are flat to gently sloping as high as 60 ft above base-flow level of river. Thickness uncertain but probably as much as 20 ft. (Description from source map: Maumee Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt, sand, gravel, and cobbles along the Buffalo River. The contact with the underlying terrace is located at a riser that is approximately 15-20 ft. (4-6 m) high and usually coincides with the edge of the riparian zone approximately 40 ft. (12 m) above the river. Ranges in thickness from 20-60 ft. (6-18 m). (Description from source map: Mt. Judea Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to the Buffalo River. Deposits are poorly exposed and are principally a lag of brown-weathered, subrounded to rounded Paleozoic rock clasts of mixed lithology that are as high as 40–60 ft (12–18 m) above the base-flow level of the river. Thickness uncertain but probably as much as 20 ft (6 m). (Description from source map: Ponca Quadrangle).

Qtm - Medial terrace deposits (Quaternary)
Unconsolidated deposits of clay, silt and sand in higher terraces approximately 40-80 feet above Crooked Creek and the Buffalo River. This terrace may correspond with Turner and Hudson's (2010) medial terrace. Thickness is variable and reaches up to 20 feet (0-6 meters). (Description from source map: Rea Valley Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated clay, silt, sand, gravel, and cobbles along the Buffalo River. The contact with the underlying young terrace is located at a riser that is approximately 15-20 ft. (4-6 m) high and usually coincides with the edge of the riparian zone along the river. This terrace is located approximately 40 ft. (12 m) above the river and ranges in thickness from 20-60 ft. (6-18 m). (Description from source map: Snowball Quadrangle).

Qtm - Medial terrace and alluvial deposits (Quaternary)
Unconsolidated sand and gravel deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally brown-weathered, fine sand but include basal zones of subrounded gravel containing pebbles to cobbles of Paleozoic sandstone and chert. Both basal strath and upper deposit surfaces are flat to gently sloping and are 30–45 ft and 65–100 ft above the base-flow level of river, respectively. Thickness 15–50 ft. (Description from source map: West-Central Buffalo National River

Region).

Qto1 - Old terrace and alluvial deposits (Quaternary)

Qto - Older terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to Buffalo River, found at one locality in northeast map area. Deposits are brown, weathered, subrounded to rounded Paleozoic sandstone cobbles in brown, silty to sandy matrix about 40 ft above river. Thickness about 10 ft. (Description from source map: Boxley Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble sized sub-angular to rounded chert and sandstone. It is located approximately 80-100 ft. (24-30 m.) above the river and ranges up to 160 feet (48 m.) above the river. Thickness variable. (Description from source map: Eula Quadrangle).

Qto -Older terrace and alluvium deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to the Buffalo and Little Buffalo Rivers. Deposits are principally a lag of subrounded to rounded clasts of mixed lithology that are as high as 100-120 ft (30-37 m) above the base-flow level of the rivers. (Description from source map: Jasper Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Consists of coarse sand to cobble-sized sub-angular to rounded chert and sandstone. Base is located approximately 80-100 ft. (24-30 m) above the river and ranges up to 160 ft. (48 m). Thickness unknown. (Description from source map: Marshall Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally lag gravel of brown-weathered, subrounded to rounded, pebble- to cobble-sized clasts of Paleozoic rocks in a sandy matrix. Clasts are primarily composed of very fine grained tan sandstone and chert. Terrace surface generally rounded 80–120 ft above base-flow level of river. Thickness about 5–10 ft. (Description from source map: Maumee Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble-sized sub-angular to rounded sandstone and chert. Located approximately 80-100 ft. (24-30 m) above the river and ranges up to 160 ft. (48 m) above the river. Thickness unknown. (Description from source map: Mt. Judea Quadrangle).

Qto - Older terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to Little Buffalo River. Deposits are brown, weathered, subrounded to rounded Paleozoic sandstone and subangular chert cobbles in brown; silty to sandy matrix about 60 to 100 ft above river. Thickness about 10 ft. (Description from source map: Murray Quadrangle).

Qto - Older terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to the Buffalo River. Deposits are poorly exposed and are principally a lag of brown-weathered, subrounded to rounded Paleozoic rock clasts of mixed lithology that are 100–120 ft (30–37 m) above the base-flow level of the river. Thickness uncertain but probably no more than 5 ft (1.5 m). (Description from source map: Ponca Quadrangle).

Qto1 - Old terrace deposits (Quaternary)
Unconsolidated deposits of gravel and sand in even higher observed terraces approximately 80-160 feet above Crooked Creek. Deposits are poorly exposed and consists of pebble to cobble sized

angular to rounded chert and other Paleozoic rocks in a coarse sandy matrix. Several isolated deposits are located above the western portion of the Crooked Creek. This terrace may correspond with Turner and Hudson's (2010) old terrace. Thickness is variable but reaches 20 feet (0-6 meters). (Description from source map: Rea Valley Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble sized sub-angular to rounded chert and sandstone. It is located approximately 80-100 ft. (24-30 m) above the river and ranges up to 160 ft. (48 m) above the river. Thickness unknown. (Description from source map: Snowball Quadrangle).

QTto - Older terrace and channel alluvial deposits (Quaternary and Tertiary(?))
Unconsolidated gravel, sand, and silt deposits adjacent to Buffalo River. Deposits are principally a lag of brown-weathered, subrounded to rounded cobbles of Paleozoic sandstone and chert in a reddish-brown sandy to silty matrix. Fine sand, silt, and clay locally overlie cobble deposits. Deposits are 80–120 ft above base-flow level of river. Deposits are as thick as 20 ft. (Description from source map: Western Grove Quadrangle).

Qto1 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel and sand deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally lag gravel of brown-weathered, subrounded to rounded, pebble- to cobble- sized clasts of Paleozoic sandstone and chert in a sandy matrix, locally overlain by fine sand, silt, and clay. Basal strath and upper deposit surfaces are flat to gently sloping and are 65–120 ft and 100–160 ft above the base-flow level of river, respectively. Thickness 15–50 ft. (Description from source map: West-Central Buffalo National River Region).

Qbx - Remnant block deposits (Quaternary)

Qbx -Remnant block deposits (Quaternary)
Remnant erosional blocks of Batesville Sandstone (Mbv) in sinkholes and along faults within the underlying main body of the Boone Formation (Mb). Deposits are characterized by tabular sandstone blocks with moderately rounded edges 1 to 4 ft in diameter and interspersed with chert. Deposits interpreted to be related to more recent, late-stage karst development because blocks are not encased in paleokarst features such as calcified collapse breccia. Relationship to faults is unknown. (Description from source map: Maumee Quadrangle).

Qbx - Remnant block deposits (Quaternary)
Unconsolidated and consolidated remnants of Batesville Sandstone and St. Joe Limestone in large sinkholes or collapsed features within the Boone and Everton Formations. Deposits most likely correspond to those that were first recognized by Turner and Hudson (2010). The erosional blocks of the Batesville Sandstone are characterized by tabular sandstone blocks with moderately rounded edges 1 to 4 feet in diameter and interspersed with the chert of the Boone Formation (Tuner and Hudson, 2010). The remnant beds of St. Joe Limestone are preserved in a sinkhole or collapse feature within the dolostones of the Everton Formation. Deposits are interpreted to be related to more recent, late- stage karst development because blocks are not encased in paleokarst features as observed in calcified collapsed breccia (Tuner and Hudson, 2010). Exact relationship to faulting and thickness of deposits are unknown, but appear to occur in close proximity to faults and other structures. (Description from source map: Rea Valley Quadrangle).

Qbx - Remnant block deposits (Quaternary)
Remnant erosional blocks of Upper Mississippian Batesville Sandstone (Mbv) in sinkhole and along faults within the underlying main body of the Upper and Lower Mississippian Boone Formation (Mb) in eastern part of map area. Deposits are characterized by tabular sandstone blocks with moderately rounded edges 1 to 4 ft in diameter and interspersed with chert. Deposits interpreted to be related to late-stage karst development. (Description from source map: West-Central Buffalo National River

Region).

Qto2 - Very old terrace and alluvial deposits (Quaternary)

Qto2 - Very old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble sized angular to rounded chert. Two small deposits are exposed approximately 200 feet (60 meters) above the river just south of the confluence of Leatherwood Creek. This terrace corresponds with Turner and Hudson's (2010) very old terrace. Thickness unknown. (Description from source map: Big Flat Quadrangle).

Qto2 - Old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits along the White and Buffalo Rivers. Deposit consists of coarse sand to cobble sized angular to rounded chert. One deposit is exposed approximately 280-300 feet (85-91 meters) above the White River just south of the confluence of Crooked Creek. The other deposit is exposed approximately 240 feet (73 meters) above the Buffalo River just north of Gosha Creek. These terraces probably correspond with Turner and Hudson's (2010) very old terrace. Thickness unknown. (Description from source map: Buffalo City Quadrangle).

QTto - Older terrace and alluvial deposits (Quaternary and Tertiary (?))
Unconsolidated gravel and sand deposits adjacent to Buffalo River. Deposits are poorly exposed and are principally a lag of brown-weathered, subrounded to rounded Paleozoic rock clasts of mixed lithology in a sandy matrix 140–180 ft above base-flow level of river. Thickness uncertain but probably no more than 5 ft. (Description from source map: Hasty Quadrangle).

Qto2 - Very old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Consists of coarse sand to cobble-sized sub-angular to rounded sandstone and chert. Base is located approximately 200 ft. (60 m) above the river. Thickness unknown. (Description from source map: Marshall Quadrangle).

Qto2 -Very old terrace and alluvial deposits (Quaternary)
Poorly exposed, unconsolidated gravel and sand deposits adjacent to Buffalo River. Deposits are principally a lag of weathered, rounded to well-rounded Paleozoic clasts of very fine grained tan sandstone and chert in a sandy matrix 230–260 ft above base-flow level of river. Thickness about 5–10 ft. (Description from source map: Maumee Quadrangle).

Qto2 - Very old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble-sized sub-angular to rounded sandstone and chert. Located approximately 200 ft. (60 m) above the river. Thickness unknown. (Description from source map: Mt. Judea Quadrangle).

Qto - Older terrace alluvial deposit (Quaternary)
Unconsolidated gravel and sand deposit found at one locality in northwest map area adjacent to Dry Fork, north of Dinsmore, Arkansas. Deposit contains brown, weathered, subrounded to rounded Paleozoic sandstone cobbles and white, subangular chert cobbles in brown, silty to sandy matrix about 40 ft above Dry Fork. Thickness about 10 ft. (Description from source map Osage SW Quadrangle).

Qto2 - Very old terrace and alluvial deposits (Quaternary)
Unconsolidated gravel deposits on ridges above the Buffalo River. Deposit consists of coarse sand to cobble sized sub-angular to rounded sandstone and chert. It is located approximately 200 ft. (60 m) above the river. Thickness unknown. (Description from source map: Snowball Quadrangle).

Qto2 - Very old terrace and alluvial deposits (Quaternary)
Poorly exposed, unconsolidated gravel and sand deposits adjacent to Buffalo River. Deposits are

principally a lag of weathered, rounded to well-rounded clasts of Paleozoic sandstone and chert in a sandy matrix. Basal strath and upper deposit surfaces are flat to gently sloping and are 130–245 ft and 160–280 ft above the base-flow level of river, respectively. Thickness 5–45 ft. (Description from source map: West-Central Buffalo National River Region).

PNa - Atoka Formation (Middle Pennsylvanian)

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)
Alternating shale, siltstone, and sandstone intervals underlying upper hills of map area. Where exposed, shale throughout unit is fissile and dark gray to black. Siltstone is thin bedded with ripple cross lamination. Upper sandstone intervals as thick as 10 ft underlie highest hills in southwestern part of quadrangle and vary from tan, very fine to fine-grained, ripple to planar bedded, to white, medium to coarse grained, medium planar bedded to thick crossbedded with sparse white quartz pebbles. Lower sandstone interval (fig. 3A) is about 100 ft thick and is homogeneous tan, thin to medium bedded, fine to very fine grained, and forms prominent topographic ledges. Beds are typically ripple trough laminated, and locally bioturbated. Base of unit placed in poorly exposed shale interval that forms topographic flat. Thickness is as much as 400 ft. (Description from source map: Boxley Quadrangle).

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)
Alternating shale, siltstone, and sandstone intervals underlying upper hills of map area. Where exposed, shale throughout unit is fissile and dark gray to black. Siltstone is thin bedded with ripple cross lamination. Upper sandstone intervals as thick as 10 ft underlie highest hills and vary from tan, very fine to fine grained, ripple to planar bedded to white, medium to coarse grained, medium planar bedded to thick cross-bedded with sparse white quartz pebbles. Lower sandstone interval is about 100 ft thick and is homogeneous, tan, thin to medium bedded, fine to very fine grained, and forms prominent topographic ledges. Beds are typically ripple cross-laminated, and locally bioturbated. Base of unit placed in poorly exposed shale interval that forms topographic flat. Thickness is as much as 400 ft. (Description from source map: Murray Quadrangle).

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)
Alternating shale, siltstone, and sandstone intervals underlying hills in southeastern and northeastern parts of map area. Where exposed, shale is fissile and dark gray to black. Siltstone is thin bedded with ripple cross laminations. Sandstone intervals as thick as 10 ft, are locally bioturbated, and vary between the following: tan, very fine to fine grained, ripple to planar bedded; white, medium to coarse grained, medium planar bedded; and thick, cross-bedded with sparse, white quartz pebbles. Unit is poorly exposed, and the basal contact was not observed in the map area. The inferred basal contact was placed in a poorly exposed shale interval that forms a topographic flat about 270–300 ft above base of upper Bloyd Formation (*bu). Contact is better constrained on the Ponca quadrangle to the east where contact is placed above a coal layer about 250 ft above the base of the upper part of the Bloyd Formation (Hudson and Murray, 2003). Deposits in the map area correlate with the lower part of the Atoka Formation farther south in the Arkoma Basin where the unit is more completely preserved in the subsurface (Zachry and Southerland, 1984). Thickness is as much as 120 ft. (Description from source map Osage SW Quadrangle).

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)
Consists of black to tan shales, with interbedded very thin to thin ripple-bedded micaceous siltstones, and fine to very fine grained sandstones with sub-rounded to rounded grains. The sandstones are tan to buff colored on fresh and weathered surfaces and contain clay pebbles, liesegang bands, horizontal trace fossils, and cross-beds. Occasionally the sandstones contain pebble conglomerate zones with external molds of fossils. The sandstones vary from 10 - 20 ft. (3 - 6 m) thick. This contact is tentative and will be resolved with future mapping. Approximately 120 ft. (37 m) thick. (Description from source map: Parthenon Quadrangle).

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)

Interbedded shale, siltstone, and sandstone. Unit forms highest hills of map area and is poorly exposed. Sandstone is tan, thin to medium bedded, fine to very fine grained, and holds up topographic ledges. Beds are typically ripple-trough laminated, and locally bioturbated. Less commonly, sandstone is medium to coarse grained and contains white quartz granules. Siltstone is thin bedded with ripple cross-lamination. Shale is dark gray to black. Thickness of unit is as much as 100 ft (33 m). (Description from source map: Ponca Quadrangle).

PNa - Atoka Formation (Middle Pennsylvanian, Atokan)
Alternating shale, siltstone, and sandstone intervals underlying highest hills of map area. Where exposed, shale throughout unit is fissile and dark gray to black. Siltstone is thin bedded with ripple cross-lamination. Sandstone intervals vary from common tan, very fine to fine-grained, ripple to planar bedded to less common white, medium- to coarse-grained, medium planar- bedded with sparse white quartz pebbles. Thickness as much as 100 ft. (Description from source map: West-Central Buffalo National River Region).

PNbu - Bloyd Formation, upper part (Lower Pennsylvanian)

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and lower parts. Thickness as much as 380 ft. **Upper part:** Dominantly sandstone with interbedded siltstone and shale. Upper part of sequence contains dark-gray to black shale and siltstone beds that form topographic flats interbedded with sandstone beds that form ledges. Upper sandstone beds are commonly extensively bioturbated, including horizontal, radiating burrows (fucoids) as long as 3 in (fig. 3B). Upper sandstone intervals are 5-20 ft thick and vary from orange-brown, fine to coarse grained with local very fine grained, ripple cross-laminated to planar bedded that locally contain carbonaceous films. Base of unit is crossbedded sandstone as thick as 80 ft that forms prominent cliffs in the central part of the area. This basal sandstone is white to light-brown, fine-to medium-grained quartz arenite that has a sharp erosional base and is commonly a composite of several tabular and trough-crossbed sets. Sandstone contains local concentrations of white quartz pebbles and casts of wood fragments. In northwestern and eastern parts of map area, basal interval forms a less prominent cliff composed of thin-to medium-bedded sandstone interbedded with siltstone and shale. Rocks of upper part of Bloyd Formation were originally assigned to Winslow Formation by Purdue and Miser (1916). Zachry (1977) concluded that basal sandstone was a time-equivalent unit with Woolsey Member of Bloyd Formation farther west and designated it informally as "middle Bloyd sandstone." Thickness is 200-300 ft. (Description from source map: Boxley Quadrangle).

PNbu - Bloyd Formation: Upper Part (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 240-340 ft. (73-103 m) thick. **Upper part:** Consists of interbedded thin ripple-bedded to thick-bedded micaceous sandstones and shales. The sandstones consist of fine- to coarse-grained sub-angular to sub-rounded quartz. They are light brown to gray on fresh surface but weather dark gray. The shales are dark gray to black on fresh and weathered surfaces. This interval contains many trace fossils, load features, and ball and pillow structures. Approximately 40-140 ft. (12-42 m) thick. (Description from source map: Eula Quadrangle).

PNbu - Bloyd Formation: Upper Part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 300 ft thick. **Upper part:** Prominent crossbedded sandstone that forms cliffs as tall as 60 ft capping Sulphur, Boat, and Pinnacle Mountains. Sandstone is white to light-brown, fine- to medium-grained quartz arenite and is commonly a composite of several 1- to 3-ft-thick tabular and trough crossbed sets. Sandstone has a sharp erosional base and contains concentrations

of white quartz pebbles and, locally, casts and molds of wood fragments. Rocks of the upper Bloyd Formation were originally assigned to the Winslow Formation by Purdue and Miser (1916). Zachry (1977) concluded that the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it the “middle Bloyd sandstone.” Maximum preserved thickness 160 ft. (Description from source map: Hasty Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 380 ft (116 m) thick. **Upper part:** Dominantly sandstone with interbedded siltstone and shale. Poorly exposed dark-gray to black shale beds within upper part form topographic flats between sandstone ledges. Base is prominent crossbedded sandstone that forms cliffs as tall as 60 ft (18 m) rimming high plateaus. Basal sandstone is white to light-brown, fine- to medium-grained quartz arenite that has a sharp erosional base and is commonly a composite of several 1-3-ft- (0.3-1-m-) thick tabular and trough crossbed sets. Sandstone contains concentrations of white quartz pebbles and, locally, casts of wood fragments. The rocks of the upper Bloyd Formation were originally assigned to the Winslow Formation by Purdue and Miser (1916). This convention was followed by Henderson (1972). Zachry (1977), however, concluded the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it the "middle Bloyd sandstone." Maximum thickness of unit is 280 ft (85 m). (Description from source map: Jasper Quadrangle).

PNbu - Bloyd Formation: Upper Part (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the members as recognized in the type section in northwest Arkansas. Therefore, the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 160-400 ft. (48-121 m) thick. **Upper part:** Consists of interbedded thin ripple-bedded to thick micaceous sandstones and shales . The sandstones consist of fine to coarse-grained sub-angular to sub- rounded quartz. They are light brown to gray on fresh surface but weather dark gray. The shales are dark gray to black on fresh and weathered surfaces. This interval contains many trace fossils, load features, and ball and pillow structures. Conformable with the “middle Bloyd sandstone”. Approximately 200-240 ft. (60-73 m) thick. (Description from source map: Mt. Judea Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and lower parts. Thickness as much as 380 ft. **Upper part:** Dominantly sandstone with interbedded siltstone and shale. Upper part of sequence contains dark-gray to black shale and siltstone beds that form topographic flats interbedded with sandstone beds that form ledges. Upper sandstone beds are commonly extensively bioturbated. Upper sandstone intervals are 5 to 20 ft thick and vary from orange-brown, fine to coarse grained with local quartz pebbles, and medium to thick planar bedded to cross-bedded, fine to very fine grained, ripple cross-laminated to planar bedded that is tan to olive and locally contain carbonaceous films. A calcite cemented sandstone or bioclastic crinoid-bearing limestone is observed at several locations about 140 to 180 ft above the basal contact. Base of unit is cross-bedded sandstone as thick as 80 ft that commonly forms prominent cliffs although it varies over short distances and it grades into less prominent sandstone ledges. Prominent cliff-forming sandstone is white to light-brown, fine- to medium-grained quartz arenite that has a sharp erosional base and is commonly a composite of several tabular and trough cross-bed sets. Sandstone contains local concentrations of white quartz pebbles and casts of wood fragments. Where basal interval forms a less prominent cliff, it is composed of thin- to medium-bedded sandstone interbedded with siltstone and shale. Purdue and Miser (1916) originally assigned rocks of the upper part of the Bloyd Formation to the Winslow Formation. Zachry (1977) concluded that the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it informally as the “middle Bloyd sandstone.” The middle Bloyd sandstone interval comprises the basal interval of the upper part of the Bloyd Formation map unit as used here. Thickness is 200–300 ft. (Description from source map: Murray Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and lower parts. Thickness as much as 360 ft Interbedded sandstone, siltstone and shale above a basal cliff-forming sandstone interval. Upper part of unit contains dark-gray to black shale and siltstone beds interbedded with ledge-forming sandstone beds. Upper sandstone beds are 5–20 ft thick, commonly extensively bioturbated, and vary from (1) orange-brown, fine to coarse grained that locally contain quartz pebbles; (2) medium to thick, planar bedded to cross-bedded; to (3) tan or olive, very fine to fine grained, ripple cross-laminated to planar bedded that locally contain flattened carbonaceous fragments. Base of unit is cross-bedded sandstone that generally forms prominent 20–80 ft cliffs. The basal sandstone has a sharp erosional base and is commonly a composite of several tabular and trough cross-bed sets composed of white to light-brown, fine- to medium-grained quartz arenite. Local concentrations of white quartz pebbles and casts of wood fragments are common. In the northwestern and eastern parts of the map area, basal interval forms a less prominent cliff composed of thin- to medium-bedded sandstone interbedded with siltstone and shale. Zachry (1977) correlated Bloyd Formation deposits between northwestern Arkansas and the Boxley area (south of the map area), and indicated that the finer grained upper parts of the unit are correlative with the Dye Shale Member and the basal sandstone is time-equivalent with the Woolsey Member of the Bloyd. Zachry (1977) informally designated the basal sandstone interval as the “middle Bloyd sandstone.” Thickness is 200–300 ft. (Description from source map Osage SW Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
In this quadrangle the individual members within the Bloyd Formation cannot be recognized because its limestone units (Brentwood and Kessler Limestones) are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" Zachry and Haley, 1975. Approximately 130- 450 ft. thick. **Upper Part:** Consists of interbedded thin ripple-bedded to thick micaceous sandstones and shales above the "middle Bloyd sandstone". The sandstones consist of fine to coarse grained sub-angular to sub-rounded quartz. They are light brown to gray on fresh surface but weather dark-gray. The shales are dark-gray to black on fresh and weathered surfaces. This interval contains many trace fossils, load features, and ball and pillow structures. Approximately 200-240 ft. thick. (Description from source map: Parthenon Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper parts. As much as 380 ft (116 m) thick. **Upper part:** Dominantly sandstone with interbedded siltstone and shale. Upper part of sequence is poorly exposed and contains dark-gray to black shale beds that form topographic flats and sandstone and siltstone beds that hold up ledges 3–6 ft (1–2 m) high. At least one bed of coal from 4 to 19 in (0.1 to 0.48 m) thick is interbedded with black shale and siltstone at the top of the sequence in the northwestern part of the area (J.D. McFarland, oral commun., 2000). Upper sandstone beds are tan, mostly fine to very fine grained, ripple-cross laminated to planar bedded, and locally bioturbated. Base of unit is crossbedded sandstone as thick as 100–150 ft (33–50 m) that forms prominent cliffs in most of the area. Basal sandstone is white to light-brown, fine- to medium grained quartz arenite that has a sharp erosional base and is commonly a composite of several 1–3-ft- (0.3–1-m-) thick tabular and trough-crossbed sets. Sandstone contains concentrations of white quartz pebbles and casts of wood fragments. In the west-central part of the map area, the basal sandstone is interbedded with shale and does not form a prominent cliff. Thickness of unit is about 275 ft (84 m). (Description from source map: Ponca Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 180 ft thick. **Upper part:** Crossbedded sandstone capping Pilot and St. Joe Mountains. Sandstone forms prominent cliffs as tall as 60 ft on Pilot Mountain and more subdued ledges on St. Joe Mountain. Sandstone is white to light-brown, fine- to medium-grained quartz arenite and is a composite of 1- to 3-ft-thick tabular and trough crossbed sets. Sandstone has a

sharp erosional base and contains concentrations of white quartz pebbles and, locally, casts and molds Of wood fragments. Rocks of the upper Bloyd Formation were originally assigned to the Winslow Formation by Purdue and Miser (1916). Zachry (1977) concluded that the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it the "middle Bloyd sandstone." Maximum preserved thickness is 110 ft. (Description from source map: St. Joe Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper parts. Thickness as much as 400 ft. **Upper part:** Dominantly sandstone with interbedded siltstone and shale. Upper part of sequence contains dark-gray to black shale and siltstone beds that form topographic flats interbedded with sandstone beds that form ledges. Upper sandstone intervals are 5–20 ft thick and vary from orange-brown, fine- to coarse-grained with local quartz pebbles, and medium to thick planar bedded to crossbedded, to tan or olive, fine- to very fine grained, ripple cross-laminated to planar bedded. Base of unit is crossbedded sandstone as thick as 80 ft that forms prominent cliffs. This basal sandstone is white to light- brown, fine- to medium-grained quartz arenite that has a sharp erosional base and is commonly a composite of several tabular and trough-crossbed sets. Sandstone contains local concentrations of white quartz pebbles and casts of wood fragments. Rocks of the upper part of the Bloyd Formation were originally assigned to the now abandoned Winslow Formation by Purdue and Miser (1916). Zachry (1977) concluded that the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it informally as the“middle Bloyd sandstone.” Thickness 200–300 ft. (Description from source map: West-Central Buffalo National River Region).

PNbm - Bloyd Formation, "middle Bloyd sandstone" (Lower Pennsylvanian)

PNbm - Bloyd Formation: "middle Bloyd sandstone" (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 240-340 ft. (73-103 m) thick. **"middle Bloyd sandstone":** A thin to massive-bedded, medium- to coarse-grained, cross-bedded quartz- or iron-cemented sandstone with sub-angular to sub-rounded quartz grains. Reddish, gray, or light tan on fresh surface but weathers brown to orange-brown due to iron content. The cross-bedded packages can be up to three feet thick and locally overturned. Contains abundant lycopod fossils and rounded quartz pebbles. This sandstone forms a prominent bluff throughout this quadrangle and separates the upper from the lower part of the Bloyd Formation. A pebble clast conglomerate is present at the base of this sandstone. The "middle Bloyd sandstone" is unconformable with the lower part of the Bloyd Formation or the Witts Springs Formation. Approximately 80-140 ft. (24-42 m) thick. (Description from source map: Eula Quadrangle).

PNbm - Bloyd Formation: "middle Bloyd sandstone" (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the members as recognized in the type section in northwest Arkansas. Therefore, the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 160-400 ft. (48-121 m) thick. **"middle Bloyd sandstone":** A thin- to massive-bedded, medium- to coarse-grained, cross-bedded quartz or iron-cemented sandstone with sub-angular to sub-rounded quartz grains. Reddish, gray, or light tan on fresh surfaces but weathers brown to orange-brown due to iron content. The cross-bedded packages can be up to three feet thick and locally overturned. Contains abundant lycopod fossils and rounded quartz pebbles. Forms a prominent bluff throughout this quadrangle and separates the upper and lower parts of the Bloyd

Formation. A pebble clast conglomerate is present at the base of this sandstone. Unconformable with the lower part of the Bloyd Formation. Approximately 80-160 ft. (24-48 m) thick. (Description from source map: Mt. Judea Quadrangle).

PNbm - Bloyd Formation: "middle Bloyd sandstone" (Lower Pennsylvanian, Morrowan)
In this quadrangle the individual members within the Bloyd Formation cannot be recognized because its limestone units (Brentwood and Kessler Limestones) are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" Zachry and Haley, 1975. Approximately 130-450 ft. thick. **"middle Bloyd sandstone":** A thin to massive, medium to coarse-grained, cross-bedded quartz or iron-cemented sandstone with sub-angular to sub-rounded quartz rains. Reddish, gray, or light-tan on fresh surface but weathers brown to orange-brown due to iron content. The cross-bedded packages can be up to three feet thick and occasionally "overturned". Contains abundant lycopod fossils and rounded quartz pebbles. This sandstone forms a prominent bluff throughout this quadrangle and separates the upper from the lower part of the Bloyd Formation. A pebble clast conglomerate is present at the base of this sandstone. The "middle Bloyd sandstone" is unconformable with the lower part of the Bloyd Formation. Approximately 50-160 ft. thick. (Description from source map: Parthenon Quadrangle).

PNbm - Bloyd Formation: "middle Bloyd sandstone" (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kesler Limestones are either missing or have become shaly and sandy. There are no "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" Zachry and Haley, 1975. The upper part of the Bloyd is not present in this quadrangle. The lower part of the Bloyd is equivalent to the Witts Springs Formation in this area. Approximately 240-340 ft. (73-103 m) thick. **"middle Bloyd sandstone":** A thin to massive, medium- to coarse-grained, cross-bedded quartz- or iron-cemented sandstone with sub-angular to sub-rounded quartz grains. Reddish, gray, or light tan on fresh surfaces but weathers brown to orange-brown due to iron content. The cross-bedded packages can be up to three feet thick and locally overturned. Contains abundant lycopod fossils and rounded quartz pebbles. This sandstone forms a prominent bluff throughout this quadrangle and separates the upper from the lower part of the Bloyd Formation. A pebble clast conglomerate is present at the base of this sandstone. Unconformable with the lower part of the Bloyd Formation or the Witts Springs Formation. Approximately 80-120 ft. (24-36 m) thick. (Description from source map: Snowball Quadrangle).

PNbl - Bloyd Formation, lower part (Lower Pennsylvanian)

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and lower parts. Thickness as much as 380 ft. **Lower part:** Dominantly shale and siltstone with interbedded limestone and thin beds of sandstone. Shale and siltstone are dark gray and fissile to thin, ripple bedded. Sandstone is tan, very fine to fine grained, thin bedded with ripple marks. Limestone includes medium to thick beds of red-brown conglomerate, with clasts of fossil fragments and subrounded sandstone and siltstone. The Brentwood Limestone Member at the base of formation (not mapped) is a 5- to 20-ft-thick limestone interval varying from massive gray micrite to reddish-gray, coarse bioclastic limestone. Unit is conformable with underlying Hale Formation. Forms moderate to steep slopes and is poorly exposed. Unit ranges from 40 ft thick in north to over 100 ft thick in south. (Description from source map: Boxley Quadrangle).

PNbl - Bloyd Formation: Lower Part (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There

are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 240-340 ft. (73-103 m) thick. **Lower Part:** Consists of interbedded very thin to thin ripple-bedded micaceous siltstones and sandstones that are fine- to medium-grained, however, a very thin- to thick-bedded fossiliferous sandy fine-grained limestone is present beneath the "middle Bloyd sandstone" in a few locations. This limestone is gray on fresh surfaces but weathers light brown with a rounded profile. Throughout the lower part are black fissile clay- to silty-shales interbedded with thin- to thick-bedded fossiliferous carbonate to sandy carbonate layers. The carbonate layers vary from red to gray on fresh and weathered surfaces and can be mottled. Locally, the fossiliferous sandy layers look "rotten" due to decalcification. The quartz grains are medium-grained and sub-angular to sub-rounded. The contact between the lower part of the Bloyd Formation and the Prairie Grove is placed below a shaly layer conformable with the underlying massive calcareous sand of the Prairie Grove Member of the Hale Formation. Approximately 120-160 ft. (36-48 m) thick.(Description from source map: Eula Quadrangle).

PNbl -Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 300 ft thick. **Lower part:** Sequence of predominantly dark-gray to black shale and siltstone with thin beds of sandstone and limestone; forms moderate to steep slopes, but is poorly exposed. Fine-grained, planar-bedded, olive-brown sandstone beds, 5–10 ft thick, are locally exposed as ledges. Coarse bioclastic limestone is reddish gray and weathers dark brown but is poorly exposed and mostly observed as loose blocks in lower part of sequence. Thickness 90–120 ft. (Description from source map: Hasty Quadrangle).

PNbu - Bloyd Formation: Lower Part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 300 ft thick. **Lower part:** Sequence of predominantly dark- gray to black shale and siltstone with interbedded thin beds of sandstone and limestone; forms moderate to steep slopes, but is poorly exposed. Fine-grained, planar bedded, olive-brown sandstone beds, 5-10 ft (1.5-3 m) thick, are locally exposed as ledges in upper part of sequence. The Brentwood Limestone Member at the base of the formation (not mapped) is a 5-10-ft- (1.5-3 m) thick, reddish-gray, coarse bioclastic limestone that is conformable with underlying Hale Formation. Unit is 90-120 ft (27-37 m) thick. (Description from source map: Jasper Quadrangle).

PNbl - Bloyd Formation: Lower Part (Lower Pennsylvanian, Morrowan)
In this quadrangle, the individual members within the Bloyd Formation cannot be recognized because the Brentwood and Kessler Limestones are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the members as recognized in the type section in northwest Arkansas. Therefore, the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" (Zachry and Haley, 1975). Approximately 160-400 ft. (48-121 m) thick. **Lower part:** Consists of interbedded very thin- to thin ripple bedded micaceous siltstones and sandstones that are fine to medium-grained. A very thin- to thick-bedded fossiliferous, sandy, fine-grained limestone is present beneath the "middle Bloyd sandstone" at a few locations. This limestone is gray on fresh surfaces but weathers light brown with a rounded profile. Black fissile clay to silty shales interbedded with thin- to thick-bedded fossiliferous sandstone to sandy limestone layers are present throughout the unit. The limestone layers vary from red to gray on fresh and weathered surfaces and can be mottled. Locally the fossiliferous sandy layers look "rotten" due to decalcification. The sand is medium-grained and sub-angular to sub-rounded. The basal contact of the Bloyd Formation is placed below a shaly unit that is conformable with the underlying massive calcareous sandstone of the Prairie Grove Member of the Hale Formation. Approximately 120-160 ft. (36-48 m) thick. (Description from source map: Mt. Judea Quadrangle).

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and

lower parts. Thickness as much as 380 ft. **Lower part:** Dominantly shale and siltstone with interbedded limestone and thin beds of sandstone. Shale and siltstone are dark gray and fissile to thin; ripple bedded. Sandstone is tan, very fine to fine grained, thin bedded with ripplemarks. Limestone includes medium to thick beds of red-brown conglomerate, with clasts of fossil fragments and subrounded sandstone and siltstone. The Brentwood Limestone Member at the base of the formation is not mapped separately, and is included as being in the lower part of the Bloyd and is a 5 to 20ft thick limestone interval varying from massive gray micrite to reddish-gray, coarse bioclastic limestone. Basal contact is conformable and gradational with the underlying Hale Formation. Forms moderate to steep slopes and is poorly exposed. Thickness varies from 40–180 ft. (Description from source map: Murray Quadrangle).

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Dominantly shale and siltstone, with interbedded limestone and thin beds of sandstone. Shale and siltstone are dark gray and fissile to thin, ripple laminated. Sandstone is tan, very fine to fine-grained and thin bedded with ripple marks. Limestone is medium to thick bedded, red-brown and conglomeratic, with clasts containing fossil fragments and subrounded sandstone and siltstone. The Brentwood Limestone Member, at the base of the formation (not mapped separately), is a 5- to 20-ft-thick limestone interval varying from gray micrite to reddish-gray, coarse bioclastic limestone. In the type area in northwestern Arkansas, the Brentwood Limestone Member includes marine limestone and shales. Usage here follows that of McFarland (1988) and reserves the Brentwood Limestone Member for the limestone beds at the base of the unit. Unit has a gradational contact with the underlying Hale Formation. Forms moderate to steep slopes and is poorly exposed. Thickness 20–60 ft. (Description from source map Osage SW Quadrangle).

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
In this quadrangle the individual members within the Bloyd Formation cannot be recognized because its limestone units (Brentwood and Kessler Limestones) are either missing or have become shaly and sandy. There are no other "marker zones" to divide the section into the recognizable members known from the type section in northwest Arkansas. Therefore the Bloyd Formation is divided informally into lower and upper parts (Hudson et al., 2001) separated by the "middle Bloyd sandstone" Zachry and Haley, 1975. Approximately 130-450 ft. thick. **Lower part:** Mostly seen below the "middle Bloyd sandstone" are interbedded very thin to thin ripple-bedded micaceous siltstones and sandstones that are fine to medium-grained, however, a very thin to thick bedded fossiliferous sandy fine grained limestone is present beneath the "middle Bloyd sandstone" at a few locations. This limestone is gray on fresh surface but weathers light-brown with a rounded profile. Throughout the lower part is black fissile clay shales to silty shales interbedded with thin to thick-bedded fossiliferous carbonate to sandy carbonate layers. The carbonate zones vary from red to gray on fresh and weathered surface and can be mottled. Sometimes the fossiliferous sandy zones look "rotten" due to decalcification. The sand grains are medium and sub-angular to sub-rounded. The contact between the lower part of the Bloyd Formation and the Prairie Grove is placed below a shaly layer conformable with the underlying massive calcareous sand of the Prairie Grove Member of the Hale Formation. Approximately 80-150 ft. thick. (Description from source map: Parthenon Quadrangle).

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper parts. As much as 380 ft (116 m) thick. **Lower part:** Dominantly dark-gray to black shale and siltstone interbedded with thin beds of sandstone and limestone. Sandstone beds locally exposed as ledges as much as 10 ft (3 m) high. Sandstone varies from tan, very fine to fine grained, thin bedded with ripple marks to orange brown, medium grained, thin to medium bedded with local basal conglomerate lenses containing clasts of sandstone and shale and rounded white quartz pebbles. The Brentwood Limestone Member at the base of the formation (not mapped) is a 5–20-ft- (1.5–6-m-) thick, reddish-gray, coarse bioclastic limestone. Unit is conformable with the underlying Hale Formation. Forms moderate to steep slopes and is poorly exposed. Unit is 40–100 ft (12–30 m) thick. (Description from source map: Ponca Quadrangle).

PNbu - Bloyd Formation: Upper part (Lower Pennsylvanian, Morrowan)

Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 180 ft thick. **Lower part:** Sequence of predominantly dark-gray to black shale and siltstone with thin beds of sandstone and limestone; poorly exposed under moderate to steep hillslopes. Siltstone is medium to dark gray, fissile, and moderately bioturbated. Medium beds of rippled, very fine grained sandstone are locally exposed as ledges. Coarse bioclastic limestone is reddish gray and weathers dark brown but is poorly exposed and mostly observed in loose blocks in lower part of sequence. Thickness 50-70 ft. (Description from source map: St. Joe Quadrangle).

PNbl - Bloyd Formation: Lower part (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper parts. Thickness as much as 400 ft. **Lower part:**Sequence of predominantly dark-gray to black shale and siltstone with thin beds of sandstone and limestone; poorly exposed under moderate to steep hillslopes. Siltstone is medium to dark gray, fissile, and moderately bioturbated. Medium beds of rippled, very fine grained sandstone are locally exposed as ledges. Coarse bioclastic limestone is reddish gray, weathers dark brown, and is present in lower part of sequence. Thickness 90–120 ft. (Description from source map: West-Central Buffalo National River Region).

PNw - Witts Springs Formation (Lower Pennsylvanian)

PNw - Witts Springs Formation (Lower Pennsylvanian, Morrowan)
Glick et. al., 1964, gave this name to a sequence of rocks in the Snowball Quadrangle equivalent to the Prairie Grove Member of the Hale Formation and the entire Bloyd Shale (Formation) of the type Morrowan region, northwestern Arkansas. In their definition of this unit, they identified the first massive quartz pebble sandstone they encountered above the Witts Springs as the Atoka Formation. Subsequently, the "middle Bloyd sandstone" which is not present in the type area of the Bloyd Formation in northwestern Arkansas was identified in north-central Arkansas by Zachry and Haley in 1975. The "middle Bloyd sandstone" is present above the Witts Springs Formation in the Snowball Quadrangle instead of the Atoka. Therefore, the Witts Springs Formation is equivalent to the Prairie Grove Member of the Hale Formation and the lower part of the Bloyd Formation in north central Arkansas. On the east side of Horn Mountain a blocky sandstone unlike the Prairie Grove is present above the Cane Hill. The Prairie Grove is equivalent to the lower portion of the Witts Springs Formation. The Witts Springs is underlain by the Cane Hill Member of the Hale Formation and overlain by the "middle Bloyd sandstone" and strata equivalent to the upper part of the Bloyd Formation. The Witts Springs Formation can be divided into two parts - a main body and a lower sandstone. The lower sandstone was not mapped separately due to a 40 foot contour interval. Approximately 200-320 ft. (60-97 m) thick. **Main body:** Consists mostly of thin to medium bedded sandstone and interbedded clay-shale. The sands are very fine to medium grained and usually ripple bedded near the top of the unit. Calcareous fine- to medium-grained fossiliferous sandstones with sub-angular to rounded grains are present and contain clay pebble clasts and fine- to coarse-grained quartz pebbles. Gray on fresh surfaces but weathers brown or dark gray. Approximately 170-290 ft. (51-88 m) thick. **Lower sandstone:** A massive coarse-grained iron-cemented sandstone with sub-angular to sub-rounded quartz grains. Sometimes friable. White to yellow on fresh surfaces but weathers a light brown. Contains plant fragments, iron banding, stylolites and pock marks. This unit has a blocky appearance and forms a prominent bluff on the east side of Horn Mountain and the southwest side of Point Peter Mountain. A dark-gray shale pebble conglomerate is present at the base of the sandstone. The lower sandstone is unconformable with the Cane Hill Formation. 0-approx. 30 ft. (0-9 m) thick. (Description from source map: Eula Quadrangle).

PNw - Witts Springs Formation (Lower Pennsylvanian, Morrowan)
Equivalent to the Prairie Grove Member of the Hale Formation and the lower part of the Bloyd Formation (Braden et al., 2003). Only the basal sandstone is present at the top of Bryan Mountain. There, it is thick- to very thick-bedded, massive-bedded, fine- to medium-grained, subangular, poorly-sorted, calcareous sandstone. Weathering has produced a blocky to concave appearance, honeycomb weathering, and a dark gray to medium brown color. Commonly contains liesegang banding. Fresh surfaces are gray to gray-brown, although locally decalcification makes them dark-

brown and friable. There is a cross-bedded zone on the south side of the mountain where the sandstone is coarse-grained and contains brachiopod detritus and dark-red, flattened and rounded shale pebbles. Unconformable with the Cane Hill Member, and reaches a maximum thickness of approximately 100 feet (30 meters). (Description from source map: Marshall Quadrangle).

PNw - Witts Springs Formation (Lower Pennsylvanian, Morrowan)
Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone with interbeds of limestone. Locally contains quartz pebbles in basal sandstone beds. Sandstone beds are planar or cross-bedded, and cross-beds may have bidirectional dips. Sandstone weathers to form rounded surfaces with elliptical cavities as long as 1 ft. Unit contains some interbeds of reddish-brown, coarse bioclastic limestone. Shale layers separating sandstone beds are reported regionally (Southerland, 1988), but were not observed in the map area. Unit forms steep slopes and is often covered by thin colluvium derived from overlying units. Basal contact with Cane Hill Member (*hc) is unconformable. Thickness 30–80 ft. (Description from source map Osage SW Quadrangle).

PNw - Witts Springs Formation (Lower Pennsylvanian, Morrowan)
Glick et al., 1964, gave this name to a sequence of rocks in the Snowball Quadrangle equivalent to the Prairie Grove Member of the Hale Formation and the entire Bloyd Shale (Formation) of the type Morrowan region northwestern Arkansas. In their definition of this unit, they identified the first massive quartz pebble sandstone they encountered above the Witts Springs as the Atoka Formation. Subsequently, the "middle Bloyd sandstone" which is not present in the type area of the Bloyd Formation in northwestern Arkansas was identified in north-central Arkansas by Zachry and Haley in 1975. The "middle Bloyd sandstone" is present above the Witts Springs Formation in the Snowball Quadrangle instead of the Atoka Formation. Therefore the Witts Springs Formation is equivalent to the Prairie Grove Member of the Hale Formation and the lower part of the Bloyd Formation in north central Arkansas. A blocky sandstone unlike the Prairie Grove is present above the Cane Hill. The Prairie Grove is equivalent to the base of the Witts Springs Formation. The Witts Springs is underlain by the Cane Hill Member of the Hale Formation and overlain by the "middle Bloyd sandstone" and strata equivalent to the upper part of the Bloyd Formation. The Witts Springs Formation can be divided into two parts - a main body and a lower sandstone. The lower sandstone was not mapped separately due to a 40 foot contour interval. Approximately 140-360 ft. (42-109 m) thick. **Main body:** Consists mostly of thin- to medium-bedded sandstone and interbedded clay shale. The sands are very fine to medium rained and commonly ripple bedded near the top of the unit. Calcareous fine- to medium-grained fossiliferous sandstones with sub-angular to rounded grains are present and contain clay pebble clasts and fine to coarse quartz pebbles. Gray on fresh surfaces but weathers brown or dark gray. **Lower sandstone:** A massive coarse-grained iron-cemented sandstone with sub-angular to sub-rounded quartz grains. Sometimes friable. White to yellow on fresh surfaces but weathers light brown. Contains plant fragments, iron banding, stylolites, and pock marks. This unit has a blocky appearance and forms a prominent bluff on the east side of Point Peter Mountain. A dark-gray shale pebble conglomerate is present at the base of the sandstone. Unconformable with the Cane Hill Member of the Hale Formation. 0- approx. 30 ft. (0-9 m) thick. (Description from source map: Snowball Quadrangle).

PNhp - Hale Formation, Prairie Grove Member (Lower Pennsylvanian)

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100-180 ft. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains quartz pebbles at base. Beds are planar or crossbedded, and crossbeds may have bi-directional dips. May contain interbeds of reddish-brown coarse bioclastic limestone. Weathered sandstone forms rounded surfaces with elliptical cavities as long as 1 ft. Sandstone forms steep slopes but may be covered by a colluvial mantle derived from overlying units. Thickness 20–60 ft. (Description from source map: 74842) (Boxley Quadrangle).

PNhp - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)

The Hale Formation consists of two Members; the Prairie Grove Member and the Cane Hill Member. Approximately 180 -340 ft. (54-103 m) thick. **Prairie Grove Member:** A fine- to coarse-grained quartz sandstone with varying amounts of carbonate, crinoidal fragments and quartz pebbles. Reddish-gray to brown or mottled on a fresh surfaces but weathers dark-reddish-brown. Bedding varies from thin to massive and exhibits a rounded weathering profile. This unit is a prominent bluff former that often contains cross-beds and a pitted surface that is referred to as honeycomb weathering. The base of the Prairie Grove Member contains a fossiliferous quartz pebble conglomerate that contains clasts of shale, siltstone, and sandstone as large as almost one foot in diameter. The Prairie Grove Member is unconformable with the Cane Hill Member. 0- approx. 40 ft. (0- 12 m) thick. (Description from source map: 62271) (Eula Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–180 ft. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains quartz pebbles in its base. Beds are planar or crossbedded, and crossbeds may have bidirectional dips. Weathered sandstone forms rounded surfaces. Sandstone forms steep slopes but is commonly covered by slope debris from overlying units. Thickness 10–20 ft. (Description from source map: 68982) (Hasty Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone that consists of Prairie Grove Member and Cane Hill Member. Formation is 110-150 ft (35-46 m) thick. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains abundant fossil fragments and, in its base, quartz pebbles. Beds are planar or crossbedded and crossbeds may have bi-directional dips. Weathered sandstone forms rounded surfaces with elliptical cavities as large as 8 in (20 cm) long. The sandstone forms steep slopes but is commonly covered by slope debris from overlying units. Unit is 10-40 ft (3-12 m) thick. (Description from source map: Jasper Quadrangle).

PNhp - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
The Hale Formation consists of two Members; the Prairie Grove and the Cane Hill. Approximately 160-320 ft. (48-97 m) thick. **Prairie Grove Member:** A fine- to coarse-grained quartz sandstone with varying amounts of carbonate, crinoidal fragments and quartz pebbles. Reddish-gray to brown or mottled on fresh surfaces but weathers dark reddish-brown. Bedding varies from thin to massive and exhibits a rounded weathering profile. This unit is a prominent bluff-former that often contains cross-beds and a pitted surface that is referred to as honeycomb weathering. The base of the Prairie Grove Member contains a fossiliferous quartz pebble-conglomerate that includes clasts of shale, siltstone, and sandstone, as large as one foot in diameter. One green feldspar fragment was found from this interval. Unconformable with the Cane Hill Member. Approximately 40-60 ft. (12-18 m) thick. (Description from source map: Mt. Judea Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–200 ft siltstone, shale, and thin limestone that consists of Prairie Grove Member and Cane Hill Member. Formation is 110–150 ft (35–46 m) thick. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains quartz pebbles at base. Beds are planar or cross-bedded, and cross-beds may have bi-directional dips. Commonly contains interbeds of reddish-brown coarse bioclastic limestone. Weathered sandstone forms rounded surfaces with elliptical cavities as long as 1 ft. Basal contact with underlying Cane Hill Member is unconformable. Sandstone forms steep slopes but may be covered by a colluvial mantle derived from overlying units. Thickness 20–60 ft. (Description from source map: Murray Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 130–260 ft. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone with interbeds of limestone. Locally contains quartz pebbles in basal sandstone

beds. Sandstone beds are planar or cross-bedded, and cross-beds may have bidirectional dips. Sandstone weathers to form rounded surfaces with elliptical cavities as long as 1 ft. Unit contains some interbeds of reddish-brown, coarse bioclastic limestone. Shale layers separating sandstone beds are reported regionally (Southerland, 1988), but were not observed in the map area. Unit forms steep slopes and is often covered by thin colluvium derived from overlying units. Basal contact with Cane Hill Member (*hc) is unconformable. Thickness 30–80 ft. (Description from source map Osage SW Quadrangle).

PNhp - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
The Hale Formation consists of two Members; the Prairie Grove Member and the underlying Cane Hill Member. Approximately 160 - 320 ft. thick. **Prairie Grove Member:** A fine to coarse-grained quartz sandstone with varying amounts of carbonate, crinoidal fragments and quartz pebbles. Reddish-gray to brown or mottled on a fresh surface but weathers dark reddish-brown. Bedding varies from thin to massive and exhibits a rounded weathering profile. This unit is a prominent bluff former that often contains cross-beds and a pitted surface that is referred to as honeycomb weathering. The base of the Prairie Grove Member contains a fossiliferous quartz pebble conglomerate that contains clasts of shale, siltstone, and sandstone as large as almost one foot in diameter. One green feldspar fragment was found from this interval. The Prairie Grove Member is unconformable with the Cane Hill Member. Approximately 40 - 80 ft. thick. (Description from source map: Parthenon Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone that consists of Prairie Grove Member and Cane Hill Member. Formation is 110–150 ft (35–46 m) thick. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. May contain bioclastic limestone interbeds and, at its base, quartz pebbles. Beds are planar or crossbedded and crossbeds may have bi-directional dips. Weathered sandstone forms massive, rounded surfaces with elliptical cavities as large as 8 in. (20 cm) long. The sandstone forms steep slopes that may be covered by slope debris from overlying units. Unit is 20–60 ft (6–18 m) thick. (Description from source map: Ponca Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100-180 ft. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains quartz pebbles in its base and thin interbeds of fossiliferous limestone. Beds are planar or crossbedded, and crossbeds may have bi-directional dips. Weathered sandstone forms rounded surfaces. Sandstone forms steep hillslopes or ledges that are commonly covered by slope debris from overlying units. Thickness 10-25 ft. (Description from source map: St. Joe Quadrangle).

PNhg - Hale Formation: Prairie Grove Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–180 ft. **Prairie Grove Member:** Brown to reddish-brown, fine- to medium-grained, thick-bedded, calcite-cemented sandstone. Locally contains quartz pebbles in its base and thin interbeds of fossiliferous limestone. Beds are planar or crossbedded, and crossbeds may have bi-directional dips. Weathered sandstone forms rounded surfaces. Sandstone forms steep hillslopes or ledges that are commonly covered by slope debris from overlying units. Thickness 10–60 ft. (Description from source map: West-Central Buffalo National River Region).

PNhc - Hale Formation, Cane Hill Member (Lower Pennsylvanian)

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100-180 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Upper part mostly composed of fissile to rippled, thin-bedded, dark-gray shale and siltstone but locally contains rippled, thin-bedded, very fine grained sandstone interval as thick as 5 ft. Upper part of unit is poorly exposed and

forms gentle to moderately steep slopes. Lower part is a 10- to 20-ft-thick sandstone interval that generally changes downward from olive-brown, very fine grained to fine-grained, thin-bedded sandstone with ripple cross-lamination or parallel lamination to reddish-brown, medium- to thick-bedded, very fine grained to medium-grained sandstone with trough crossbeds. Lower sandstone locally contains basal conglomerate lenses as thick as 3 ft containing quartz pebbles and subangular to subrounded clasts of sandstone, siltstone, shale, and limestone. Sandstone beds throughout unit locally affected by soft-sediment slumps and folds. Unit unconformably overlies Pitkin Limestone (Mp) and Fayetteville Shale (Mf). Thickness is 80–160 ft. (Description from source map: Boxley Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
The Hale Formation consists of two Members; the Prairie Grove Member and the Cane Hill Member. Approximately 180 -340 ft. (54-103 m) thick. **Cane Hill Member:** A gray to black fissile clay- to silty-shale containing iron nodules and small limonitic box work fragments. Varies from black to dark gray on fresh surfaces and light gray and light orange-brown on weathered surfaces. Thin-bedded ripple-marked siltstones and sandstones are present above the clay shale. Trace fossils are abundant. A 5-20 foot thick sandstone is present beneath the typical Cane Hill black in this quadrangle. It is thin to thick bedded, fine grained, cross bedded, and contains stylolites, plant fragments, and iron banding. One outcrop exposes the contact with the Pitkin as interbedded sandstone with underlying oolitic Pitkin. The Cane Hill Member is unconformable with the Pitkin Limestone. Approximately 180 - 300 ft. (54-91 m) thick. (Description from source map: Eula Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
The Hale formation consists of two members: the Prairie Grove Member and the Cane Hill Member. Only the Cane Hill member is present in the mapping area. **Cane Hill Member:** Medium to very thick beds of very fine to fine-grained, moderately sorted, iron-cemented sandstone and shale. Generally, sandstone beds are massive in appearance. Crossbeds are commonly observed. Color varies from white to light brown and various shades of reddish brown in fresh exposure. Weathered surfaces appear dark gray or reddish brown, and sometimes display honeycomb textures. Weathered blocks can travel great distances downslope, and some localities (Baker knobs NE of Devils Backbone) commonly show float of the Cane Hill sandstone along hill sides with little or no evidence of beds in place on hill tops. A unit of gray to black fissile clay shale to silty shale containing iron nodules and small limonitic box work fragments underlies the sandstone beds. The thickness of the shale ranges from 50 to 100 feet (15 to 31 meters), and thickness increases from east to west across the quadrangle. The shale unit is unconformable with the Pitkin below and is usually covered in the field. Thickness ranges from 0 to as much as 160 feet (49 meters). (Description from source map: Harriet Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–180 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Upper part is poorly exposed and composed of dark-gray shale and thin-bedded siltstone that form gentle to moderately steep slopes. Lower part is a 10- to 20-ft-thick sandstone interval of reddish-brown, medium- to thick-bedded, very fine grained to medium-grained sandstone with trough crossbeds. Lower sandstone changes upward to olive-brown, very fine grained to fine-grained, thin-bedded sandstone with ripple cross-lamination or parallel lamination. Basal sandstone locally contains casts of wood fragments and conglomerate lenses with quartz pebbles and angular to subrounded clasts of shale, siltstone, and sandstone. Unit unconformably overlies the Pitkin Limestone. Thickness varies from 80 ft to as much as 260 ft at Braden Mountain. (Description from source map: Hasty Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone that consists of Prairie Grove Member and Cane Hill Member. Formation is 110-150 ft (35-46 m) thick. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. The upper part of the Cane Hill Member is poorly exposed and composed of dark-gray shale and thin-bedded siltstone that form gentle to moderately steep slopes. The lower part is a 10-30-ft- (3-9-m-) thick sandstone interval that varies in

character from reddish-brown, poorly sorted, fine- to medium grained sandstone with trough cross beds to olive-brown, very fine to fine grained, thin-bedded sandstone with ripple cross-lamination or parallel lamination. Basal sandstone locally contains casts of wood fragments, thin, angular mudstone rip-up clasts, and red, rounded, oblate chert fragments. Unit is 80-140 ft (24-43 m) thick. Brown to reddish-brown, fine- to medium-grained, thick- bedded, calcite-cemented sandstone. Locally contains abundant fossil fragments and, in its base, quartz pebbles. Beds are planar or crossbedded and crossbeds may have bi-directional dips. Weathered sandstone forms rounded surfaces with elliptical cavities as large as 8 in (20 cm) long. The sandstone forms steep slopes but is commonly covered by slope debris from overlying units. Unit is 10-40 ft (3-12 m) thick. (Description from source map: Jasper Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Consists of two members: the Prairie Grove and the Cane Hill. Only the Cane Hill Member is present on this quadrangle. **Cane Hill Member:** Typically a fissile silty to clay shale that contains iron nodules and limonitic boxwork fragments. Color varies from dark gray to black on fresh surfaces, and from light gray to light orange-brown on weathered surfaces. Unconformable with the Pitkin and reaches a thickness of approximately 160 feet (48 meters) on this quadrangle. (Description from source map: Marshall Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
The Hale Formation consists of two Members; the Prairie Grove and the Cane Hill. Approximately 160-320 ft. (48-97 m) thick. **Cane Hill Member:** A gray to black, fissile, clay to silty shale containing iron nodules and small limonitic boxwork fragments. Varies from black to dark gray on fresh surfaces to light gray and light orange-brown on weathered surfaces. Thin-bedded ripple-marked siltstones and sandstones are present above the clay shale. Trace fossils are abundant. A one foot thick conglomerate containing black pebble clasts, fossil fragments, and clay clasts is present at the base at one locality. Unconformable with the Pitkin Limestone. Approximately 120-240 ft. (36-73 m) thick. (Description from source map: Mt. Judea Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–200 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Upper part mostly composed of fissile to rippled, thin-bedded, dark-gray shale and siltstone but locally contains rippled, thin-bedded, very fine grained sandstone interval as thick as 5 ft. Upper part of unit is poorly exposed and forms gentle to moderately steep slopes. Lower part is a 10- to 20-ft-thick sandstone interval that generally changes downward from olive-brown, very fine grained to fine-grained, thin-bedded sandstone with ripple cross-stratification or parallel lamination to reddish-brown, medium- to thick-bedded, very fine grained to medium-grained sandstone with trough cross-beds. Lower sandstone locally contains basal conglomerate lenses as thick as 3 ft containing quartz pebbles and subangular to subrounded clasts of sandstone, siltstone, shale, and limestone. Sandstone beds throughout unit locally affected by soft-sediment slumps and folds. Unit unconformably overlies Pitkin Limestone and Fayetteville Shale. Thickness is 80–160 ft. (Description from source map: Murray Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 130–260 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Upper part composed of fissile to ripple-laminated, dark-gray shale and siltstone underlain by 15- to 30-ft-thick middle interval of ripple-laminated to thin-bedded, very fine grained sandstone; middle interval also may contain channels of massive cross-bedded, fine- to medium-grained sandstone that locally has shale and siltstone ripup clasts and wood casts (fig. 3A). Lower part of unit includes gray shale and siltstone underlain by a 5- to 15-ft-thick, pale-orange, very fine to fine-grained, calcite-cemented sandstone that is often punky and friable due to partial leaching of calcite. Sandstone at base of unit locally overlies conglomerate lenses as thick as 3 ft that contain quartz pebbles and subangular to subrounded clasts of sandstone, siltstone, shale, and limestone. Sandstone beds throughout unit locally display slumps and folds attributed to soft-sediment deformation. Unit unconformably overlies Pitkin Limestone (Mp) and Fayetteville Shale (Mf). Thickness is 100–180 ft. (Description from source map Osage SW

Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
The Hale formation consists of two Members; the Prairie Grove Member and the underlying Cane Hill Member. Approximately 160 - 320 ft. thick. **Cane Hill Member:** A gray to black fissile clay to silty shale that contains iron nodules and small limonitic box work fragments. Varies from black to dark-gray on fresh surface to light-gray and light- orange-brown on weathered surface. Thin-bedded ripple-marked siltstones and sandstones are present above the clay shale. Trace fossils are abundant. A one foot thick conglomerate containing black pebble clasts, fossil fragments, and clay clasts is present at the base of the Cane Hill at one locality. The Cane Hill Member is unconformable with the Pitkin Limestone. Approximately 120 - 240 ft. thick. (Description from source map: Parthenon Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone that consists of Prairie Grove Member and Cane Hill Member. Formation is 110–150 ft (35–46 m) thick. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. The upper part of the Cane Hill Member is poorly exposed and composed mostly of dark-gray shale and thin-bedded siltstone that form gentle to moderately steep slopes. The lower part is a 10–40-ft- (3–12-m-) thick sandstone interval with siltstone and shale interbeds. Sandstone varies from reddish brown, poorly sorted, fine to medium grained in medium to thick beds that may contain trough crossbeds, to tan to olive brown, very fine to fine grained, thin bedded with ripple cross-lamination or parallel lamination. Lower sandstone beds may contain wood as carbonized fragments or as casts and angular mudstone intraclasts, and also contain local conglomerate lenses with clasts of sandstone, shale, and crinoid-bearing limestone. Sandstone beds locally display soft sediment slump folds. Unit unconformably overlies the Pitkin Limestone, the Wedington Member of the Fayetteville Shale, and the main body of the Fayetteville Shale. Unit is 80–140 ft (24–43 m) thick. (Description from source map: Ponca Quadrangle).

PNhc - Hale Formation: Cane Hill (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100-180 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Most of unit is poorly exposed dark- gray fissile shale and thin-bedded siltstone that form gentle to moderately steep slopes. Upper part locally contains rippled, thin-bedded, very fine and fine grained sandstone intervals as thick as 5 ft. Lower part includes 10-ft-thick sandstone interval that changes downward from olive-brown, very fine grained, thin-bedded sandstone with ripple cross-lamination to reddish brown, medium- to thick-bedded, very fine grained to medium-grained sandstone with trough crossbeds. Lower sandstone contains sparse casts of wood fragments and conglomerate lenses with quartz pebbles and angular to subrounded clasts of shale, siltstone, and sandstone. Unit unconformably overlies the Pitkin Limestone. Thickness varies from 60 ft to as much as 200 ft on east side of Pilot Mountain. (Description from source map: St. Joe Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
The Hale Formation consists of two Members; the Prairie Grove Member and the Cane Hill Member. Only the Cane Hill Member is present in this quadrangle. The base of the Witts Springs Formation is equivalent to the Prairie Grove Member. **Cane Hill Member:** A gray to black fissile clay to silty shale containing iron nodules and small limonitic box work fragments. Varies from black to dark gray on fresh surfaces and light gray and light orange-brown on weathered surfaces. Thin-bedded ripple-marked siltstones and sandstones are present above the clay shale. Trace fossils are abundant. Unconformable with the Imo interval. Approximately 160- 200 ft. (48-60 m) thick. (Description from source map: Snowball Quadrangle).

PNhc - Hale Formation: Cane Hill Member (Lower Pennsylvanian, Morrowan)
Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–180 ft. **Cane Hill Member:** Interbedded sequence of shale, siltstone, and sandstone. Most of unit is poorly exposed dark-gray fissile shale and thin-bedded siltstone that form gentle to moderately steep slopes. Upper part locally contains rippled, thin-bedded, very-fine and fine-grained sandstone intervals as thick as 5 ft. Lower part includes 10-ft-thick sandstone interval that changes downward from olive-brown, very

fine-grained, thin-bedded sandstone with ripple cross-lamination to reddish-brown, medium- to thick-bedded, very-fine grained to medium-grained sandstone with trough crossbeds. Lower sandstone contains sparse casts of wood fragments and conglomerate lenses with quartz pebbles and angular to subrounded clasts of shale, siltstone, and sandstone. Unit unconformably overlies the Pitkin Limestone or Fayetteville Shale. Thickness 80–240 ft. (Description from source map: West-Central Buffalo National River Region).

Mi - Imo interval (Upper Mississippian)

Mi - Imo interval (Upper Mississippian, Chesterian)
Consists of several shale units with intervening sandstone units. Present near the top of Bryan and South Mountain is a persistent, fine to medium-grained, thin- to massive- and locally cross-bedded sandstone. Fresh surfaces are buff to tan and locally mottled or banded with dark red iron blebs. Weathered surfaces are dark orangey-brown to gray, and blocky. Commonly exhibits pronounced stylolites, liesegang banding, and honeycomb weathering. This unit is approximately 15 feet (5 meters) thick. Shaly units above this sandstone are covered with vegetation. Conformable with the Pitkin. Ranges from approximately 80-100 feet (24-30 meters) in thickness. (Description from source map: Marshall Quadrangle).

Mi - Imo interval (Upper Mississippian, Chesterian)
Consists of limestones interbedded with clay shale. The limestones are fossiliferous and reddish on weathered surfaces. The shale is dark gray on fresh and weathered surfaces. A 5-20 ft. (1.5-6 m) thick sandstone is present at the base of the unit. It is thin- to thick bedded, fine grained, cross-bedded, and contains stylolites, plant fragments, and iron banding. Conformable with the Pitkin Limestone. Approximately 160 ft. (48 m) thick. (Description from source map: Snowball Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian)

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Medium- to dark-gray, fetid limestone. Limestone varies from micrite at base to coarse grained and locally oolitic near top. Limestone beds may contain abundant crinoids, brachiopods, corals, and bryozoan Archimedes. Black fissile-shale interbeds as thick as 3 ft are present within lower part of unit. Basal contact with Fayetteville Shale (Mf) is conformable, although rarely exposed. Pitkin generally outcrops as a prominent ledge or cliff. Thickness as much as 130 ft in south; locally absent in northeast part of quadrangle. (Description from source map: Boxley Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
A fine-to-coarsely-crystalline locally fossiliferous limestone containing crinoid fragments, Archimedes bryozoa, gastropods, coral (rugose and colonial) and ooliths. Varies from light gray to dark gray on fresh surfaces but usually weathers light or medium gray. Medium- to massive-bedded. Often has a petroliferous odor on freshly broken surfaces. A black shale occurs at the top of the Pitkin just beneath the Cane Hill Member of the Hale Formation at a few localities. It is distinctive from the Cane Hill in that it is not silty and does not contain box work fragments. No fossils were found from this shale interval. The Pitkin Limestone is conformable with the Fayetteville Shale. Approximately 120-240 ft. (36-73 m) thick. (Description from source map: Eula Quadrangle).

Mp- Pitkin Limestone (Upper Mississippian, Chesterian)
Thin to very thick-bedded, fine to coarse-grained, oolitic, oncolitic or bioclastic limestone with occasional interbedded black, fissile clay shale. Generally, bedding is massive in appearance with occasional cross-beds near the upper contact Typically contains abundant fossils including crinoid fragments, the bryozoan Archimedes, corals (solitary and colonial), brachiopods, gastropods, and trilobites. Color ranges from dark-gray to light-gray on fresh surfaces and typically weathers light or medium-gray but becomes more tan near the upper contact, possibly due to an increase in the silt

content. The limestone often has a petroliferous odor when freshly broken. Interbedded shales become common in the upper 50 - 70 feet (15 - 21 meters) of the formation near the southern edge of the outcrop belt (Blue Mountain, Begley Creek). These shales consist of gray-brown to black, fissile, calcareous clay shale with interbedded limestone concretions. Abundant crinoid columnals, often up to 1 inch (2.54 cm) in diameter, are present in this interval. The Pitkin Limestone is conformable with the Fayetteville Shale. Thickness ranges from 60 to 260 feet (18 -80 meters). (Description from source map: Harriet Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Generally medium to dark-gray, fetid limestone. Limestone texture varies from micritic to coarse grained and is locally oolitic. Limestone beds may contain abundant crinoids, brachiopods, corals, and bryozoan Archimedes. Basal contact with the Fayetteville Shale is conformable, although rarely exposed. The Pitkin generally forms a prominent ledge or cliff. Thickness 40–100 ft. (Description from source map: Hasty Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Generally medium- to dark-gray, fetid limestone. Limestone texture varies from micritic to coarse grained and is locally oolitic. Limestone beds may contain abundant crinoids, brachiopods, corals, and Archimedes. The basal contact with the Fayetteville Shale is conformable, although rarely exposed. The Pitkin Limestone generally forms a prominent ledge or cliff. Its thickness varies from 0 to 60 ft (0 to 18 m), thinning to zero in the southwest corner of map. (Description from source map: Jasper Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Thin to very thick, massive-bedded, fine to coarse-grained, locally oolitic bioclastic limestone. Contains abundant fossils including crinoid fragments, the bryozoan Archimedes, corals, nautiloids, brachiopods, gastropods, and trilobites. Fresh surfaces are light to dark gray, and weather light to medium gray. Grades to a tan color near the upper contact due to an increase in silt content. Commonly yields a petroliferous odor when freshly broken. Conformable with the Fayetteville Shale. Ranges from approximately 160-260 feet (49–79 meters) in thickness. (Description from source map: Marshall Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
A fine to coarsely crystalline, often fossiliferous limestone containing crinoidal fragments, Archimedes bryozoa, gastropods, coral (rugose and colonial), and ooliths. Varies from light gray to dark gray on fresh surfaces but usually weathers light or medium gray. Medium- to massive-bedded. Often has a petroliferous odor on freshly broken surfaces. A black shale occurs at the top of the Pitkin just beneath the Cane Hill Member of the Hale Formation at a few localities. It is distinctive from the Cane Hill in that it is not silty and does not contain boxwork fragments. No fossils were found from this shale interval. Conformable with the Fayetteville Shale. Approximately 160 ft. (48 m) thick. (Description from source map: Mt. Judea Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Medium- to dark-gray fetid limestone. As unit thickens to the south, upper part of unit is oolitic coarse crystalline dark-gray to brown limestone overlain by sandy limestone to calcite cemented sandstone horizon. Upper sandy interval, as thick as 20 ft, is restricted to southeasternmost areas. Limestone beds may contain abundant crinoids, brachiopods, corals, and bryozoan Archimedes. At base, varies from micrite to fine grained crystalline limestone with black fissile shale interbeds up to 5 ft thick as it grades downward into the Fayetteville Shale. Pitkin generally outcrops as a prominent ledge or cliff. Thickness in the northern half of the quadrangle is generally between 40 to 60 ft but is absent in the northeastern corner; unit thickens to the southeast to as much as 200 ft. (Description from source map: Murray Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Medium- to dark-gray fetid limestone. Limestone varies from micrite at base to coarse grained and locally oolitic near top. Limestone beds locally contain abundant crinoids, brachipods, corals, and

bryzoan Archimedes (fig. 3B). Basal contact with the Fayetteville Shale (Mf) is conformable. Pitkin generally crops out as a prominent ledge or cliff. Only present in the southwest and northwest parts of the map area. Thickness 0–40 ft. (Description from source map Osage SW Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
A fine to coarsely crystalline often fossiliferous limestone containing crinoidal fragments, Archimedes bryozoans, gastropods, coral (rugose and colonial), and ooliths. Varies from light-gray to dark-gray on fresh surface but, usually weathers light or medium-gray. Medium to massive-bedded. Often has a petroliferous odor on freshly broken surfaces. A black clay shale occurs at the top of the Pitkin just beneath the Cane Hill Member of the Hale Formation at a few localities. It is distinctive from the Cane Hill in that it is not silty and does not contain box work fragments. No fossils were found from this shale interval. The contact of this shale with the Cane Hill was not seen. The Pitkin Limestone is conformable with the Fayetteville Shale. Approximately 80 - 160 ft. thick. (Description from source map: Parthenon Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Generally medium- to dark-gray, fetid limestone. Limestone varies from micritic to coarse grained and is locally oolitic. Limestone beds may contain abundant crinoids, brachiopods, corals, and Archimedes. The unit commonly forms a prominent ledge. Distribution of Pitkin is restricted to the northeastern part of the map area. The basal contact with the Fayetteville Shale is conformable, although rarely exposed. Upper contact with Cane Hill Member is unconformable and Pitkin was eroded beneath the unconformity in the western part of the area. Its thickness varies from 0 to 60 ft (0 to 18 m). (Description from source map: Ponca Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Generally medium- to dark-gray, fetid limestone. Limestone in medium to thick wavy beds varies from micrite at base to coarse grained and locally oolitic near top. Limestone beds may contain abundant crinoids, brachiopods, corals, and bryozoan Archimedes. Basal contact with Fayetteville Shale is conformable, although rarely exposed. Pitkin generally forms a prominent ledge or steep slope. Thickness 40-80 ft. (Description from source map: St. Joe Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
A fine to coarsely-crystalline often fossiliferous limestone containing crinoidal fragments, Archimedes bryozoa, gastropods, coral (rugose and colonial), and ooliths. Varies from light gray to dark gray on fresh surfaces but typically weathers light or medium gray. Medium to massive bedded. Commonly has a petroliferous odor on freshly broken surfaces. A black shale is present at the top of the Pitkin just beneath the Imo interval at a few localities. No fossils were found from this shale interval. Conformable with the Fayetteville Shale. Approximately 140-180 ft. (42-54 m) thick. (Description from source map: Snowball Quadrangle).

Mp - Pitkin Limestone (Upper Mississippian, Chesterian)
Generally medium- to dark-gray, fetid limestone; commonly forms a prominent ledge or steep slope. Limestone in medium to thick wavy beds varies from micrite at base to coarse grained and locally oolitic near top. Limestone beds may contain abundant crinoids, brachiopods, corals, and bryozoan Archimedes. Basal contact with the Fayetteville Shale is conformable. Thickness 0–100 ft. (Description from source map: West-Central Buffalo National River Region).

Mf - Fayetteville Shale, undivided (Upper Mississippian)

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
Main body composed of black shale with interbeds of sandstone. Tan, calcite-cemented sandstone as thick as 12 ft, representing the Wedington Sandstone Member (Purdue and Miser, 1916), is sparsely exposed within upper 40 ft of unit. Sandstone is very fine grained in medium to thin planar to rippled beds with internal parallel laminations. Main body of unit is black, fissile shale that is poorly exposed in low slopes. Lower part of Fayetteville outcrops along stream gullies where it consists of black shale

that may contain medium-to light-gray, fetid septarian concretions as large as 2 ft in diameter. Fayetteville Shale is susceptible to landslides. Thickness varies from 140 to 220 ft. (Description from source map: Boxley Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Meramecian)
A black fissile clay shale. Alternating beds of micrite and shale occur in the upper portion. Black chert is present within the micrite. The micritic beds in the upper portion of this unit form resistant and commonly form steep ledges. Septarian concretions are present near the base of the shale. Very thin fine-grained sandstones are interbedded within the lower portion of the shale. Thin sandstone dikes with flow structures on both sides are present on the west side of Point Peter Mountain in the lower portion of the shale. The Fayetteville Shale is conformable with the underlying Batesville Sandstone. Approximately 120-280 ft. (36-85 m) thick. (Description from source map: Eula Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
Black, fissile clay shale which becomes increasingly interbedded with thin to medium-bedded, gray to black, micritic to finely-crystalline limestone in the upper half of the unit. The micritic beds are sparsely fossiliferous, have a petroliferous odor when broken, and often form resistant, steep ledges. Near the contact with the Pitkin, interbedded black chert becomes more common. The lower shale unit forms a gentle slope above the Batesville sandstone. Thin bedded limonitic siltstones that form sharp, angular float blocks associated with very thin calcite-filled veins are locally present in the lower shale unit (Stephenson Mountain). Septarian concretions can be present in the upper and lower parts of the formation. Thickness ranges from 240 to 320 feet (73 - 98 meters). (Description from source map: Harriet Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
Is comprised of a black, fissile clay shale which is increasingly dominated by thin- to medium-bedded, gray to black, micritic to finely crystalline limestone in its upper part. As the conformable contact with the overlying Pitkin Limestone is reached, the shale forms only very thin partings between the beds of micritic limestone. This upper section typically contains septarian concretions, and near the upper contact, nodular or discontinuous, thin-bedded black chert. The micritic beds typically yield a petroliferous odor when broken, and are sparsely fossiliferous. The upper Fayetteville Shale forms resistant and sometimes steep ledges where protected by the massive Pitkin above. The lower shaly unit forms a gentle slope above the relatively resistant, flat-lying beds of Batesville Sandstone. Limonitic, calcareous siltstone beds and concretions are locally present near the base of the shale. Ranges from approximately 180-270 feet (55-82 meters) in thickness and is unconformable with the Batesville Sandstone. (Description from source map: Marshall Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
A black fissile clay shale. Alternating beds of micrite and shale are present in the upper portion of the formation. Black chert is common in the micrite. The micritic beds in the upper portion of this unit form resistant and steep ledges. Septarian concretions are present near the base of the shale. Thin sandstone dikes are exposed near a small spring along County Road 249 near the center of Sec. 8, T15N, R19W. Conformable with the underlying Batesville Sandstone. Approximately 200- 280 ft. (60-85 m) thick. (Description from source map: Mt. Judea Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
Composed of black fissile shale that is poorly exposed in low slopes. Upper contact includes alternating beds of black shale and thin limestone beds as it grades upward into the Pitkin Limestone. Lower part of the Fayetteville outcrops along stream gullies where it consists of black shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. Basal contact with underlying Batesville Sandstone is conformable. Fayetteville Shale is susceptible to landslides. Thickness varies from 120 to 220 ft. (Description from source map: Murray Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
Black shale with interbeds of dark-gray to tan sandstone. Upper part of unit is usually absent, but where present in southwestern part of map, includes a tan, calcite-cemented sandstone as thick as 12

ft, representing the Wedington Sandstone Member (Purdue and Miser, 1916). Sandstone is very fine grained, and medium to thin, planar to ripple bedded with internal parallel laminations. Main body of unit is black, fissile shale that generally forms gentle slopes. Lower part of the Fayetteville may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. Fayetteville Shale is susceptible to landslides. Unit is conformable with underlying Batesville Sandstone. Where overlain by Pitkin Limestone, Fayetteville Shale is as thin as 60 ft in the northwest part of the map but as thick as 170 ft in the southwest part of the map. (Description from source map Osage SW Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
A black fissile clay shale. Alternating beds of micrite with shale occur in the upper portion of the formation to the contact with the overlying Pitkin Limestone. Black chert can be found within the micrite. The micritic beds in the upper portion of this unit form resistant and sometimes steep ledges. Septarian concretions are present near the base of the shale. One locality yielded small limonitic ammonoids in the lower portion of the shale. The Fayetteville Shale is conformable with the underlying Batesville Sandstone. Approximately 120- 240 ft. thick. (Description from source map: Parthenon Quadrangle).

Mf - Fayetteville Shale (Upper Mississippian, Chesterian)
A black fissile clay shale. Alternating beds of micrite with shale occur in the upper portion of the formation. Black chert is common the micrite. The micritic beds in the upper portion of this unit form resistant and sometimes steep ledges. Septarian concretions are present near the base of the shale. Very thin fine-grained sandstones are interbedded within the lower portion of the shale. The Fayetteville Shale is conformable with the underlying Batesville Sandstone. Approximately 200-240 ft. (60-73 m) thick. (Description from source map: Snowball Quadrangle).

Mfw - Fayetteville Shale, Wedington Sandstone Member (Upper Mississippian)

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of the Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness varies from 250 to 370 ft. **Wedington Sandstone Member:** Brown, well-indurated, calcite-cemented sandstone and siltstone. The Wedington caps a steep slope and is separated from the overlying Pitkin Limestone by thin black shale that commonly forms a bench. Sandstone is fine grained to very fine grained and is present in thick to thin planar beds with internal parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. The Wedington grades downward into main body. Thickness 25–33 ft (Description from source map: (Hasty Quadrangle).

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness varies from 220 to 370 ft (67 to 113 m). **Wedington Sandstone Member:** Brown, well-indurated, calcite-cemented sandstone and siltstone. The Wedington Sandstone Member caps a steep slope and is separated from overlying Pitkin Limestone by a thin black shale that commonly forms a bench. Sandstone is fine- to very fine grained and is present in thick to thin planar beds with internal parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. The sandstone is thickest in the northwest corner of the map but thins and contains limestone interbeds in the southwest part of the map. Wedington grades downward into main body. Thickness is 5-20 ft (1.5-6 m). (Description from source map: Jasper Quadrangle).

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member (Mfw) that grades downward

into main body of black, slope-forming shale. Thickness 125–170 ft. **Wedington Sandstone Member:** Brown to light-gray, well-indurated, calcite-cemented, very fine grained sandstone and siltstone; thin to thick bedded and has parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. Unit gradational with underlying main body and caps steep slopes of the main body to form a topographic bench. Thickness 25–50 ft. (Description from source map: Maumee Quadrangle).

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Consists of fine-grained sandstone and siltstone of Wedington Sandstone Member that grade downward into black, slope forming shale of the main body of the unit. Thickness varies from 10 to 360 ft (3 to 110 m). **Wedington Sandstone Member:** Brown, well-indurated, calcite-cemented sandstone and siltstone that form a distinctive unit in the upper part of the Fayetteville Shale. The Wedington Sandstone Member caps a steep slope and is separated from overlying Pitkin Limestone by a rarely exposed, thin, black shale that commonly forms a bench. Sandstone is fine- to very fine grained and is present in thin to thick planar beds with internal parallel laminations and locally developed low-angle crossbeds in highest beds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. Distribution of the sandstone is restricted to the northeastern part of the map area and is thickest in the northeast corner of the map. Contains limestone interbeds south of the Buffalo River. The unit was probably eroded from the western part of the map area before deposition of the Cane Hill Member of the Hale Formation. The Wedington grades downward into main body, and its basal contact is placed at the first outcrop of dominantly siltstone or sandstone beds. Thickness is 0–20 ft (0–6 m). (Description from source map: Ponca Quadrangle).

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 160-200 ft. **Wedington Sandstone Member:** Brown to light-gray, well-indurated, calcite-cemented sandstone and siltstone. Wedington caps a steep slope and is separated from overlying Pitkin Limestone by a common topographic bench. Sandstone is very fine grained and is present in thick to thin planar beds with internal parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. Wedington grades downward into main body. Thickness 25-40 ft. (Description from source map: St. Joe Quadrangle).

Mfw - Fayetteville Shale: Wedington Sandstone Member (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of the Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 10–500 ft. **Wedington Sandstone Member:** Brown to light-gray, well-indurated, calcite-cemented sandstone and siltstone. The Wedington caps a steep slope and is commonly separated from the overlying Pitkin Limestone by a topographic bench. Sandstone is very fine grained and is present in thick to thin planar beds with internal parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. The Wedington grades downward into main body. Thickness 0–40 ft. (Description from source map: West-Central Buffalo National River Region).

Mfmb - Fayetteville Shale, main body (Upper Mississippian)

Mf - Fayetteville Shale: Main body (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of the Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness varies from 250 to 370 ft. **Main body:** Below the Wedington Sandstone Member, the middle part of the Fayetteville Shale is black shale that is rarely exposed; local topographic flats in this interval suggest the presence of more resistant rock, like a thin sandstone that is exposed about 100 ft below the Wedington Sandstone Member on east side of Pinnacle Mountain. The lower part of the Fayetteville crops out along stream gullies, where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. The Fayetteville Shale is susceptible to landslides. Thickness varies from

230 to 350 ft. (Description from source map: Hasty Quadrangle).

Mf - Fayetteville Shale: Main body (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness varies from 220 to 370 ft (67 to 113 m). **Main Body:** Below the Wedington Sandstone Member, the middle part of Fayetteville Shale is black shale that is rarely exposed; local topographic flats in this interval suggest the presence of more resistant rock, possibly thin sandstone or limestone interbeds. The lower part of the Fayetteville Shale outcrops along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft (0.6 m) in diameter. Fayetteville Shale is susceptible to landslides. Formation thickness varies from 210 to 360ft (64 to 110 m). (Description from source map: Jasper Quadrangle).

Mf - Fayetteville Shale: Main Body (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member (Mfw) that grades downward into main body of black, slope-forming shale. Thickness 125–170 ft. **Main Body:** Fissile black shale that locally contains thin beds of ripple marked olive-brown siltstone near its top. Lower part of Fayetteville exposed along stream gullies and may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. Unit is susceptible to landslides and is conformable with underlying Batesville Sandstone. Thickness 100–120 ft. (Description from source map: Maumee Quadrangle).

Mf - Fayetteville Shale: Main Body (Upper Mississippian, Chesterian)
Consists of fine-grained sandstone and siltstone of Wedington Sandstone Member that grade downward into black, slope forming shale of the main body of the unit. Thickness varies from 10 to 360 ft (3 to 110 m). **Main Body:** Below the Wedington Sandstone Member, the main body of the Fayetteville Shale is black shale that is poorly exposed. The lower part of the Fayetteville Shale outcrops along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft (0.6 m) in diameter. Unit is susceptible to landslides. Formation thickness varies from 10 to 340 ft (3 to 110 m). Large variation in thickness of unit partly results from Late Mississippian-Early Pennsylvanian erosion beneath unconformity at base of the Cane Hill Member of the Hale Formation. (Description from source map: Ponca Quadrangle).

Mf - Fayetteville Shale: Main Body (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 160-200 ft. **Main Body:** Below the Wedington Sandstone ember, middle part of Fayetteville Shale is poorly exposed black shale that locally contains thin, rippled beds of olive-brown siltstone near its top. Lower part of Fayetteville crops out along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. The Fayetteville Shale is susceptible to landslides. Thickness 130-160 ft. (Description from source map: St. Joe Quadrangle).

Mf - Fayetteville Shale: Main body (Upper Mississippian, Chesterian)
Fine-grained sandstone and siltstone of the Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 10–500 ft. **Main body:** Below the Wedington Sandstone Member, the Fayetteville Shale is poorly exposed black shale that locally contains thin, rippled beds of olive-brown siltstone near its top. The lower part of the Fayetteville crops out along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. The Fayetteville Shale is susceptible to landslides. Thickness 10–460 ft (Description from source map: West-Central Buffalo National River Region).

Mbv - Batesville Sandstone/ Formation (Upper Mississippian)

Mbv - Batesville Sandstone (Mississippian, Chesterian)
Consists of very fine- to fine-grained sandstone. The sand grains are angular to subangular. Contains

abundant iron blebs and stringers. Thin-bedded and channel bedded. Light brown on fresh surfaces, but weathers buff to gray. Forms a plateau surface in the community of Big Flat, its only exposure on the quadrangle. Conformable with the underlying Moorefield Formation. Approximately 140-160 feet (42-49 meters) thick. (Description from source map: Big Flat Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine-grained to very fine grained, light- to medium-brown, calcite-cemented sandstone with interbedded limestone. Upper part of unit in southern map area is a 3- to 55 ft-thick bed of dark-gray fetid limestone with common crinoid fragments. Sandstone of main body of unit present in thin to medium planar to hummocky beds that are parallel laminated. Sandstone may contain disseminated pyrite framboids that oxidize to reddish spots. Basal Hindsville Limestone Member is locally preserved and consists of angular white chert clasts in gray limestone matrix, 2–4 ft thick. Top of Batesville is a common topographic flat that may host sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Thickness is 5–30 ft. (Description from source map: Boxley Quadrangle).

Mbv - Batesville Formation (Upper Mississippian, Chesterian)
A very fine- to medium-grained, sub-angular, moderately-sorted, iron-cemented sandstone. Thin- to medium-bedded. Light brown to cream-colored on fresh surfaces. Weathers light to dark gray. Minor amounts of sandstone are present in this quadrangle. This interval consists mostly of the Hindsville Limestone Member. The Batesville Sandstone is unconformable with the Boone Formation. Approximately 5 -40 ft. (1.5 -12 m) thick. **Hindsville Limestone Member:** A thin-bedded, fine- to coarsely-crystalline limestone. Light to dark gray on fresh surfaces but generally weathers light gray or brown. Typically has a strong petroliferous odor on freshly broken surface. The limestones are fossiliferous and/or oolitic, contain pyrite and are sometimes interbedded with thin layers of clay shale and thin beds of siltstone to fine-grained sandstone. A breccia containing angular chert and limestone fragments is present at the base of this interval at some localities. (Description from source map: Eula Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Very fine- to medium-grained, subangular, moderately sorted, iron cemented sandstone. Thin to medium beds typically contain thin parallel laminations or cross-beds. Sandstones are light- brown to buff on fresh surface and weather to reddish brown to gray. Typically forms a flat plateau surface where present. Locally, a few beds of micritic to very finely crystalline, medium- bedded, light-gray to gray limestone is present at the top (Baker area and Shiloh Hollow area). Thickness ranges from 20 to 100 feet (6 - 30 meters). **Hindsville Limestone Member:** Thin to medium-bedded, fine to coarsely crystalline, massive limestone lies directly beneath the Batesville sandstone. Color is light to dark-gray on fresh surface but weathers gray to brown. Beds can be fossiliferous, oolitic, oncolitic and typically have a petroliferous odor when broken. The unit was only observed in the headwaters of Bear Creek north of Baker. Thickness ranges from 3 to 10 feet (1 - 3 meters). (Description from source map: Harriet Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine-grained to very fine grained, light- to medium-brown, calcite-cemented sandstone with sparse interbedded limestone. Thin to medium beds are typically parallel laminated; low-angle crossbeds common in upper part of unit. Sandstone commonly contains burrows on bedding plane surfaces. Sandstone breaks into thin flat blocks. One or more discontinuous, 1- to 3-ft-thick, medium to dark-gray, fetid, fossiliferous limestone beds are locally interbedded with sandstone; limestone beds are fossiliferous and contain crinoids and brachiopods. Both sandstone and limestone beds may contain 2- to 10- mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. The Batesville commonly forms a topographic ledge that forms small waterfalls along streams. Where stripped of the overlying Fayetteville Shale, the top of the Batesville is typically a topographic flat. Unit commonly hosts sinkholes formed by collapse into dissolution cavities in the underlying Boone Formation. Thickness 40–60 ft. (Description from source map: Hasty Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)

Fine to very fine grained, light- to medium-brown, calcite-cemented sandstone with interbedded limestone. Thin to medium beds are typically parallel laminated with low-angle crossbeds common in upper part of unit. Sandstone commonly contains burrows on bedding plane surfaces and breaks into thin flat blocks. One or more discontinuous, 1-3-ft- (0.3-1 m) thick, medium- to dark-gray, fetid, fossiliferous limestone beds are locally interbedded with sandstone; limestone beds are more abundant in western map area. The Hindsville Limestone Member (Purdue and Miser, 1916) is present in the northwest map area at base of formation and is as much as 5 ft (1.5 m) thick in the Cecil Creek drainage. Hindsville Limestone Member is distinguished by the presence of subangular clasts of white chert that range in size to as much as 2 in (5 cm). Limestone beds of the Batesville are fossiliferous and contain crinoids and brachiopods. Both sandstone and limestone beds may contain 2- to 10-mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. The Batesville commonly forms a topographic ledge that forms small waterfalls along streams. Where stripped of overlying Fayetteville Shale, the top of the Batesville is typically a topographic flat that may host sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Thickness is 10-40 ft (3-12 m). (Description from source map: Jasper Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Very fine- to medium-grained, subangular, moderately-sorted, iron-cemented, calcareous sandstone. It is thin- to medium bedded and often cross-bedded. Fresh surfaces are dark gray to dark brown and weather light red-brown to buff. It is rarely fossiliferous, but commonly contains the molds where fossils have weathered out. It is widely quarried as a dimension stone, and its plateau-like upper surface is much favored for home sites. Conformable with the Moorefield Formation. Its thickness ranges from approximately 20-90 feet (6-24 meters), though it typically measures between 40 and 60 feet (12 and 18 meters). **Hindsville Limestone Member:** Discontinuous, thin- to medium-bedded, fine- to coarsely- crystalline limestone. It is light to dark gray on fresh surfaces, but weathers gray to brown. Typically yields a petroliferous odor when freshly broken. It is sporadically fossiliferous, oolitic, and interbedded with very thin- to thin-bedded clay shale, siltstone, or sandy siltstone. On Forest Creek, large-scale ripple-beds are present that measure 2-3 feet (0.6-0.9 meter) trough to trough. At most, only approximately 15 feet (4 meters) of the Hindsville is exposed on this quadrangle, so it is mapped with the Batesville Sandstone. Conformable with the Moorefield Formation. (Description from source map: Marshall Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Light- to medium brown, fine-grained to very fine grained, calcite-cemented sandstone with sparse interbedded limestone. Sandstone is thin to medium bedded with parallel laminations and occasional low-angle crossbeds in upper part of unit. Commonly contains burrows on bedding-plane surfaces and weathers to form thin flat blocks or tabular blocks. Fetid, fossiliferous limestone in discontinuous 1- to 3-ft-thick beds. Unit contains oxidized pyrite framboids 0.1–0.5 in. in diameter; framboids weather to reddish-brown spheres. Batesville caps topographic flats where Fayetteville Shale is eroded and contains sinkholes resulting from collapse in underlying Boone Formation. Unconformable with underlying Boone Formation. Thickness 40–60 ft. (Description from source map: Maumee Quadrangle).

Mbv - Batesville Formation (Upper Mississippian, Meramecian)
A very fine- to medium-grained, sub-angular, moderately sorted, iron-cemented sandstone. Thin to medium bedded. Light brown to cream colored on fresh surfaces. Weathers light to dark gray. Minor amounts of sandstone are present in this quadrangle. This interval is mostly made up of the Hindsville Limestone Member. **Hindsville Limestone Member:** Consists of thin-bedded, fine to coarsely-crystalline limestone. Light to dark gray on fresh surfaces but generally weathers light gray or brown. Commonly has a strong petroliferous odor on freshly broken surface. The limestones are fossiliferous and/or oolitic, contain pyrite, and are locally interbedded with thin layers of clay shale and thin beds of siltstone to fine-grained sandstone. A breccia containing angular chert and limestone fragments is present at the base of this interval in some localities. Unconformable with the Boone Formation. Approximately 5-20 ft. (1.5-6 m) thick. (Description from source map: Mt. Judea Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)

Fine-grained to very fine grained, light- to medium-brown, calcite-cemented sandstone with interbedded limestone. Upper part of unit is a 3- to 5-ft-thick bed of dark-gray fetid limestone with common crinoid fragments and often with oolites. Sandstone of main body of unit present in thin to medium planar to hummocky beds that are parallel laminated. Sandstone may contain disseminated pyrite framboids that oxidize to reddish spots. Basal Hindsville Limestone Member is locally preserved and consists of angular white chert clasts in gray limestone matrix, 2- to 4-ft thick, indicating an erosional contact with the underlying Boone Formation. The top of the Batesville is a common topographic flat that may host sinkholes formed by collapse into dissolution cavities in the underlying Boone Formation. Thickness is 5- 25 ft. (Description from source map: Murray Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Very fine to fine-grained, light- to medium-brown, calcite-cemented sandstone with interbedded limestone. Upper part is a 3- to 5-ft-thick bed of dark-gray fetid limestone with common crinoid fragments, but limestone is not always present. Main body of unit is thin to medium planar to hummocky beds of sandstone that are parallel laminated. Basal Hindsville Limestone Member (not mapped separately) is locally preserved and consists of 2–7 ft thick bed of gray limestone with angular white chert clasts (fig. 3C), inferred to have eroded from the underlying Boone Formation, indicating an unconformable contact. Sandstone and limestone commonly contain disseminated pyrite framboids that oxidize to reddish spots. Topographic surfaces underlain by the Batesville are commonly flat and may host sinkholes formed by collapse into dissolution cavities in the underlying Boone Formation. Thickness is 10- 30 ft. (Description from source map Osage SW Quadrangle).

Mbv - Batesville Formation (Upper Mississippian, Meramecian)
A very fine to medium-grained, sub-angular, moderately sorted, iron-cemented sandstone. Thin to medium-bedded. Light- brown to cream colored on fresh surface. Weathers light to dark-gray. Minor amounts of sandstone are present in this quadrangle. This interval is mostly made up of the Hindsville Limestone Member. The Batesville Sandstone is unconformable with the Boone Formation. Approximately 5 - 20 ft. thick. **Hindsville Limestone Member:** A thin-bedded, fine to coarsely crystalline limestone. Light to dark gray on fresh surface but generally weathers to a light-gray or brown. Usually has a strong petroliferous odor on freshly broken surface. The limestones are fossiliferous and/or oolitic, contain pyrite and are sometimes interbedded with thin layers of clay shale and thin beds of siltstone to fine-grained sandstone. A breccia containing angular chert and limestone fragments is present at the base of this interval. (Description from source map: Parthenon Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine- to very fine grained, light to medium-brown, calcite-cemented sandstone with interbedded limestone. Thin to medium beds are typically parallel laminated with low-angle crossbeds common in upper part of unit. Sandstone commonly contains burrows on bedding plane surfaces and breaks into tabular blocks. One or more discontinuous, 1–3-ft- (0.3–1-m-) thick, medium to dark-gray, fetid, fossiliferous limestone beds are locally interbedded with sandstone. The Hindsville Limestone Member (Purdue and Miser, 1916) is present in the northeast map area at the base of the formation and is as much as 5 ft (1.5 m) thick in the Cecil Creek drainage. Hindsville Limestone Member is distinguished by the presence of subangular clasts of white chert that range in size to as much as 2 in. (5 cm). Limestone beds of the Batesville contain crinoids and brachiopods. Sandstone and limestone beds contain 2–10-mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. The Batesville commonly forms a topographic ledge that forms small waterfalls along streams. Where stripped of overlying Fayetteville Shale, the top of the Batesville is typically a topographic flat that hosts sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Thickness is 3–30 ft (1–9 m) and is greatest in the northeastern part of the area. (Description from source map: Ponca Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine-grained to very fine grained, light- to medium-brown, calcite-cemented sandstone with sparse interbedded limestone. Thin to medium beds are typically parallel laminated; low-angle crossbeds common in upper part of unit. Sandstone commonly contains burrows on bedding plane surfaces.

Sandstone breaks into thin flat blocks. One or more discontinuous, 1- to 3-ft-thick, medium to dark-gray, fetid, fossilifer us limestone beds are locally interbedded with sandstone; limestone beds contain crinoids and brachiopods. Both sandstone and limestone beds may contain 2- to 10-mm-diameter oxidized pyrite framboids that weather to reddish- brown spheres. Where stripped of overlying Fayetteville Shale, top of Batesville forms topographic flats. Unit hosts sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Thickness 40-60 ft. (Description from source map: St. Joe Quadrangle).

Mbvm - Batesville Formation (Upper Mississippian, Chesterian)
A very fine to medium-grained, sub-angular, moderately sorted, iron-cemented sandstone. Thin to medium bedded. Light brown to cream-colored on fresh surface. Weathers light to dark gray. The Batesville Sandstone is unconformable with the Boone Formation. Approximately 10 - 60 ft. (3-18 m) thick. **Hindsville Limestone Member:** A thin-bedded, fine to coarsely-crystalline limestone. Light to dark gray on fresh surfaces but generally weathers light gray or brown. Typically has a strong petroliferous odor on freshly broken surface. The limestones are fossiliferous and or/oolitic, contain pyrite and are locally interbedded with thin layers of clay shale and thin beds of siltstone to fine-grained sandstone. **Moorefield Formation (Upper Mississippian, Meramecian):** Silty shales with interbedded very thin to thin siltstones. The shaly zones are usually dark gray to black on fresh surfaces but weather gray-green. The siltstones are dark gray to brown on fresh surfaces but weather light gray to buff color. 0 - approx. 10 ft. (3 m) thick. (Description from source map: Snowball Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine-grained to very fine grained, light- to medium-brown, calcite-cemented sandstone. Thin to medium beds are parallel laminated, and low-angle crossbeds are common. Sandstone commonly displays burrows on bedding surfaces. Sandstone locally contains 2- to 10-mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. Sandstone breaks into thin, flat blocks. The Batesville surface may display sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Batesville Sandstone is chiefly preserved within Mill Creek graben. Thickness is 40–60 ft. (Description from source map: Western Grove Quadrangle).

Mbv - Batesville Sandstone (Upper Mississippian, Chesterian)
Fine-grained to very fine-grained, light- to medium-brown, calcite-cemented sandstone with sparse interbedded limestone. Thin to medium beds are typically parallel laminated; low-angle crossbeds common in upper part of unit. Sandstone commonly contains burrows on bedding planes and breaks into thin flat blocks. One or more discontinuous, 1- to 3-ft-thick, medium- to dark-gray, fetid, fossiliferous limestone beds are commonly interbedded with sandstone; limestone beds contain crinoids and brachiopods. Both sandstone and limestone beds may contain 2- to 10-mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. Where stripped of the overlying Fayetteville Shale, the top of the Batesville forms topographic flats. Unit hosts sinkholes formed by collapse into dissolution cavities in the underlying Boone Formation. Thickness 5–60 ft. (Description from source map: West-Central Buffalo National River Region).

Mm - Moorefield Formation (Middle Mississippian)

Mm - Moorefield Formation (Mississippian, Meramecian)
Consists of clay to silty shale. Black to dark-gray on fresh surfaces, but weathers gray to light-gray. Contains trace fossils. Poorly exposed beneath the Batesville plateau surface around the community of Big Flat. Unconformable with the underlying Boone Formation. Approximately 20 feet (6 meters) thick. (Description from source map: Big Flat Quadrangle).

Mm - Moorefield Formation (Upper Mississippian, Meramecian)
Silty shales with interbedded very thin to thin-bedded shaly siltstones. The shale zones are typically dark-gray to black on fresh surface but weather dark-gray with a yellowish tint. The siltstones are dark-gray to dark-brown on fresh surface but weather light-gray to buff. The Moorefield forms a gentle

slope supporting the Batesville sandstone. The unit appears to be unconformable with the Boone throughout much of the mapping area. Thickness ranges from 20 feet to 60 feet (6 - 18 meters). (Description from source map: Harriet Quadrangle).

Mm - Moorefield Formation (Middle Mississippian, Meramecian)
Silty shale with interbedded very thin- to thin-bedded siltstone. The shaly zones are usually dark gray to black on fresh surfaces, but weather medium gray with a yellow tint. The siltstone is dark gray to dark brown on fresh surfaces, but weathers light gray to buff. Develops a gentle slope between the plateau-like surface of the Batesville Formation above and the Springfield Plateau (Boone Formation) below. Unconformable with the Boone, and typically ranges from 20-50 feet (6-15 meters) in thickness. (Description from source map: Marshall Quadrangle).

Mbu - Boone Formation, undivided (Lower to Upper Mississippian)

Mb - Boone Formation (Mississippian - Osagean)
Consists of interbedded thin- to medium-bedded limestone and chert. Light- to medium-gray on fresh surfaces, but weathers white. The chert is various shades of gray and green. Springs and sinkholes are present. Quartz crystal mineralization is present locally. The Boone Formation is present on the tops of the ridges but is mostly covered with a chert rubble. Unconformable with the underlying Fernvale Limestone, Plattin Limestone or St. Peter Sandstone. Approximately 300-360 feet (91-110 meters) thick. **St. Joe Limestone Member (Osagean-Kinderhookian)-** Consists of thin-bedded reddish to gray crinoidal limestone. Locally contains white crinoid fragments in a red fine-grained matrix and green clay buttons. At one locality, manganese within the limestone has been mined. A one foot bed of basal Mississippian sandstone is present at one locality. Ranges from 0-15 feet. (0-4 meters) thick. (Description from source map: Big Flat Quadrangle).

Mb - Boone Formation (Lower Mississippian, Osagean and Kinderhookian)
Coarse-grained fossiliferous and fine-grained limestones interbedded with anastomosing and bedded chert. Light to medium gray on fresh surfaces but usually weathers dark gray. The chert varies in color from light gray to dark gray. Springs and sinkholes are abundant. In this area the Boone Formation exhibits an undulating topography that tends to form steep hillsides separated by ravine-like drainages. Approximately 220-400 ft. (67-121 m) thick. **Short Creek Oolite:** A thin to massive cross-bedded, oolitic crinozoan biosparite and oolitic biomicrite in the upper part of the formation. White to gray on fresh and weathered surfaces. Easily recognized by a chalky appearance and in some places a concave weathering profile. Locally, intervals are durable while other intervals are friable. The Short Creek Oolite is present at Eula in the section of Boone exposed on the northeast side of Richland Creek at Eula ford. 0- approx. 8 ft. (0-2.4 m) thick. **St. Joe Limestone Member:** A medium-grained thin-bedded crinoidal limestone containing very thin shaly limestones. Dark gray to reddish in color but sometimes with green mottling on fresh surfaces. Typically weathers a medium to dark gray color. Sometimes contains phosphate nodules near the lower contact. Approximately 0-30 ft. (0-9 m) thick. Basal sandstone - A fine- to medium-grained, moderately sorted, sub-rounded to rounded, iron- or quartz-cemented sandstone. White to light gray and tan on fresh surfaces with a salt and pepper appearance that is commonly blotchy due to iron staining. Weathers tan to white. Thin to thick bedded but most often seen as float. Contains phosphate pebbles and angular white and light-gray chert fragments. This unit yields abundant conodonts. The basal sandstone is unconformable with the Lafferty or the Fernvale Limestone. 0- approx. 5 ft. (0-1.5 m) thick. **Lafferty Limestone:** A sparsely fossiliferous finely-crystalline limestone. Medium gray with small red blebs on fresh surfaces but weathers light gray. Commonly contains pyrite cubes near the upper contact. Thin to thick bedded with stylolites along bedding planes. This limestone is present on the north hillside along County Road 252 after crossing Cave Creek heading east. It is also present in the head of the drainage in Sec. 19, T15N, R18W on the north edge of Horn Mountain. Unconformable with the Fernvale Limestone. O- approx. 15 ft. (0-4 m) thick. (Description from source map: Eula Quadrangle).

Mb - Boone Formation: St. Joe Limestone (Middle-Lower Mississippian, Osagean and Kinderhookian)

Coarse-grained fossiliferous and fine grained limestones interbedded with anastomosing and bedded chert. Limestones are light to medium-gray on fresh surface but usually weather to a dark-gray. The cherts are white to dark-gray or red but usually weather a lighter color than the surrounding limestone. Locally contains dendritic manganese. A reddish brown weathered regolith layer consisting of chert fragments and clay is common at the top of Boone outcrops. Regionally, the undulating topography of the Boone is expressed as a flat surface (the Springfield Plateau) that is incised by steep-sided drainages. Karst features including springs, sinkholes and small caves are common. Thickness ranges from 50 to 400 feet (15- 122 meters). **St. Joe Limestone Member:** Fine to medium-grained, thin to medium-bedded crinoidal limestone which often contains very thin shaly limestones. Typically dark-gray to reddish in color but locally can be light gray to black. Manganese-rich (Little Rocky Creek) beds typically are darker in color. Often contains pyrite as individual crystals or clusters, or if weathered as limonitic blebs. Stratigraphically, the unit commonly rests directly on the Fernvale Limestone or above the basal sandstone, but lies directly above the Plattin in the drainages west of Mill Hollow and Spring Branch and in South Bratton Creek. Thickness ranges from 2 to 20 feet (.5 - 6 meters). **Basal Sandstone:** Fine to medium-grained, moderately sorted phosphatic sandstone. Grains are subangular to subrounded in shape. Poikilotopic calcite cement is common. Color is white to light-gray or tan in fresh surface and typically displays a "salt and pepper" or blotchy appearance. Phosphate grains range from fine sand to pebble size. Conodonts are also common. Weathered exposures are dark brown to buff. Where present, it is unconformable with Silurian rocks or with the Fernvale Limestone. Thickness ranges from 30 to 5 feet (0 - 1.5 meters). (Description from source map: Harriet Quadrangle).

Mb - Boone Limestone (Middle-Lower Mississippian, Osagean and Kinderhookian)
Fine- to coarse-grained, crystalline to coarse grained fossiliferous limestone interbedded with anastomosing or discontinuous, thin-bedded chert. The limestone is light to medium gray on fresh surfaces, but weathers light to dark gray and locally contains crinoid columnals or brachiopod fossils. The chert is white to dark gray and rarely red on fresh surfaces, but typically weathers buff to white and tripolitic. In the northeastern quadrant, locally contains dendritic manganese at the base. A regolith composed of red-brown residual clay and angular chert gravel covers nearly the entire surface of the Boone and the formations below it. Karst features including springs, sinkholes and small caves are common. Bedding broadly undulates due to settling into the paleokarst features of older units. The topography of the Boone features steep, relatively flat-topped ridges that are incised by ravine-like drainages. The tops of these ridges form the surface of the Springfield Plateau. Unconformable with the underlying formations, and ranges from 250-320 feet (76-98 meters) in thickness. **St. Joe Limestone Member:** Thin- to medium-bedded, fine to coarse grained, crinoidal limestone. Lithology can vary considerably between a coarse-grained, light pink to light gray, crystalline limestone and a fine-grained, light green, shaly limestone with included white or pink crinoid fragments. It usually weathers light to dark gray. Locally, it contains pyrite in the form of single crystals, clusters or rusty blebs where weathered. Manganese-rich zones exhibit dark gray colors on fresh surfaces and are typically fine-grained and shaly. Normally ranges from 2-8 feet (0.6-2.4 meters) in thickness, but can be as much as 20 feet (6 meters) thick along the northern edge of the map. (Description from source map: Marshall Quadrangle).

Mb - Boone Formation (Lower Mississippian, Osagean and Kinderhookian)
Coarse-grained fossiliferous and fine-grained limestones interbedded with anastomosing and bedded chert. Light to medium gray on fresh surfaces but commonly weathers dark gray. The chert varies in color from light gray to dark gray. Springs and sinkholes are abundant. Exhibits an undulating topography that forms steep hillsides separated by ravine-like drainages. Approximately 120-400 ft. (36-121 m) thick. **Short Creek Oolite:** A thin- to massive-bedded, cross-bedded, oolitic crinozoan biosparite and oolitic biomicrite. White to gray on fresh and weathered surfaces. Easily recognized by its chalky appearance and by a concave weathering profile. Various intervals are durable due to a calcite cement while other intervals are friable. Around 35 ft. (10 m) of this unit is quarried at Mt. Judea Quarry and mixed with cherty limestone for road aggregate. The oolite is present along Hwy 74 in the town of Mt. Judea and on the eastern edge of the map. The oolite is present approximately 10-15 ft. (3-4 m) below the base of the Batesville Formation in Mt. Judea Quarry. Approximately 5-35 ft. (1.5-10 m) thick. **St. Joe Limestone Member:** A medium-grained thin-bedded crinoidal limestone with

interbedded very thin-bedded shaly limestones. Dark gray to reddish in color but locally contains green mottling on fresh surfaces. Commonly weathers medium to dark gray. Locally, phosphate nodules are present near the lower contact. The St. Joe Limestone is present along the Buffalo River and Big Creek and their drainages south to Vendor in the central portion of the quadrangle. Approximately 10-30 ft. (3-9 m) thick. **Basal Sandstone:** A fine- to medium-grained, moderately sorted, sub-rounded to rounded, iron- or quartz-cemented sandstone. White to light gray and tan on fresh surfaces but commonly blotchy due to iron staining. Weathers tan to white. Thin to thick bedded but typically present as float. Contains phosphate pebbles and angular white and light-gray chert fragments. This unit yields abundant conodonts. Unconformable with the Fernvale Limestone. 0-approx. 3 ft. (.9 m) thick. (Description from source map: Mt. Judea Quadrangle).

Mb - Boone Formation (Lower Mississippian, Osagean and Kinderhookian)
Coarse-grained fossiliferous and fine grained limestones interbedded with anastomosing and bedded chert. Light to medium-gray on fresh surface but usually weathers dark-gray. The chert varies in color from light-gray to dark-gray. Springs and sinkholes are abundant. In this area the Boone Formation exhibits an undulating topography that tends to form steep hillsides separated by ravine-like drainages. Approximately 120 - 400 ft. thick. **Short Creek Oolite:** A thin to massive cross-bedded, oolitic crinozoan biosparite or oolitic biomicrite. White to gray on fresh and weathered surface. Can be easily recognized by a chalky appearance and in some places a concave weathering profile. Some intervals are durable due to calcite cement, while other intervals are friable. The Short Creek Oolite is present along the Left Fork of Big Creek in Sec 1, T14N, R21W, and on the hillside in Sec 31, T15N, R2OW. This oolitic interval occurs from approximately 5 feet to 80 feet below the top of the Boone Formation. Approximately 5-15 ft. thick. **St. Joe Limestone Member:** A medium-grained thin bedded crinoidal limestone containing very thin shaly limestones. Dark-gray to reddish in color but sometimes with green mottling on fresh surface. Usually weathers medium to dark-gray. The St. Joe Limestone is present along the Little Buffalo River in Sections 33 and 34, T16N, R21W, along Henson Creek in Section 5, T15N, R21W, and Spider Creek. Approximately 20-30 ft. thick. **Basal sandstone:** A fine to medium-grained, moderately sorted, sub-rounded to rounded, iron or quartz-cemented sandstone. White to light-gray and tan on fresh surface with a salt and pepper appearance but sometimes blotchy due to iron staining. Weathers tan to white. Thin to thick-bedded but most often seen as float. Contains phosphate pebbles and angular white and light-gray chert fragments. The thickest outcrop occurs along Henson Creek where it weathers white and contains sandstone pipes thus resembling the St. Peter Sandstone. This unit yields abundant conodonts. The basal sandstone is unconformable with the Fernvale Limestone. Approximately 6 in. -10 ft. thick. (Description from source map: Parthenon Quadrangle).

Mb - Boone Formation (Lower Mississippian, Osagean and Kinderhookian)
Coarse-grained fossiliferous and fine-grained limestones interbedded with anastomosing and bedded chert. Light to medium gray on fresh surfaces but weathers dark gray. The chert varies in color from light gray to dark gray. Springs and sinkholes are abundant. In this area, the Boone Formation exhibits an undulating topography that tends to form steep hillsides separated by ravine-like drainages. Approximately 120 - 400 ft. (36-122 m) thick. **St. Joe Limestone Member:** A medium-grained thin-bedded crinoidal limestone containing very thin shaly limestones. Dark-gray to reddish in color but sometimes with green mottling on fresh surfaces. Commonly weathers medium to dark gray. Locally contains phosphate nodules near the lower contact. Approximately 0-approx. 7 ft. (2 m) thick. **Basal sandstone:** A fine to medium-grained, moderately sorted, sub-rounded to rounded, iron or quartz-cemented sandstone. White to light gray and tan on fresh surfaces with a salt and pepper appearance but locally blotchy due to iron staining. Weathers tan to white. Thin to thick bedded and typically seen as float. Contains phosphate pebbles and angular white and light gray chert fragments. This unit yields abundant conodonts. Unconformable with the Fernvale Limestone or Silurian units. 0-approximately 1 ft. (.3 m) thick. (Description from source map: Snowball Quadrangle).

Mbmb - Boone Formation, main body (Lower to Upper Mississippian)

Mb - Boone Formation: Main Body (Upper to Lower Mississippian, Meramecian to Osagean)
Limestone and cherty limestone of main body that grade into basal St. Joe Limestone Member (Mbs). The Boone Formation is a common host of caves and sinkholes. Total thickness is 380-405 ft. **Main Body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is locally present in upper 10 ft of the Boone Formation. Dense, fine-grained beds of limestone are present in upper one-third of unit. Beds are typically parallel planar to wavy. Chert content varies vertically and laterally within the Boone and is locally greater than 50 percent. Chert is light to medium gray and forms lenticular to anastomosing lenses. Chert rich horizons are generally poorly exposed but produce abundant float of white, weathered chert on hill slopes. Chert in uppermost part of unit contains common brachiopod molds. Thickness 310–375 ft. (Description from source map: Boxley Quadrangle).

Mb - Boone Formation (Mississippian - Osagean)
Consists of interbedded thin- to medium-bedded limestone and chert. Limestone is light to gray on fresh surfaces, but weathers white. The chert is various shades of gray and green. Springs, sinkholes and quartz crystal mineralization are present locally. The Boone Formation is present on the tops of the ridges but is mostly covered with a chert rubble. Unconformable upon the Plattin Limestone or St. Peter Sandstone. Approximately 60-160 feet (18-48 meters) is exposed. (Description from source map: Buffalo City Quadrangle).

Mb - Boone Formation (Mississippian - Osagean)
Consists of interbedded thin- to medium-bedded limestones and anastomosing and bedded cherts. Limestones are light- to medium-gray on fresh surfaces, but weathers white. The cherts are various shades of white, gray, blue, brown and green. Springs and sinkholes are common. Quartz crystal mineralization is present locally, especially near faults. The Boone Formation is present on the tops of most ridges as regolith consisting of chert rubble and clay. Conformable with the underlying St. Joe Member and unconformable with the underlying Plattin Limestone or St. Peter Sandstone where the St. Joe is absent. Thickness ranges from approximately 40-360 feet (12-110 meters). (Description from source map: Cozahome Quadrangle).

Mb - Boone Formation: Main Body (Lower Mississippian, Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness 380–405 ft. **Main Body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is common in upper 10 ft of the Boone Formation. Dense, fine-grained beds of limestone are present in upper one-third of unit. Beds are typically parallel planar to wavy, but channel fills are locally present in lower part of unit. Chert content varies vertically and laterally within the Boone and is greatest in the southeastern part of map area. Chert forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed but produce abundant float of white-weathered chert on hill slopes. Chert in uppermost part of unit contains prominent brachiopod molds. Thickness 310–375 ft. (Description from source map: Hasty Quadrangle).

Mb - Boone Formation: Main body (Upper to Lower Mississippian, Meramecian-Osagean)
Formation consists of limestone and cherty limestone of main body that grades into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. The total thickness of the formation is 380-405 ft (116-122 m) in most of the area but thins to less than 350 ft (107 m) near Jasper. **Main Body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1-3-ft- (0.3-1-m-) thick bed of oolitic limestone is common at the top of the Boone Formation. Dense, fine-grained beds of limestone are present in the upper third of the unit. Beds are typically parallel planar to wavy, but channel fills are locally present in the lower part of the unit. The chert content varies vertically and laterally within the Boone Formation and is greatest in the

southeast part of the map. Chert forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed and form slopes littered with float of white weathered chert that in uppermost part of unit contains prominent brachiopods casts. Thickness is 310-375 ft (95-114 m). (Description from source map: Jasper Quadrangle).

Mb - Boone Formation: Main body (Upper to Lower Mississippian, Meramecian to Osagean) Limestone and cherty limestone of main body that grade into basal St. Joe Limestone Member (Mbs). The Boone Formation is a common host of caves and sinkholes. Total thickness 365– 75 ft. **Main Body:** Light- to medium-gray, coarsely crystalline, bioclastic limestone and interbedded chert; thin- to thick-bedded with parallel planar and wavy beds of limestone. Crinoid ossicles are common throughout and a 1- to 3-ft-thick bed of oolitic limestone is common in upper part of unit. Chert content is highly variable both laterally and vertically; horizons with abundant chert are typically poorly exposed and only chert lag is observed. Brachiopod and crinoid ossicle molds are observed in chert in upper part of unit. Most chert is white but blue, orange, or reddish chert become more common approaching gradational contact with St. Joe Limestone Member (Mbs). Thickness 300–350 ft. (Description from source map: Maumee Quadrangle).

Mb - Boone Formation: Main body (Upper to Lower Mississippian, Meramecian to Osagean) Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness is 380- 405 ft. **Main body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is locally present in upper 10 ft of the Boone Formation. Dense, fine-grained beds of limestone are present in upper one-third of unit. Beds are typically parallel planar to wavy. Chert content varies vertically and laterally within the Boone and is locally greater than 50 percent. Chert is light to medium gray and forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed but produce abundant float of white, weathered chert on hill slopes. Chert in uppermost part of unit contains common brachiopod molds. Thickness 310- 375 ft. (Description from source map: Murray Quadrangle).

Mb - Boone Formation: Main body (Middle to Lower Mississippian, Meramecian to Osagean) Mostly limestone and chert-bearing limestone that grades downward into the basal St. Joe Limestone Member. Formation commonly hosts caves and sinkholes. Total thickness is 370- 410 ft. **Main body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is locally present in upper 10 ft of the Boone Formation. Dense, fine-grained limestone is present in upper one-third of unit. Beds are typically parallel planar to wavy. Chert content varies vertically and laterally within the Boone and is locally greater than 50 percent. Chert is light to medium gray or white and forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed, and are characterized by abundant, weathered chert fragments on hillslopes. Chert in uppermost part of unit often contains brachiopod molds. Basal contact with the St. Joe Limestone Member is gradational. Thickness 340- 360 ft. (Description from source map Osage SW Quadrangle).

Mb - Boone Formation: Main Body (Upper to Lower Mississippian, Meramecian-Osagean) Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness is 380-405 ft. **Main Body:** Medium- to thick-bedded, chert-bearing bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is common in upper part of unit. Beds of dense, fine-grained limestone are present in upper one-third of unit. Beds are typically parallel planar to wavy, but channel fills are locally present in lower part of unit. Chen content varies vertically and laterally within Boone and forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed but produce abundant float of white-weathered chert on hillslopes. Chert in uppermost part of unit contains prominent brachiopod molds. Thickness 310-375 ft. (Description from source map: Ponca Quadrangle).

Mb - Boone Formation (Mississippian - Osagean)
Consists of interbedded thin- to medium-bedded limestone and anastomosing and bedded chert. The limestone is light- to medium-gray on fresh surfaces, but weathers white. The chert is various shades of white, gray, blue, brown and green. Springs and sinkholes are common. Quartz crystal mineralization is present locally, especially near faults. The Boone Formation is present on the tops of most ridges as regolith consisting of chert rubble and clay. Conformable with the underlying St. Joe Member and unconformable with the underlying Plattin Limestone or St. Peter Sandstone when the St. Joe is absent. Thickness ranges from approximately 20-160 feet (6-49 meters). (Description from source map: Rea Valley Quadrangle).

Mb - Boone Formation: Main Body (Upper to Lower Mississippian, Meramecian to Osagean)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 160-200 ft. **Main Body:** Below the Wedington Sandstone ember, middle part of Fayetteville Shale is poorly exposed black shale that locally contains thin, rippled beds of olive-brown siltstone near its top. Lower part of Fayetteville crops out along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. The Fayetteville Shale is susceptible to landslides. Thickness 130-160 ft. (Description from source map: St. Joe Quadrangle).

Mb - Boone Formation: Main body (Upper to Lower Mississippian, Meramecian to Osagean)
Thick sequence of limestone and cherty limestone of main body that grades downward into basal St. Joe Limestone Member. Boone Formation is a common host of caves and sinkholes. Total thickness of the formation is 380–405 ft. **Main Body:** Medium- to thick-bedded, cherty bioclastic limestone. Limestone is light to medium gray on fresh surfaces, generally coarsely crystalline, and contains interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is present locally in the upper 10 ft of Boone Formation. Beds of dense, fine-grained limestone are present in upper one-third of the unit. Beds typically have planar to wavy boundaries; shallow channel fills are present locally in lower part. Chert forms lenticular to anastomosing lenses typically 2–20 in. long that are light to medium gray on fresh surfaces. Chert content varies within main body of Boone Formation but is commonly greater than 50 percent. Most chert-rich intervals are poorly exposed but are identifiable by abundant float of white-weathered, angular chert fragments on hill slopes. Thickness is 350–375 ft. (Description from source map: Western Grove Quadrangle).

Mb - Boone Formation: Main body (Upper to Lower Mississippian, Meramecian to Osagean)
Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness is 350–400 ft. **Main body:** Medium to thick-bedded, chert-bearing bioclastic limestone. Limestone is light- to medium-gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3-ft-thick bed of oolitic limestone is common in upper part of unit. Beds of dense, fine-grained limestone are present in upper one-third of unit. Beds are typically parallel and planar to wavy, but channel fills are locally present in lower part of unit. Chert content varies vertically and laterally within the Boone and forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed but produce abundant float of white-weathered chert on hillslopes. Chert in uppermost part of unit contains prominent brachiopod molds. Thickness 310–350 ft (Description from source map: West-Central Buffalo National River Region).

Mbsco - Boone Formation, Short Creek Oolite (Lower to Upper Mississippian)

Short Creek Oolite (Lower Mississippian, Osagean and Kinderhookian) A thin to massive cross-bedded, oolitic crinozoan biosparite and oolitic biomicrite in the upper part of the formation. White to gray on fresh and weathered surfaces. Easily recognized by a chalky appearance and in some places a concave weathering profile. Locally, intervals are durable while other intervals are friable. The Short Creek Oolite is present at Eula in the section of Boone exposed on the northeast side of Richland Creek at Eula ford. 0- approx. 8 ft. (0-2.4 m) thick. (Description from source map: Eula Quadrangle).

Short Creek Oolite (Lower Mississippian, Osagean and Kinderhookian) A thin- to massive-bedded, cross-bedded, oolitic crinozoan biosparite and oolitic biomicrite. White to gray on fresh and weathered surfaces. Easily recognized by its chalky appearance and by a concave weathering profile. Various intervals are durable due to a calcite cement while other intervals are friable. Around 35 ft. (10 m) of this unit is quarried at Mt. Judea Quarry and mixed with cherty limestone for road aggregate. The oolite is present along Hwy 74 in the town of Mt. Judea and on the eastern edge of the map. The oolite is present approximately 10-15 ft. (3-4 m) below the base of the Batesville Formation in Mt. Judea Quarry. Approximately 5-35 ft. (1.5-10 m) thick. (Description from source map: Mt. Judea Quadrangle).

Oolite Outcrop (Lower Mississippian, Osagean and Kinderhookian)
A thin to massive cross-bedded, oolitic crinozoan biosparite or oolitic biomicrite. White to gray on fresh and weathered surface. Can be easily recognized by a chalky appearance and in some places a concave weathering profile. Some intervals are durable due to calcite cement, while other intervals are friable. The Short Creek Oolite is present along the Left Fork of Big Creek in Sec 1, T14N, R21W, and on the hillside in Sec 31, T15N, R2OW. This oolitic interval occurs from approximately 5 feet to 80 feet below the top of the Boone Formation. Approximately 5-15 ft. thick. (Description from source map: Parthenon Quadrangle).

Mbsj - Boone Formation, St. Joe Limestone Member (Lower Mississippian)

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into basal St. Joe Limestone Member (Mbs). The Boone Formation is a common host of caves and sinkholes. Total thickness is 380-405 ft. **St. Joe Limestone Member:** Thin-bedded, bioclastic limestone with ubiquitous 3- to 6-mm-wide crinoid fragments in fine matrix. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color and hematite concentrations vary with location. Thin beds are typically wavy in form. Chert nodules are uncommon but, where present, are tabular and reddish. Contact with the overlying main body of the Boone Formation (Mb) is gradational. Middle to lower part of the St. Joe Limestone Member may contain shaly limestone interval. Base of unit is a 0.5- to 1-ft-thick bed of tan sandstone containing phosphate pebbles. Unit only exposed in northeastern map area. Thickness approximately 30–50 ft. (Description from source map: Boxley Quadrangle).

Mbsj - St. Joe Limestone Member (Kinderhookian- Osagean)
Consists of thin-bedded reddish to gray crinoidal limestone. Locally contains white crinoid fragments in a red fine-grained matrix and green clay “buttons”. Where present, the St. Joe is commonly 5 feet thick but is only mappable on the north side of Warrior Creek Mountain. Ranges from 0 to 60 feet. (0-18 meters) thick. (Description from source map: Buffalo City Quadrangle).

Mbsj - St. Joe Limestone Member (Kinderhookian-Osagean)
Consists of thin-bedded, red to gray crinoidal and argillaceous limestones interbedded with very thin shaly intervals. Locally contains white crinoid fragments in a red fine-grained matrix. Manganese-rich beds (darker in color) are locally present in the lower portion of the unit. Thickness ranges from 0-40 feet (0-12 meters). **Basal Sandstone:** Fine to medium-grained, moderately sorted phosphatic sandstone. Grains are subangular to subrounded. Color is white to light-gray or tan in fresh surface and typically displays a “salt and pepper” or blotchy appearance. Phosphate grains range from fine sand to pebble size. Where present, it is unconformable with the underlying Silurian, Fernvale and Plattin Limestones and the St. Peter Sandstone. Thickness ranges from 0-15 feet. (0-5 meters). (Description from source map: Cozahome Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness 380–405 ft. **St. Joe**

Limestone Member: Thin-bedded, coarse-crystalline bioclastic limestone with ubiquitous 3- to 6-mm-wide crinoid fragments. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but its color and hematite concentrations vary with location. Thin beds are typically wavy in form. Chert nodules are uncommon but, where present, are tabular and reddish. Contact with the overlying main body of the Boone Formation is gradational. Middle to lower part of the St. Joe Limestone Member may contain shaly limestone interval that is best developed in eastern part of map area. Base of unit is a sequence of phosphate-pebble-bearing tan sandstone and overlying greenish-ray shale that is typically 0.5–3 ft thick but thickens to as much as 10 ft where it is exposed along the Davis Creek drainage in northwestern part of sec. 33, T. 17 N., R. 19 W. Thickness approximately 30–50 ft. (Description from source map: (Hasty Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Formation consists of limestone and cherty limestone of main body that grades into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. The total thickness of the formation is 380-405 ft (116-122 m) in most of the area but thins to less than 350 ft (107 m) near Jasper. **St. Joe Limestone Member:** Thin-bedded, coarse-crystalline bioclastic limestone with ubiquitous 3-6 mm crinoid fragments. Limestone is commonly pink to red on fresh surfaces due to hematite staining, but its color and hematite concentrations vary with location. Thin beds are typically wavy in form. Chert nodules are uncommon but, where present, are tabular and may be reddish. The contact with the overlying main body of Boone Formation is gradational. The middle part of the St. Joe Limestone Member forms a local topographic flat on a slightly shaly limestone interval that commonly overlies a low limestone ledge above the basal unconformity. Base of unit is a 1.5-3-ft- (0.5-1-m-) thick sequence of phosphate-pebble-bearing tan sandstone and overlying greenish-gray shale that, although thin, is laterally persistent throughout much of northwestern Arkansas. (Description from source map: Jasper Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into basal St. Joe Limestone Member (Mbs). The Boone Formation is a common host of caves and sinkholes. Total thickness 365– 75 ft. **St. Joe Limestone Member:** Limestone is red to pink on fresh surface due to hematite content in the matrix, but color varies and gray or white is not uncommon. Matrix varies from muddy to finely to coarsely crystalline supporting abundant crinoid fragments in thin to medium, parallel wavy beds. Chert-poor except in upper part where red to pink lenticular chert becomes more persistent as it grades upward into main body of Boone Formation (Mb). Middle and lower parts of unit contain greenish-gray, tan, and yellow interbedded shale. Base of St. Joe is a 1- to 10-ft-thick, fine-grained, moderately sorted sandstone containing phosphate pebbles; sandstone has discontinuous conglomerate beds with clasts from underlying units. Unit unconformable with underlying Silurian and Ordovician rocks, amount of missing section beneath unconformity increases to northwest. Thickness 30–60 ft. (Description from source map: Maumee Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness is 380- 405 ft. **St. Joe Limestone Member:** Thin-bedded, bioclastic, medium to coarse crystalline or marly limestone with ubiquitous 0.1- to 0.25-in-wide crinoid fragments. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color and hematite concentrations vary with location. Thin beds are typically wavy in form. Chert nodules are uncommon but, where present in upper part, are tabular and reddish. Contact with the overlying main body of the Boone Formation is gradational. Middle to lower part of the St. Joe Limestone Member may contain shaly limestone interval. Base of unit is a 0.5- to 1-ft-thick bed of tan sandstone containing phosphate pebbles that marks a regional erosional unconformity. Thickness approximately 30- 50 ft (Description from source map: Murray Quadrangle).

Mbs - St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)

Thin-bedded, bioclastic limestone with ubiquitous 3- to 6-mm-wide crinoid fragments in fine matrix. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color and hematite concentrations vary with location. Thin beds are typically wavy in form. Chert nodules are uncommon but, where present, are tabular and reddish. Middle to lower part of unit may contain shaley limestone interval. Base of unit is up to 1-ft-thick bed of tan sandstone containing phosphate nodules. Unit exposed along the Buffalo River and tributaries in southeastern map area where it unconformably overlies Ordovician units. Thickness approximately 30- 50 ft. (Description from source map Osage SW Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Formation consists of limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. The total thickness of the formation is 380–405 ft (116–122 m). **St. Joe Limestone Member:** Thin bedded, coarse-crystalline bioclastic limestone with ubiquitous 3–6-mm-diameter crinoid fragments. Limestone is commonly pink to red due to hematite staining, but its color and hematite concentrations vary with location. Beds are thin and wavy in form. Chert nodules are uncommon but, where present, are tabular and reddish. The contact with the overlying main body of Boone Formation is gradational. The middle part of the St. Joe Limestone Member forms a local topographic flat on a slightly shaly limestone interval that commonly overlies a low limestone ledge above the basal unconformity. Base of unit is a 1.5–3-ft- (0.5–1-m-) thick sequence of phosphate-pebble-bearing tan sandstone and overlying greenish-gray shale that, although thin, is laterally persistent throughout much of northwestern Arkansas (McKnight, 1935). The member is approximately 30–50 (9–15 m) ft thick. (Description from source map: Ponca Quadrangle).

Mbsj - Boone Formation: St. Joe Limestone Member (Kinderhookian - Osagean)
Consists of thin-bedded, reddish to gray crinoidal and argillaceous limestones interbedded with very thin shaly intervals. Locally contains white crinoid fragments in a red fine- grained matrix with red chert nodules. Manganese-rich beds (darker in color) are locally present in the lower portion of the unit. Thickness ranges from 0-40 feet (0-12 meters). However, it is up to 80 feet (24 meters) thick on Hall Mountain and the NW corner of Section 26 T18N R15W. **Basal Sandstone** – Fine to medium-grained, moderately sorted phosphatic sandstone. Grains are subangular to subrounded in shape. Color is white to light gray or tan in fresh surface and typically displays a “salt and pepper” or blotchy appearance. Phosphate grains range from fine sand to pebble size. Where present, it is unconformable with the underlying Fernvale or Plattin Limestones. Thickness ranges from 0 to 15 feet. (0-5 meters). (Description from source map: Rea Valley Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Fine-grained sandstone and siltstone of Wedington Sandstone Member that grades downward into main body of black, slope-forming shale. Thickness 160-200 ft. **St. Joe Limestone Member:** Thin and wavy bedded bioclastic limestone containing ubiquitous 3- to 6-mm-wide crinoid fragments in a finely crystalline matrix. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color varies depending on hematite concentration. Lenticular red to pink chert nodules are locally present in upper part. Contact with overlying main body of Boone Formation is gradational and marked by increase in chert and thicker beds upward. Middle to lower part of St. Joe Limestone Member contains greenish-gray shale interbeds. Base of St. Joe is a 0.3- to 8-ft-thick, very fine to fine-grained, moderately sorted, tan sandstone containing phosphate pebbles. Base of unit is an important unconformity that variably truncates Fernvale Limestone, Plattin Limestone, St. Peter Sandstone, or upper part of the Everton Formation in various parts of quadrangle. Total thickness of member is 20-50 ft. (Description from source map: St. Joe Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Thick sequence of limestone and cherty limestone of main body that grades downward into basal St. Joe Limestone Member. Boone Formation is a common host of caves and sinkholes. Total thickness

of the formation is 380–405 ft. **St. Joe Limestone Member:** Thin-bedded bioclastic limestone containing ubiquitous 3- to 6- mm-wide crinoid fragments in a finely crystalline matrix. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color varies depending on hematite concentration. Thin beds are typically wavy. Lenticular red to pink chert nodules are locally present but uncommon. Contact with overlying main body of Boone Formation is gradational and marked by increase in chert and thicker beds upward. Middle to lower part of St. Joe Limestone Member contains greenish-gray shale interbeds; shale interval is well exposed in footwall of St. Joe fault adjacent to Hurricane Cave (sec. 7, T. 16 N., R. 18 W.). Base of St. Joe is a 0.3- to 0.6-ft-thick, fine-grained tan sandstone, or limestone locally, containing phosphate pebbles. Base of unit is an important unconformity that variably truncates Fernvale Limestone, Plattin Limestone, St. Peter Sandstone, or upper part of the Everton Formation in various parts of quadrangle. Total thickness of member is approximately 30–50 ft. (Description from source map: Western Grove Quadrangle).

Mbs - Boone Formation: St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)
Limestone and cherty limestone of main body that grade into the basal St. Joe Limestone Member. The Boone Formation is a common host of caves and sinkholes. Total thickness is 350–400 ft. **St. Joe Limestone Member:** Thin- and wavy-bedded bioclastic limestone containing ubiquitous 3- to 6-mm-wide crinoid fragments in a finely crystalline matrix. Limestone is commonly pink to red on fresh surfaces due to hematite in matrix, but color varies depending on hematite concentration. Lenticular red to pink chert nodules are locally present in upper part. Contact with overlying main body of Boone Formation is gradational and marked by increase in chert and thicker beds upward. Middle to lower part of St. Joe Limestone Member contains greenish-gray shale interbeds. Base of St. Joe is a 0.3- to 8-ft-thick, very fine to fine-grained, moderately sorted, tan sandstone containing phosphate pebbles. Unit unconformably overlies Silurian rocks, Cason Shale, Fernvale Limestone, Plattin Limestone, St. Peter Sandstone, or upper part of Everton Formation. Total thickness of member is 10–50 ft (Description from source map: West-Central Buffalo National River Region).

Su - Silurian Limestone, undifferentiated (Silurian)

Su - Silurian Limestone, undifferentiated (Silurian)
The individual limestone units are generally less than 20 feet (6 meters) thick. They are grouped as one undifferentiated unit. The combined unit is unconformable with the underlying Ordovician rocks. Combined thickness ranges from 0-40 feet (0-12 meters). **Lafferty Limestone** – Micritic to very fine crystalline limestone that breaks with a conchoidal fracture. Medium to thick bedded. Color varies from light-gray to gray to reddish-gray with red blebs throughout. The medium to thick limestone beds weather to form a rounded outcrop surface. Thickness ranges from 0-15 feet (0-6 meters). **St. Clair Limestone** – Very coarsely-crystalline fossiliferous limestone that is massive bedded. The color is typically white with a pink hue but weathers to gray in outcrop. Contains pyrite framboids, and irregular vugs with colorless to white sparry calcite. Thickness ranges from 0-15 feet (0-6 meters). **Brassfield Limestone** – Coarse to very coarsely-crystalline limestone that is thick to very thick to massive bedded. The color is mottled light-gray to dark red. Contains crinoid ossicles, pyrite framboids, and irregular vugs with colorless to white sparry calcite. Thickness ranges from 0-15 feet (0-6 meters). (Description from source map: Cozahome Quadrangle).

Su - Undifferentiated (Silurian)
These limestones are each noted at two locations, Rocky Creek and Little Rocky Creek, in the northeast corner of the quadrangle. Because individual formations are generally less than 20' thick, the formations are grouped together and treated as an undifferentiated unit on the map. Combined thickness of the formations ranges from 0 to 60 feet (0 - 18 meters). **Lafferty Limestone -** Medium to thick-bedded, micritic to very finely-crystalline limestone. Color ranges from gray to reddish-gray to brown with reddish blebs throughout. The Lafferty rests unconformably on the St. Clair. **Brassfield Limestone -** Thick to very thick bedded, coarse to very coarsely-crystalline, massive limestone. Color ranges from light-gray to dark-red. Vugs (1 - 5 cm) are common throughout the formation and are typically filled with calcite and buff colored, very fine silt or clay. Fossil types present in this unit

include crinoids, bryozoa, and brachiopods. The Brassfield rests unconformably on Ordovician rocks. (Description from source map: Harriet Quadrangle).

Su - Silurian (undifferentiated)
Though present in more places than designated, these limestones are only considered mappable where their combined thickness is greater than 20 feet (6 meters). Individual formations are even less likely to form mappable units, and are therefore combined. The Silurian units crop out along the Buffalo River and its major drainages, and typically form broad domes and troughs with the Ordovician below. They are unconformable with these older units and range from 0-60 feet (0–18 meters) in thickness. **Lafferty Limestone:** Medium- to thick-bedded, stylolitic, finely crystalline, sparsely fossiliferous limestone. On fresh surfaces, color ranges from light to medium-gray with light- to dark-pink blebs throughout. Weathers medium- to dark- gray and rounded to blocky. Contains minor inclusions of pyrite crystals which weather to rusty blebs. Typical fossils include crinoids, brachiopods, and bryozoans. **St. Clair Limestone:** Thick-bedded, coarsely crystalline, fossiliferous limestone. Its color ranges from light gray to light pink-gray or white on fresh surfaces, but weathers medium gray. Contains pyrite clusters, especially along stylolitic boundaries. Commonly contains veins of white to clear, coarsely crystalline calcite. Typical fossils include brachiopods, ostracods, trilobites, crinoids, corals, and gastropods. **Brassfield Limestone:** Thick- to massive-bedded, coarsely to very coarsely crystalline, sparsely fossiliferous limestone. Color ranges from light-gray to light- to dark-pink on fresh surfaces, but weathers light- to medium-gray or tan to brown. Outcrops weather rounded along the streams, but blocky on the hillsides. Generally contains vugs up to 3 inches (7.6 centimeters) across that are filled with very coarsely crystalline calcite, or less commonly, with calcite and a buff-colored silt or clay. Locally, contains veins of coarsely crystalline calcite as well. Typical fossils include crinoids, cephalopods, bryozoans, and brachiopods. (Description from source map: Marshall Quadrangle).

Su - Silurian rocks, undivided (Upper to lower Silurian, Ludlow to Llandovery)
Includes parts of units discussed below. Cumulative thickness 0–95 ft although no more than 60 ft exposed in any one location. **Llaferty Limestone (upper to middle Silurian, Ludlow):** Light-gray, purple, and red dense micrite that breaks with conchoidal fracture; white to light-gray on weathered surface. Medium bedded and forms rounded outcrop. Contact with St. Clair Limestone sharp and described as unconformable by Wise and Chaplin (1979) and Smart and Hutto (2008) but Craig and others (1984) and Craig (1993) interpreted as conformable. Thickness 0–5 ft. **St. Clair Limestone (middle to lower Silurian, Ludlow to upper Llandovery):** Light-pink, tan, and light-gray fossiliferous limestone; contains crinoid and brachiopod fragments. Limestone is micritic to coarsely crystalline and massive bedded. Unit contains pyrite framboids and irregular vugs filled with white or colorless sparry calcite crystals. Basal contact with Brassfield Limestone is unconformable. Thickness 0–60 ft. **Brassfield Limestone (lower Silurian, Llandovery):** Light-gray to light-pink, micritic to coarsely crystalline, thin- to massive-bedded limestone mottled red and gray. Contains crinoid ossicles, pyrite framboids, and irregular vugs filled with colorless to white sparry calcite; alteration around calcite-filled vugs produces red to maroon color that contributes to mottled appearance. Unit underlain unconformably by the Cason Shale (Oc). Thickness 0–30 ft. (Description from source map: Maumee Quadrangle).

S - Undifferentiated (Silurian)
A reddish-gray coarsely crystalline limestone and gray fossiliferous medium- crystalline limestone. Thin to medium bedded with stylolites along bedding planes. The reddish-gray coarsely-crystalline limestone contains calcite vugs and green-clay partings and plugs. 0- approx. 15 ft. (0-4 m) thick exposed. (Description from source map: Snowball Quadrangle).

Su - Silurian rocks, undivided (Ludlow to Llandovery)
Medium- to massive-bedded, light-pink, light-gray, and red micrite to coarsely crystalline limestone of the Lafferty Limestone, St. Clair Limestone, and Brassfield Limestone. Lafferty Limestone only observed as a dense micrite whereas St. Clair and Brassfield Limestones are more often medium to coarsely crystalline fossiliferous limestone and contain pyrite framboids and calcite- filled vugs. Preserved in structural lows in the eastern portion of the map area. Cumulative thickness up to 95 ft,

although no more than 60 ft observed in any one location. (Description from source map: West-Central Buffalo National River Region).

Ocs - Cason Shale (Upper Ordovician)

Ocs - Cason Shale (Upper Ordovician)
The unit is poorly exposed and consists predominately of shale and siltstone with a 3 foot (1 meter) oolitic fossiliferous limestone observed at one location. The shale is silty and calcareous and contains polished phosphate nodules. The color is greenish-gray to black on fresh surfaces and weathers to greenish-tan to dark brownish-black. The siltstone is yellowish-green with laminations, cone-in-cone structures, and polished phosphate nodules. The limestone is light-gray and varies from micritic to coarsely-crystalline with oolites and crinoidal clasts. This unit was observed at two localities in the quadrangle: NE corner of Section 34 T17N R15W and the NW corner of Section 19 T16N. Thickness ranges from 0-20 feet (0-6 meters). (Description from source map: Cozahome Quadrangle).

Oc - Cason Shale (Upper Ordovician)
Green, tan, black, and blue-green, poorly exposed, fissile shale and siltstone that is occasionally dolomitic. Contains phosphate-replaced fossils and abundant, polished phosphate nodules from sand to pebble size and oxidized pyrite framboids. At type section to the east near Batesville, Ark., Cason Shale extends into the Silurian (Craig and others, 1984; Craig, 1993). Unit unconformably overlies Fernvale Limestone (Of). Thickness 0–15 ft. (Description from source map: Maumee Quadrangle).

Cason Shale (Upper Ordovician)
Mapped undivided with Fernvale Limestone is a 5-ft-thick fissile to massive black to blue-green shale with 1 to 2 in. black phosphate pebbles, which is assigned to Cason Shale (Upper Ordovician) where it was observed beneath a cliff of St. Joe Limestone Member adjacent to Mill Creek (NE1/4, NE1/4, Sec. 18, T. 16 N., R. 17 W.). (Description from source map: St. Joe Quadrangle).

Ocs - Cason Shale (Upper Ordovician)
Green, tan, black, and blue-green, poorly exposed, fissile shale and siltstone that is occasionally dolomitic. Contains phosphate-replaced fossils and abundant, polished phosphate nodules from sand to pebble size and oxidized pyrite framboids. Outcrop limited to eastern part of map area. Thickness 0–15 ft. (Description from source map: West-Central Buffalo National River Region).

Ocsf - Cason Shale and Fervale Limestone (Upper Ordovician)

Of - Cason Shale, Fernvale Limestone (Upper Ordovician)
Cason Shale: This formation was observed at only two localities on this quadrangle: Rocky Creek and in a road cut in SE1/4, NW1/4, Sec. 13, T15N R15W along the Barren Hollow drainage. The shale is silty and calcareous and often contains phosphate nodules. Color ranges from blotchy medium gray to black on fresh surfaces and weathers greenish buff or dark brownish black. Thickness ranges from 1 to 5 feet (.3 - 1.5 meters), therefore the unit is not considered to be a mappable unit and is grouped with the Fernvale Limestone. **Fernvale Limestone:** Medium to thick bedded, medium to coarsely-crystalline limestone. Generally the limestone beds are massive in appearance. Color ranges from white to light-gray with a pink to reddish tint or mottled appearance on fresh surfaces. Weathers light to dark-gray. Fossils occurring in this formation include barrel-shaped crinoid columnals, nautiloids, and brachiopods that are accentuated on weathered surfaces. Weathered exposures of the Fernvale occur as rounded, lichen and moss-covered masses that are usually friable. Throughout this quadrangle, the absence of the Kimmswick Limestone indicates that Fernvale is unconformable with the underlying Plattin Limestone. Thickness ranges from 0 to 60 feet (0-13 meters), but is typically 10 to 20 feet (3 - 6 meters). (Description from source map: Harriet Quadrangle).

Ocsfk - Cason Shale, Fernvale Limestone and Kimmswick Limestone (Upper Ordovician)

Ofk - Cason Shale, Fernvale Limestone, and Kimmswick Limestone (Upper, Upper, and Middle Ordovician)
Cason Shale: Rarely exposed and of abbreviated thickness, therefore mapped with the Fernvale Limestone. Composed of silty to clay shale that is light blue-green on fresh surfaces, but weathers medium green-gray. Locally, contains dark brown to black, irregularly rounded phosphate pebbles, especially near the top. In locations where these pebbles have weathered out, they may provide the only trace of the Cason Shale in that particular outcrop. A dark gray, fine-grained, nodular limestone with sparse, fine-grained pyrite and glauconite inclusions is exposed at the top of the Cason just beneath the Silurian bluff at Grinder's Ferry on the Buffalo River. Ranges from a few inches to approximately 10 feet (3 meters) thick near Gilbert, and is unconformable with the older units. **Fernvale Limestone:** Medium- to coarse grained crystalline, sparsely fossiliferous limestone. On fresh surfaces, is white to light-gray with light- to dark-pink tint or pink mottling. Weathers light to dark gray. The medium- to very thick-bedding is usually massive, and can be locally crossbedded. Weathered exposures are rounded, moss-covered masses that are typically friable. Locally, contains barrel-shaped crinoid columnals, nautiloids, and brachiopods that are typically revealed on weathered surfaces. Normally 10-20 feet (3-6 meters) thick, but can be as much as 40 feet (12 meters) thick. Unconformable with older units. **Kimmswick Limestone:** Fine to medium-grained, crystalline, sparsely fossiliferous limestone. Light-gray on fresh surfaces. Weathers light to dark gray. Only a few feet thick and exposed in only a few places, therefore it is mapped with the Fernvale Limestone. Unconformable with the Plattin Limestone. (Description from source map: Marshall Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)

Of - Fernvale Limestone (Upper-Middle Ordovician)
A medium-to coarse-grained limestone. Medium-to thick or massive- bedded. Light-pink to reddish on fresh surfaces, but weathers dark-gray. Contains barrel-shaped crinoids, brachiopod fragments, calcite vugs and pyrite. Weathers to rounded moss covered boulders. This limestone is present in the southwestern portion of the quadrangle. Unconformable with the underlying Plattin Limestone. Ranges from 10-30 feet (0-9 meters) thick. (Description from source map: Big Flat Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Medium- to thick-bedded, coarse-crystalline bioclastic limestone. Limestone is light pinkish gray to medium gray on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel-shaped crinoid ossicles. Unit only exposed in northeastern map area. Thickness 10–30 ft. (Description from source map: Boxley Quadrangle).

Of - Fernvale Limestone (Upper-Middle Ordovician)
A medium- to coarse-grained bioclastic limestone that is medium to thick-bedded. Color is light-pink to reddish white on fresh surfaces, but weathers dark-gray. Locally, contains barrel-shaped crinoids, brachiopod fragments, calcite vugs and pyrite. It weathers to rounded moss-covered boulders that are usually friable. It is predominantly observed in the southern portion of the quadrangle. It is unconformable with the underlying Plattin Limestone. Thickness ranges from 0-60 feet (0-18 meters). (Description from source map: Cozahome Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Medium- to thick-bedded, coarse crystalline bioclastic limestone. Limestone is light to medium gray on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel shaped crinoid ossicles. Distribution is discontinuous and limited to three thin lenses less than 10 ft thick that are mapped where locally recognized in central and southwestern parts of map area beneath unconformity at base of the St. Joe Limestone Member of the Boone Formation (Mbs). (Description from source map: Hasty

Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Thin- to medium-bedded, coarse crystalline bioclastic limestone. Limestone is light to medium gray on fresh surfaces and it contains abundant 3-10 mm cylindrical to barrel-shaped crinoid ossicles. Distribution of this thin unit is restricted to the south central part of the quadrangle near Jasper where its thickness reaches 10 ft (3 m). (Description from source map: Jasper Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Light-pink, red, and light-gray coarse-grained fossiliferous limestone; massive to thick bedded and crossbedded with distinctive stylolitic partings 2–3 in. thick that enhance dissolution giving the appearance of thinner bedding. Crinoid fragments are common including distinctive barrel-shaped crinoid ossicles and phosphate nodules are present. Unit unconformably overlies Plattin Limestone (Opl). Thickness 0–60 ft. (Description from source map: Maumee Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Medium- to thick-bedded, coarse-crystalline bioclastic limestone. Limestone is light pinkish gray to medium gray on fresh surfaces and contains abundant 0.1- to 0.4-in-wide cylindrical to barrel-shaped crinoid ossicles. Unit only exposed in northwestern map area. Thickness 10- 30 ft. (Description from source map: Murray Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Medium- to thick-bedded, coarse-crystalline bioclastic limestone. Limestone is light pinkish gray to medium gray on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel-shaped crinoid ossicles. Unit exposed along the Buffalo River and tributaries in southeastern map area but is interpreted to pinch out northward based on thickness variations seen in regional mapping (Hudson and Turner, 2014a). Thickness 0- 30 ft. (Description from source map Osage SW Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Thin- to medium-bedded, coarse-crystalline bioclastic limestone. Limestone is light to medium gray on fresh surfaces and it contains abundant cylindrical to barrel-shaped crinoid ossicles 3–10 mm in diameter. Continuous outcrop of this unit is restricted to the southwest part of the quadrangle but local lenses are recognized farther east in quadrangle. Thickness reaches 20 ft (6 m) in southwestern corner of map (McFarland, 1982). (Description from source map: Ponca Quadrangle).

Of - Fernvale Limestone (Upper-Middle Ordovician)
A medium- to coarse-grained bioclastic limestone that is medium to thick-bedded. Color is light-pink to reddish white on fresh surfaces, but weathers dark-gray. Locally, contains barrel-shaped crinoids, brachiopod fragments, calcite vugs and pyrite. It weathers to rounded moss-covered boulders that are usually friable. Present in isolated outcrops within the Rush Creek Graben and in the southeast corner of Section 1 T17N R15W of the quadrangle. It is unconformable with the underlying Plattin Limestone. Thickness ranges from 0-30 feet (0-9 meters). (Description from source map: Rea Valley Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Thick- to massive-bedded, coarsely crystalline bioclastic limestone. Limestone is light gray to pink on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel shaped crinoid ossicles in a coarsely crystalline matrix. Mapped undivided with Fernvale Limestone is a 5-ft-thick fissile to massive black to blue-green shale with 1 to 2 in. black phosphate pebbles, which is assigned to Cason Shale (Upper Ordovician) where it was observed beneath a cliff of St. Joe Limestone Member adjacent to Mill Creek (NE1/4, NE1/4, Sec. 18, T. 16 N., R. 17 W.). Unit is exposed in eastern Mill Creek graben where it is as thick as 20 ft. (Description from source map: St. Joe Quadrangle).

* On the source map this unit is considered the Fernvale Limestone but the unit description indicates that it is mapped undivided with the Cason Shale (Ocs).

Of - Fernvale Limestone (Upper Ordovician)
Medium- to thick-bedded, coarsely crystalline bioclastic limestone. Limestone is light gray to pink on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel shaped crinoid ossicles in a coarsely crystalline matrix. Unit is discontinuous and limited to thin lenses less than 10 ft thick mapped only where observed beneath St. Joe Limestone Member of Boone Formation. (Description from source map: Western Grove Quadrangle).

Of - Fernvale Limestone (Upper Ordovician)
Thick- to massive-bedded, coarsely crystalline bioclastic limestone. Limestone is light gray to pink on fresh surfaces and contains abundant 3- to 10-mm-wide cylindrical to barrel-shaped crinoid ossicles in a coarsely crystalline matrix. Thickness 0–20 ft. (Description from source map: West-Central Buffalo National River Region).

Ofp - Fernvale Limestone and Plattin Limestone (Upper and Middle Ordovician)

Ofp -Fernvale Limestone and Plattin Limestone (Upper Ordovician & Middle Ordovician)
Fernvale Limestone: A medium- to coarsely-crystalline crinoidal limestone. Medium to massive bedded. White to light gray with a pink to reddish tint or mottling on fresh surfaces but weathers a dark- ray. Contains nautiloids, barrel-shaped crinoids, and brachiopods that are accentuated on a weathered surface. Commonly contains pyrite. Locally cross-bedded when beds are massive. On a weathered slope the Fernvale Limestone occurs as rounded masses that are usually friable. The Fernvale is unconformable with the Plattin Limestone. 0- approx. 15 ft. (0-4 m) thick. **Plattin Limestone:** A thin- to thick-bedded micritic limestone that locally displays a sugary texture. Light gray to dark gray on fresh surfaces and weathers white to dark gray. A dolomitic interval is present at the top of the formation. The Plattin Limestone is unconformable with the St. Peter Sandstone or Everton Formation in this quadrangle. 5- approx. 80 ft. (1.5-24 m) thick. (Description from source map: Eula Quadrangle).

Ofp - Fernvale Limestone and Plattin Limestone (Upper Ordovician & Middle Ordovician)
Fernvale Limestone: A medium- to coarsely-crystalline crinoidal limestone. Medium to massive bedded. White to light gray with a pink to reddish tint or mottling on fresh surfaces but weathers dark gray. Contains nautiloids, barrel-shaped crinoids, and brachiopods that are accentuated on a weathered surface. Often contains pyrite. Locally cross-bedded when beds are massive. Typically weathers to rounded masses that are usually friable. Unconformable with the Plattin Limestone. 0- approx. 25 ft. (0-7 m) thick. **Plattin Limestone:** A thin to thick bedded micritic limestone that locally displays a sugary texture. Light to dark gray on fresh surface but weathers white to dark gray. A dolomitic interval is present at the top of the formation. Unconformable with the St. Peter Sandstone or Everton Formation in this quadrangle. 0- approx. 80 ft. (0-24 m) thick. (Description from source map: Mt. Judea Quadrangle).

Ofp - Fernvale Limestone and Plattin Limestone (Upper Ordovician & Middle Ordovician)
Fernvale Limestone: A medium to coarsely crystalline crinoidal limestone. Medium to thick to massive-bedded. White to light-gray with a pink to reddish tint or mottling on fresh surface but weathers dark-gray. Contains nautiloids, barrel-shaped crinoids, and brachiopods that are accentuated on a weathered surface. Often contains pyrite. Sometimes cross- bedded when beds are massive. On a weathered slope the Fernvale Limestone occurs as rounded masses that are usually friable. This limestone is present in Hudson Quarry in Section 34, T16N, R21W, along Hwy 327. The Fernvale Limestone is unconformable with the Plattin Limestone. 0- approx. 10 ft. thick. **Plattin Limestone:** A micritic limestone that sometimes displays a sugary texture. Light-gray to dark gray on fresh surface and weathers white to dark-gray. Very thin to thick-bedded. Contains stylolites and rounded quartz grains. This section does not resemble typical micritic Plattin Limestone, however it contains a conodont fauna similar to the Plattin Limestone, (Repetski and Leslie, 2003, personal communication). Approximately 6 to 8 ft. thick. (Description from source map: Parthenon Quadrangle).

Ofp - Fernvale Limestone and Plattin Limestone (Upper Ordovician & Middle Ordovician)
Fernvale Limestone: A medium- to coarsely-crystalline crinoidal limestone. Medium to thick to massive bedded. White to light gray with a pink to reddish tint or mottling on fresh surfaces but weathers dark gray. Contains nautiloids, barrel-shaped crinoids, and brachiopods that are accentuated on a weathered surface. Commonly contains pyrite. Locally cross-bedded when beds are massive. Commonly weathers to rounded masses that are usually friable. 0- approx. 5 ft. (0-1.5 m) thick. **Plattin Limestone (Middle Ordovician):** A thin- to thick bedded micritic limestone that locally displays a sugary texture. Light gray to dark gray on fresh surfaces and weathers white to dark gray. A dolomitic interval is present at the top of the formation. Unconformable with the St. Peter Sandstone in this quadrangle. Approximately 5-15 ft. (1.5-4 m) thick. (Description from source map: Snowball Quadrangle).

Opl - Plattin Limestone (Middle Ordovician)

Op - Plattin Limestone (Middle Ordovician)
A thin bedded micritic to finely crystalline limestone. Light-to medium- gray on fresh surfaces, but weathers white-to light-gray. The limestone is locally argillaceous and dolomitic. Contains stylolites and locally chert. Springs are abundant at the Plattin/St. Peter contact. The Plattin Limestone is present in the extreme southwestern and southeastern edges of the quadrangle. Unconformable with the underlying St. Peter Sandstone. Ranges from 0- 40 feet (0-12 meters) thick. (Description from source map: Buffalo City Quadrangle).

Op - Plattin Limestone (Middle Ordovician)
Consists of thin- to thick-bedded, micritic to finely crystalline limestone that is light- to medium-gray on fresh surfaces, but weathers white- to light-gray. It is locally argillaceous and dolomitic with stylolites and chert nodules. Intervals of medium-gray fine- to medium-grained dolostone were observed at some localities. Springs are abundant at the Plattin/St. Peter contact. It is unconformable with the underlying St. Peter Sandstone.Thickness ranges from 0-160 feet (0-49 meters). (Description from source map: Cozahome Quadrangle).

Op - Plattin Limestone (Middle Ordovician)
Very thin to thick bedded, micritic limestone that sometimes displays a sugary texture. Color is light to dark-gray on fresh surfaces weathering white to dark-gray. A tan to buff siltstone is present at the top of the formation at a few localities (notably around South Bratton Creek). The unit typically forms persistent, blocky ledges. Springs commonly emerge at or near the contact with the St. Peter Sandstone below. Throughout the mapping area, the Plattin rests unconformably upon the St. Peter Sandstone. Thickness ranges from 40 to 80 feet (12 - 24 meters) but is typically about 60 feet (18 meters). (Description from source map: Harriet Quadrangle).

Opl - Plattin Limestone (Middle Ordovician)
Thin- to medium-planar-bedded, fine-grained, dense limestone that typically breaks with conchoidal fracture. Limestone is medium gray on fresh surfaces but weathers to white to light gray tabular blocks. Distribution is restricted to southeastern part of quadrangle where thickness reaches 10 ft. (Description from source map: Hasty Quadrangle).

Op - Plattin Limestone (Middle Ordovician)
Thin to thick-bedded, micritic limestone that is locally fine-grained. Very dense and typically breaks with conchoidal fracture. Light beige-gray to dark gray on fresh surfaces, and weathers white to medium-gray. Locally contains interbedded calcareous shale up to a foot (0.3 meter) thick. Resistant enough to form a persistent blocky ledge. Springs and seeps commonly emerge at or near the contact with the St. Peter Sandstone below. Unconformable with the St. Peter Sandstone. Ranges from approximately 60-150 feet (18-46 meters) in thickness. (Description from source map: Marshall Quadrangle).

Opl - Plattin Limestone (Middle Ordovician)
Light-gray to tan, medium- to thin-planar-bedded micrite with discontinuous calcarenite beds. Micrite is dense and breaks with conchoidal fracture and locally contains, fine-grained, well- bounded quartz grains. Calcarenite is tan, yellow, and light-brown, medium bedded, slightly fetid, and contains poikilitic calcite growth. Unit unconformably overlies St. Peter Sandstone (Osp). Thickness 0–120 ft. (Description from source map: Maumee Quadrangle).

Op - Plattin Limestone (Middle Ordovician)
Consists of thin- to thick-bedded, micritic to finely crystalline limestone and is light- to medium-gray on fresh surfaces, but weathers white- to light-gray. It is locally argillaceous and dolomitic with occasional stylolites and chert nodules. Intervals of medium-gray fine- to medium-grained dolostone were observed in thicker sections. Springs are abundant at the Plattin/St. Peter contact. The Plattin Limestone is present in the southern portion of the quadrangle. It is unconformable with the underlying St. Peter Sandstone. Where present, the Plattin is commonly 20-40 feet (6-12 meters) thick but is up to 120 feet (37 meters) thick south of Cabin Creek Monocline in Section 2 T17N R15W. (Description from source map: Rea Valley Quadrangle).

Opl - Plattin Limestone (Middle Ordovician)
Thin to medium-planar-bedded, fine-grained, dense limestone locally interbedded with calcarenite. Characteristically, dense, very fine grained, medium-gray limestone that breaks with conchoidal fracture and weathers to very light gray, thin, tabular blocks. Locally in upper parts there are interbeds of laminated, tan to light-gray, fine-grained to very fine grained, limey to dolomitic calcarenite as thick as 10 ft; calcarenite has fetid odor when freshly broken. Thickness ranges from 40 ft in southwestern part of area to nothing in northwestern parts due to pre-Mississippian erosion beneath unconformity at base of St. Joe Limestone Member of Boone Formation. (Description from source map: St. Joe Quadrangle).

Opl - Plattin Limestone (Middle Ordovician)
Thin- to medium-planar-bedded, fine-grained, dense limestone locally interbedded with calcarenite. Characteristically, dense, very fine grained, medium-gray limestone that breaks with conchoidal fracture and weathers to very light gray, thin, tabular blocks. Locally in upper part contains interbeds of laminated, tan to light-gray, fine-grained to very fine grained, limey to dolomitic calcarenite as thick as 10 ft; calcarenite has fetid odor when freshly broken. Thickness 0–100 ft. (Description from source map: West-Central Buffalo National River Region).

Oplj - Plattin Limestone and Joachim Dolomite (Middle Ordovician)

Opj - Plattin Limestone (Middle Ordovician)
A thin bedded micritic to finely crystalline limestone. Light - to medium- gray on fresh surfaces, but weathers white - to light- gray. The limestone is locally argillaceous and dolomitic. Contains stylolites and locally chert. Conformable when overlying the Joachim Dolomite, but unconformable when overlying the St. Peter Sandstone. Springs are abundant at the Plattin/St. Peter contact. Ranges from 0-80 feet (0- 42 meters) thick. **Joachim Dolomite (Middle Ordovician) -** A finely crystalline dolostone that is medium-bedded. Contains sand in the lower portion close to the contact with the St. Peter Sandstone. Medium- to dark-gray on fresh surfaces,but weathers light-gray to white. Petroliferous and locally contains calcite veins. This unit is present sporadically throughout the quadrangle. Conformable with the underlying St. Peter Sandstone. Ranges from 0-15 feet (0- 4 meters) thick. (Description from source map: Big Flat Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)

Osp - St. Peter Sandstone (Middle Ordovician)
A fine-grained medium-to massive-bedded, cross-bedded sandstone. Quartz grains are sub-angular

to subrounded. White to light-gray on fresh surfaces, but weathers light- brown. Locally, sandstone will be reddish or greenish color due to iron or clay content. Commonly case hardened but friable when broken. Contains the vertical trace fossil Skolithos which weathers in relief to resemble icicles. This sandstone is a bluff former throughout the quadrangle. Balds or glades occur locally. Cylindrical columns of sandstone referred to as “sandstone pipes” are present at various localities throughout the quadrangle. Sinkholes in the St. Peter are common. Unconformable with the underlying Everton Formation with up to 20 feet (6 meters) of relief on the undulating contact. Approximately 80-100 feet (24-30 meters) thick. (Description from source map: Big Flat Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
A fine-grained medium- to massive- cross-bedded sandstone. Quartz grains are sub-angular to sub-rounded. White to light-gray on fresh surfaces, but weathers light brown. Locally, sandstone is reddish or greenish in color due to iron or clay content. Commonly case hardened but friable when broken. Contains the vertical trace fossil Skolithos which weathers in relief to resemble icicles. This sandstone is a bluff former. Balds or glades occur locally. Cylindrical columns of sandstone referred to as “sandstone pipes” are present at various localities throughout the outcrop area. Sinkholes in the St. Peter are common. Unconformable with the underlying Everton Formation with up to 20 feet (6 meters) of relief on the undulating contact. Ranges from 0- 100 feet (0-30 meters) thick. (Description from source map: Buffalo City Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Consists of fine-grained medium- to massive- cross-bedded calcite-cemented quartz arenite sandstone with locally inter-bedded blue-green to dark-gray shale. Quartz grains are sub-angular to sub-rounded. The sandstone is white to yellowish-brown on fresh surfaces, but weathers to gray. Commonly case hardened but otherwise friable where the calcite cement has been leached out. The St. Peter contains the vertical trace fossil Skolithos which weathers in relief to resemble icicles. Locally, the unit can be subdivided into three parts. When present, the upper part of the unit forms a sandstone ledge up to 20 feet (6 meters) thick. The middle part is a poorly exposed slope-former comprised of thin-bedded sandstone and light-green shale. Dark-gray silty shale approximately 1 foot (0.3 meter) thick was noted at two localities. The lower part is most persistent and forms a bluff up to 40 feet (12 meters) thick. Glades, sinkholes and cylindrical columns of sandstone referred to as “sandstone pipes” were observed at several localities. Unconformable with the underlying Everton Formation with up to 20 feet (6 meters) of relief on the undulating unconformable contact surface. Thickness ranges from 20-120 feet (6-37 meters). (Description from source map: Cozahome Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
A thin- to thick-bedded very fine- to fine-grained sandstone. White to green on fresh surfaces but weathers light gray-green to brown. Green shale clasts are present and locally weather to give the sandstone a green color. Contains a calcite cement that when leached leaves sandstone friable. The quartz grains are rounded. Green siltstones and shales are interbedded with the sandstone. Contains vertical trace fossils referred to as Skolithos by Adams et. al. 1904, that weather to resemble icicles in cross-section view. The St. Peter Sandstone is unconformable with the Everton Formation. Approximately 20-160 ft. (6-48 m) thick. (Description from source map: Eula Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Fine to medium grained, angular to rounded, well sorted, calcite-cemented sandstone. The unit is friable where the calcite is leached out of the sandstone matrix. Bedding is thick to very-thick bedded, is massive to cross-bedded, and forms either concave or convex rounded ledges. Color is typically light-tan to white or greenish-white on fresh surfaces but weathers gray to dark tan. The St. Peter commonly acts as a confining unit to groundwater flow and therefore produces many springs and seeps along its upper contact with the Plattin Limestone. Often these springs are marked by travertine deposits. The unit commonly forms bluffs along creeks and steep hillsides. Outcrops and loose boulders commonly contain Skolithos (Adams et. al. 1904), a trace fossil that forms vertical tubes of more resistant sandstone that when weathered resemble tightly packed icicles in section view. The St. Peter rests unconformably on the Everton, and the contact is typically undulatory showing evidence

that the unit likely eroded and cut down into the underlying Everton. Thickness ranges from 20 feet to 60 feet (6 - 18 meters) but is typically 30 to 40 feet (9 - 12 meters). (Description from source map: Harriet Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Fine-grained to very fine grained, tan sandstone and interbedded blue-green siltstone and shale. Sandstone is calcite-cemented quartz arenite with rounded grains; commonly strongly bioturbated. In central part of map area, unit consists mainly of interbedded blue-green shale, siltstone, and sandstone that are locally exposed along roadside. Thickness varies from 0 to 40 ft. (Description from source map: Hasty Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Fine- to medium grained, angular to rounded, well-sorted, calcite-cemented sandstone that generally displays a sugary texture. Interstitial calcite commonly exhibits a poikilotopic texture in freshly broken samples. Where the calcite has leached out, the sandstone is friable when broken. Locally dolomitic towards the top especially on Brush Creek near Buffalo River. White or light green to light tan on fresh surfaces, but weathers dark tan or gray. Thick- to very thick-bedded and locally cross-bedded, this massive sandstone typically crops out as a distinctive, smooth, concavely or convexly rounded bluff. Outcrops and especially loose boulders commonly contain Scolithos (Adams et al., 1904) trace fossils that weather to form tubes of more resistant sandstone perpendicular to bedding resembling tightly-packed icicles. Tight sandstone that acts as a confining unit for groundwater. Therefore, many springs and seeps along its upper contact. Travertine is locally precipitated by these springs. Unconformable with the Everton Formation, and typically displays a distinctive undulating contact Averages approximately 15-30 feet (5-9 meters) thick, but locally as much as approximately 60 feet (18 meters) thick. (Description from source map: Marshall Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Tan, white, and lesser blue calcite-cemented quartz arenite with minor interbedded dolomite and blue-green shale and siltstone. Sandstone is medium to massive bedded, often crossbedded, with well-rounded, fine-grained quartz grains; friable where calcite cement has been leached out. Upper part of unit rarely preserved but as thick as 15 ft when present and forms a ledge above middle slope-forming part. Middle part of unit is poorly exposed slope former and consists of interbedded sandstone, dolomitic layers, and blue-green shale and siltstone. Basal part is best preserved and forms a 5 to 30 ft ledge with an undulatory unconformable contact with the Everton Formation. Sandstone beds often bioturbated and characteristically contain cylindrical Skolithos burrows perpendicular to bedding. Thickness 0–120 ft. (Description from source map: Maumee Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
A thin- to thick bedded very fine- to fine-grained sandstone. White to green on fresh surfaces but weathers light gray-green to brown. Locally, green shale clasts are present and weather to give the sandstone a green color. Contains a calcite cement, but where leached sandstone is friable. The quartz grains are rounded. Green siltstones and shales are interbedded with the sandstone. Contains vertical trace fossils referred to as Skolithos by Adams et. al. 1904, that weather to resemble icicles in cross-section view. Unconformable with the Everton Formation. Approximately 0-40 ft. (0-12 m) thick. (Description from source map: Mt. Judea Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Consists of fine-grained medium- to massive- cross-bedded calcite-cemented quartz arenite sandstone with locally inter-bedded blue-green to dark-gray shale. Quartz grains are sub-angular to sub-rounded. The sandstone is white on fresh surfaces, but weathers to yellowish-brown. Commonly case hardened on the surface but friable when the calcite cement has been leached out. The St. Peter contains the vertical trace fossil Skolithos which weathers in relief to resemble icicles. Locally, the unit can be subdivided into three parts. When present, the upper part of the unit forms a ledge up to 20 feet (6 meters) thick. The middle part is a poorly exposed slope former comprised of thin-bedded sandstones and shale. The lower part is best preserved and forms a bluff up to 40 feet (12 meters) thick. Glades, sinkholes and cylindrical columns of sandstone referred to as “sandstone pipes” were

observed at several localities. Unconformable with the underlying Everton Formation with up to 20 feet (6 meters) of relief on the undulating contact. Thickness ranges from 0-100 feet (0-30 meters). (Description from source map: Rea Valley Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Very fine grained, grayish-yellow sandstone interbedded with blue-green siltstone, shale, and sparse dolostone. Sandstone is calcite-cemented arenite containing well-rounded quartz grains. Upper part of unit, as thick as 25 ft, is sandstone interbedded with blue-green fissile shale, thin-bedded siltstone, and sparse 0.5- to 3-ft-thick beds of brown-gray, fine crystalline dolostone; shale, siltstone, and dolostone interval poorly exposed, but is locally marked by zone of slumped sandstone blocks on hill slopes. Main part of unit contains a sequence of Ito 2-ft-thick sandstone beds overlying a massive basal sandstone ledge as thick as 20 ft. Bioturbation is common in most sandstone beds and includes cylindrical burrows (Skolithos) perpendicular to bedding that weather to distinctive straw-like forms. Basal sandstone is crossbedded, contains inclined fractures, and discordantly overlies laminated sandy dolomite in upper part of Everton Formation at local recesses. Unit thins to nothing to northwest due to pre-Mississippian erosion beneath unconformity at base of St. Joe Limestone Member of Boone Formation. Thickness ranges from 0 to 70 ft. (Description from source map: St. Joe Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
A thin- to thick bedded very fine- to fine-grained sandstone. White to green on fresh surfaces but weathers a light gray-green to brown. Green shale clasts are present which weather to give the sandstone a green color. Contains a calcite cement but when leached leaves sandstone friable. The quartz grains are rounded. Green siltstones and shales are interbedded with the sandstone. Contains vertical trace fossils referred to as Skolithos by Adams et. al. 1904, that weather to resemble icicles in cross-section view. Unconformable with the Everton Formation. Approximately 80 ft. (120 m) thick. (Description from source map: Snowball Quadrangle).

Osp - St. Peter sandstone (Middle Ordovician)
Very fine grained, grayish-yellow sandstone interbedded with blue-green siltstone and shale. Sandstone is calcite-cemented arenite containing well-rounded quartz grains. Upper part of unit, as thick as 25 ft, is blue-green shale and siltstone interbedded with sandstone; shale and siltstone are poorly exposed, but interval is locally marked by zone of slumped sandstone blocks on hill slopes. Main part of unit contains a sequence of 1- to 2-ft-thick sandstone beds overlying a massive basal sandstone ledge as thick as 15 ft. Bioturbation is common in most sandstone beds and includes cylindrical burrows (skolithos) perpendicular to bedding that weather to distinctive straw-like forms. Basal sandstone is crossbedded, contains inclined fractures, and discordantly overlies laminated sandy dolomite in upper part of Everton Formation at local recesses; basal unit thins westward and eventually disappears. Unit thins to nothing to north and west due to pre-Mississippian erosion beneath unconformity at base of St. Joe Limestone Member of Boone Formation. Thickness ranges from 0 to 100 ft. (Description from source map: Western Grove Quadrangle).

Osp - St. Peter Sandstone (Middle Ordovician)
Very fine-grained, grayish-yellow sandstone interbedded with blue-green siltstone, shale, and sparse dolostone. Sandstone is calcite-cemented arenite containing well-rounded quartz grains. Upper part of unit, as thick as 25 ft, is sandstone interbedded with blue-green fissile shale, thin-bedded siltstone, and sparse 0.5- to 3-ft-thick beds of brown-gray, fine crystalline dolostone; shale, siltstone, and dolostone interval is commonly marked by zone of slumped sandstone blocks on hillslopes. Main part of unit contains a sequence of 1- to 2-ft-thick sandstone beds overlying a massive basal sandstone ledge as thick as 20 ft. Bioturbation is common in most sandstone beds and includes cylindrical burrows (Skolithos) perpendicular to bedding that weather to distinctive straw-like forms. Basal sandstone is crossbedded, contains inclined fractures, and discordantly overlies Everton Formation. Thickness 0–70 ft. (Description from source map: West-Central Buffalo National River Region).

Oe - Everton Formation, undivided (Middle Ordovician)

Oe - Everton Formation (Middle Ordovician)
Consists primarily of interbedded dolostone, sandy dolostone, and sandstone. Dolostones are thin- to medium-bedded and fine- to coarsely-crystalline. They are medium- gray on fresh surfaces, but weather light-gray. Sandstones are very thin- to medium -bedded and are locally silica-cemented. Quartz grains are fine to coarse and sub-rounded to well-rounded. A very thin- to thin-bedded limestone approximately 30 feet thick (9 meters) is present beneath the unconformity with the overlying St. Peter Sandstone. It is finely crystalline to micritic and commonly contains stromatolites. This limestone is referred to as the Jasper Limestone by Purdue and Miser (1916). Another section of limestone is present in the lower part of the formation. This limestone is approximately 40-80 feet thick (12-24 meters) and is very similar to the Jasper Limestone. Both limestones are light- to medium-gray on fresh surfaces but weather white to light-gray and are finely crystalline to micritic. Microkarst is common on the surface of the limestones. Oncolites, nautiloids and various fossil fragments are present in the limestones. Chert containing gastropods and oolites is also present locally. Contains thin bedded black chert in the lower portion of the formation. Springs are abundant. Travertine is locally abundant forming cascades and rimstone pools in streams. All of the zinc prospects are located in this unit. Conformable with the underlying Powell Dolomite. Approximately 60-500 feet (18-152 meters) thick. (Description from source map: Big Flat Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Interbedded limestone, dolostone, and sandstone sequence. Upper part of Everton Formation contains 3- to 20-ft-thick, light- to dark-gray limestone and dolostone beds that are interbedded with sandstone. Directly below contact with Fernvale Limestone (Of) exposed along Highway 43 (NE corner of sec. 3, T. 15 N., R. 23 W.), medium-gray, fine-crystalline dolostone contains light-gray chert lenses that are uncommon elsewhere in formation. Carbonate beds of unit are typically finely crystalline and sparsely fossiliferous, and commonly display crinkly laminations. Sandstone is quartz arenite with well-sorted, well-rounded, and fine to medium quartz grains. Sandstone is present in medium to thick planar beds and is light tan to white and cemented by dolomite and (or) calcite. As much as 40 ft of upper Everton Formation is exposed along Whitely Creek in northeast part of quadrangle, but unit is about 300 ft thick to the northeast in Ponca quadrangle (Hudson and Murray, 2003). (Description from source map: Boxley Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Consists primarily of interbedded dolostone, sandy dolostone, and sandstone. Dolostones are thin- to medium bedded and fine-to coarsely-crystalline. They are medium- gray on fresh surfaces, but weather light-gray. Sandstones are very thin- to medium -bedded and are locally silica-cemented. Quartz grains are fine to coarse and sub-rounded to well-rounded. A very thin- to thin bedded limestone approximately 30 feet thick (9 meters) is present beneath the unconformity with the overlying St. Peter Sandstone. It is finely crystalline to micritic and commonly contains stromatolites. This limestone is referred to as the Jasper Limestone by Purdue and Miser (1916). Another section of limestone is present in the lower part of the formation. This limestone is approximately 40-80 feet thick (12-24 meters) and is very similar to the Jasper Limestone. Both limestones are light- to medium-gray on fresh surfaces but weather white to light-gray and are finely crystalline to micritic. Microkarst is common on the surface of the limestones. Oncolites, nautiloids and various fossil fragments are present in the limestones. A trilobite was discovered at one locality. Chert containing gastropods and oolites is also present locally. Contains thin bedded black chert in the lower portion of the formation. Springs are abundant. Travertine is locally abundant forming cascades and rimstone pools in streams. All of the zinc prospects are located in this unit. Conformable with the underlying Powell Dolomite. Approximately 60-640 feet (18-195 meters) thick. (Description from source map: Buffalo City Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Consists primarily of interbedded dolostone, sandy dolostone, and sandstone with lesser amounts of bedded chert. Dolostones are thin- to medium-bedded and fine- to coarsely-crystalline. They are medium-gray on fresh surfaces, but weathers light-gray. Sandstones are very thin- to medium-bedded and locally silica-cemented. Quartz grains are fine to coarse and sub-rounded to well-rounded. At

most localities, a very thin- to medium-bedded limestone approximately 30 feet (9 meters) thick is present beneath the unconformity with the overlying St. Peter Sandstone. It is light- to medium-gray on fresh surfaces but weathers white to light-gray and is finely crystalline to micritic. This limestone commonly contains stromatolites. It is referred to as the Jasper Limestone by Purdue and Miser (1916). Another interval of limestone and thin bedded chert is present in the lower part of the formation. Springs are common. The majority of documented zinc prospects are located in this unit. Approximately 60-460 feet (18-140 meters) of Everton is exposed in the quadrangle. (Description from source map: Cozahome Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Very fine to fine grained crystalline, sandy and limy dolostones that are thin- to massive-bedded. Thin to medium beds of fine- to medium-grained quartz sandstone are common and similar to the overlying St. Peter Sandstone. Medium to dark gray on fresh surfaces but usually weathers light gray. Approximately 10-360 ft. (3-109 m) exposed at the surface. (Description from source map: Eula Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Very fine to finely crystalline sandy and limy dolostones that are thin to massive bedded. Color is medium to dark-gray on fresh surfaces but weathers to a lighter gray. Dolostones are often mottled and contain stromatolites, mudcracks, and calcite and dolomite filled veins and vugs. Thin-bedded intervals near the top of the unit are often deformed along the contact with the St. Peter. Freshly broken surfaces have a strong petroliferous odor. Exposures in this quadrangle range from 6 inches up to 160 feet (0.2 to 49 meters). (Description from source map: Harriet Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Interbedded sandstone, dolostone, and limestone sequence. Sandstone is quartz arenite with well-sorted, well rounded, and fine to medium quartz grains. Sandstone is present in medium to thick planar beds and is light tan to white and cemented by dolomite and (or) calcite. Poorly cemented sandstone breaks with sugary texture. Upper part of the Everton Formation contains 3- to 20-ft-thick, light- to dark-gray limestone and dolostone beds that are commonly interbedded with sandstone. Middle part is a sandstone interval, the Newton Sandstone Member of the Everton of McKnight (1935). Lower part contains 3- to 6-ft-thick limestone and dolostone beds interbedded with sandstone. Carbonate beds in both upper and lower parts of unit are typically finely crystalline and sparsely fossiliferous, and commonly display crinkly laminations. Exposed thickness along Little Buffalo River as much as 200 ft, but base not exposed. (Description from source map: Hasty Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Interbedded sandstone, dolomite, and limestone sequence. The unit is mostly quartz arenite containing well sorted, well-rounded, and fine- to medium-grained quartz grains. Sandstone is light tan to white and variably cemented by dolomite or calcite that locally form large crystals that envelop sand grains in a poikilitic texture. Sandstone is typically poorly cemented with sugary texture. The sandstone generally has medium to thick planar beds. The top part of Everton Formation contains 3-20-ft- (1-6-m-) thick light- to dark-gray dolomite and limestone beds that are commonly interbedded with sandstone. Fine, light gray, limestone with conchoidal fracture present near Jasper is the Jasper Limestone of Purdue and Miser (1916); Glick and Frezon (1953) showed that this limestone is part of the Everton. The middle part of the Everton is a thick sandstone interval that commonly forms prominent bluffs and correlates with the Newton Sandstone Member of the Everton of McKnight (1935). The lower part of unit contains 3-6-ft- (1-2-m-) thick limestone and dolomite beds interbedded with sandstone. Carbonate beds in both upper and lower parts of unit are typically finely crystalline, sparsely fossiliferous, and commonly display crinkly laminations. The lower limestone-rich part of the Everton is a common host of paleokarst features that consist of vertical columns or walls of highly fractured or brecciated Everton Formation sandstone that collapsed from overlying horizons. Unit is about 230 ft (70 m) thick in its only complete exposure along Harp Creek. (Description from source map: Jasper Quadrangle).

Oe - Everton Formation (Middle Ordovician)

Very fine- to fine grained, thin- to very thick-bedded, sandy to limy dolostone. Medium to dark gray on fresh surfaces, but usually weathers light-gray. Thin to medium beds of fine- to medium-grained quartz sandstone, similar to the overlying St. Peter Sandstone, are present in the upper section. The dolostone is typically mottled or banded, and locally contains stromatolites, mudcracks or rarely, grains of glauconite. Freshly broken pieces yield a strong petroliferous odor. Crops out only along the northern edge of the map, therefore a maximum of approximately 100 feet (30 meters) is exposed. (Description from source map: Marshall Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Very fine to fine-grained, crystalline to sandy, and limy dolostones that are thin to massive-bedded. Thin to medium-beds of fine to medium-grained quartz sandstone are common and similar to the overlying St. Peter Sandstone. Medium to dark gray on fresh surface but typically weathers light gray. Approximately 40-140 ft. (12-42 m) is exposed. (Description from source map: Mt. Judea Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Interbedded limestone, dolostone, and sandstone. Jasper Member (Glick and Frezon, 1953) forms uppermost part of formation and is light-gray finely crystalline to micritic limestone and sandy limestone. Below Jasper Member, upper part of the Everton Formation contains 3- to 20-ft-thick, light- to dark-gray dolostone beds that are interbedded with sandstone. Carbonate beds of unit are typically finely crystalline and sparsely fossiliferous, and commonly display crinkly laminations. Sandstone is quartz arenite with well-sorted, well-rounded, and fine to medium quartz grains. Sandstone is present in medium to thick planar beds and is light tan to white and cemented by dolomite and (or) calcite. As much as 60 ft of upper Everton Formation is exposed in Dry Creek in northwest part of quadrangle, but unit is about 300 ft thick to the northeast in the Ponca 7.5-minute quadrangle (Hudson and Murray, 2003). (Description from source map: Murray Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Very fine to fine grained crystalline to sandy and limy dolostones that are thin to massive-bedded. Thin to medium beds of fine to medium grained quartz sandstone are common and similar to the overlying St. Peter Sandstone. Medium to dark-gray on fresh surface but usually weathers light-gray. Only exposed in the bottom of Hudson Quarry in Section 34, T16N, R21W, along H w3y27, the Little Buffalo River in Section 34, T16N, R21W, and in Spider Creek. Approximately 5 - 10 ft. exposed. (Description from source map: Parthenon Quadrangle).

Oe - Everton Formation (Middle Ordovician)
Consists primarily of interbedded dolostone, sandy dolostone, and sandstone with lesser amounts of bedded chert. Dolostones are thin- to medium-bedded and fine to coarsely- crystalline. They are medium-gray on fresh surfaces, but weather light-gray. Sandstones are very thin to medium bedded and are locally silica-cemented. Quartz grains are fine to coarse and sub-rounded to well-rounded. At most localities, a very thin- to medium-bedded limestone approximately 40 feet (12 meters) thick is present beneath the unconformity with the overlying St. Peter Sandstone. It is light- to medium-gray on fresh surfaces but weathers white to light-gray and is finely crystalline to micritic. This limestone commonly contains stromatolites. This limestone is referred to as the Jasper Limestone by Purdue and Miser (1916). Another interval of limestone approximately 30 feet (9 meters) thick and thin bedded cherts are present in the lower part of the formation. Springs are common. The majority of the zinc prospects are located in this unit. The Everton is unconformable with the underlying Powell Dolomite. Thickness ranges from approximately 200-420 feet (60-128 meters). (Description from source map: Rea Valley Quadrangle).

Oeu - Everton Formation, upper part (Middle Ordovician)

Oeu - Everton Formation: Upper part (Middle Ordovician)
Interbedded dolostone, dolomitic sandstone, and limestone, divided into upper and lower parts. Base not exposed in quadrangle. Total thickness 320 ft. **Upper part:** Jasper Member (Glick and Frezon,

1953) forms up to 80 ft of upper part of Everton Formation and is light-gray, finely crystalline to micritic, medium-bedded limestone and sandy limestone. Below Jasper Member, upper part of Everton Formation consists of dark- to light-gray, micritic to finely crystalline dolostone, limey dolostone, and carbonate cemented sandstone. Dolostone and limey dolostones are planar-laminated to medium-bedded and commonly contain rounded to well-rounded quartz grains. Sandstone is well-sorted, rounded to well-rounded, fine- to medium-grained quartz arenite that is dolomite or limey-dolomite cemented. Unit contains dolomitic stromatolite mounds. Farther west base of upper part of Everton Formation is marked by base of Newton Sandstone Member (McKnight, 1935) but is absent in this quadrangle; therefore, basal contact is placed above the first consistent limestone beds. Thickest exposed section is in northwestern part of quadrangle, 140–160 ft, where Jasper is mostly removed. Cumulative thickness 220–240 ft. (Description from source map: Maumee Quadrangle).

Oeu - Upper part of Everton Formation (Middle Ordovician)
Interbedded limestone, dolostone, and sandstone. Up to 10 ft of light-gray micrite and limestone-cemented sandstones of the Jasper Member (not mapped separately) directly below contact with Fernvale Limestone in Whitely Creek. Below Jasper Member, unit includes 3- to 20-ft-thick, light- to dark-gray limestone and dolostone beds interbedded with sandstone. Carbonate beds are typically finely crystalline, sparsely fossiliferous, and commonly display crinkly laminations. Sandstone is medium to thick, planar-bedded, light tan to white quartz arenite that is well-sorted, well-rounded, fine to medium grained, and cemented by dolomite and (or) calcite. As much as 40 ft exposed along Whiteley Creek and 60 ft on the southeast side of the Buffalo River in southeast part of quadrangle. Unit is about 300 ft thick to the east of map area on the Ponca quadrangle where base of unit is exposed (Hudson and Murray, 2003). (Description from source map Osage SW Quadrangle).

Oeu - Everton Formation: Upper part (Middle Ordovician)
Interbedded sandstone, dolomite, and limestone sequence divided into upper part, Newton Sandstone Member, and lower part. Unit is 310–350 ft (95–107 m) thick). **Upper part:** The upper part of Everton Formation contains 3–20-ft- (1–6-m-) thick light- to dark-gray dolomite and limestone beds interbedded with sandstone. Fine crystalline, light gray, limestone as thick as 10 ft (3 m) is present near top of unit in southwestern part of map. Sandstone is light tan to white quartz arenite containing well-sorted, well-rounded, and fine- to medium-grained quartz grains. Sandstone is variably cemented by dolomite or calcite and is transitional from carbonate sandstone to sandy carbonate; carbonate crystals locally envelop sand grains. Sandstone generally has medium to thick planar beds. Dolomite is light to dark gray, fine to medium crystalline, and thin to medium bedded with common sandstone stringers and beds. Dolomite is typically laminated and forms intervals 1–10 ft (0.3–3 m) thick. Includes Jasper Member and the informal “Member C” of Everton Formation of Suhm (1974). Unit is 80–100 ft (24–30 m) thick. (Description from source map: Ponca Quadrangle).

Oeu - Everton Formation: Upper part (Middle Ordovician)
Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 300-400 ft thick. **Upper part:** Interbedded dolostone, sandstone, and limestone. Limestone is finely crystalline, light gray, thick bedded, and locally fossiliferous, and is present in intervals as thick as 20 ft. Dolostone is light to dark gray, finely to medium crystalline, laminated, and medium to thick bedded commonly containing sandstone stringers. Sandstone is arenite composed of well-sorted, well-rounded, fine to medium quartz grains. Sandstone is light tan to white in planar, medium to thick beds and is variably cemented by dolomite or calcite; sandstone locally grades into sandy dolostone or limestone. Limestone interbedded with limy sandstone and lesser dolostone at top of unit comprises Jasper Member of Glick and Frezon (1953). Jasper Member is up to 40 ft thick but has been removed in northwestern part of quadrangle due to pre-Mississippian erosion. Dolostone and dolomitic sandstone underlying Jasper Member make up most of upper part of Everton. Base of upper part of Everton is marked by base of Newton Sandstone Member (McKnight, 1935), a planar, medium-bedded quartz arenite composed of well-sorted, well-rounded, fine to medium quartz grains. Newton Sandstone Member is 5-10 ft thick. Upper part of Everton Formation is 180-200 ft thick. (Description from source map: St. Joe Quadrangle).

Oeu - Everton Formation: Upper part (Middle Ordovician)

Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 300–400 ft thick. **Upper part:** Interbedded dolostone, sandstone, and limestone. Limestone is finely crystalline, light gray, thick bedded, and locally fossiliferous, and is present in intervals as thick as 20 ft. Dolostone is light to dark gray, finely to medium crystalline, laminated, and medium to thick bedded commonly containing sandstone stringers. Sandstone is arenite composed of well sorted, well-rounded, fine to medium quartz grains. Sandstone is light tan to white in planar, medium to thick beds and is variably cemented by dolomite or calcite; sandstone locally grades into sandy dolostone or limestone. Limestone interbedded with limy sandstone and lesser dolostone at top of unit comprises Jasper Member of Glick and Frezon (1953). Jasper Member is 50–70 ft thick in southern part of quadrangle (Glick and Frezon, 1953) but is absent in northern part of quadrangle due to pre-Mississippian erosion beneath unconformity at base of St. Joe Limestone Member of Boone Formation. Dolostone and dolomitic sandstone underlying Jasper Member make up most of upper part of Everton. Base of upper part of Everton is marked by Newton Sandstone Member (McKnight, 1935), a planar, medium- bedded quartz arenite composed of well-sorted, well-rounded, fine to medium quartz grains. Newton Sandstone Member is 10–15 ft thick. Upper part of Everton Formation is 110–200 ft thick. (Description from source map: Western Grove Quadrangle).

Oeu - Everton Formation: Upper part (Middle Ordovician)
Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 250–400 ft thick. **Upper part:** Interbedded dolostone, sandstone, and limestone. Limestone is finely crystalline, light gray, thick bedded, locally fossiliferous, and is present in intervals as thick as 20 ft. Dolostone is light to dark gray, finely to medium crystalline, laminated and medium- to thick-bedded and commonly contains sandstone stringers. Sandstone is arenite composed of well-sorted, well-rounded, fine to medium quartz grains. Sandstone is light tan to white in planar, medium to thick beds and is variably cemented by dolomite or calcite; sandstone locally grades into sandy dolostone or limestone. Limestone interbedded with limy sandstone and lesser dolostone at top of unit composes Jasper Member of Glick and Frezon (1953). Dolostone and dolomitic sandstone underlying Jasper Member make up most of upper part of Everton. Base of upper part of Everton is marked by base of Newton Sandstone Member (McKnight, 1935), a planar, medium-bedded quartz arenite composed of well-sorted, well- rounded, fine to medium quartz grains. Newton Sandstone Member is 10–100 ft thick. Upper part of Everton Formation is 110–200 ft thick. (Description from source map: West-Central Buffalo National River Region).

Oel - Everton Formation, lower part (Middle Ordovician)

Oeu - Everton Formation: Lower part (Middle Ordovician)
Interbedded dolostone, dolomitic sandstone, and limestone, divided into upper and lower parts. Base not exposed in quadrangle. Total thickness 320 ft. **Lower part:** Interbedded finely crystalline to micritic dark- to light-gray limestone, limey sandstone, and sandy limestone. Medium to thick bedded with planar to wavy laminations. Near upper contact stromatolite mounds are present. Upper beds also contain collapse breccia with clasts of overlying dolomitic rocks of upper part of Everton. Only about 60 ft exposed in quadrangle. (Description from source map: Maumee Quadrangle).

Oel - Everton Formation: Lower Part (Middle Ordovician)
Interbedded sandstone, dolomite, and limestone sequence divided into upper part, Newton Sandstone Member, and lower part. Unit is 310–350 ft (95–107 m) thick). **Lower part:** Interbedded sandstone, limestone, and dolomite. Upper part of unit is mostly limestone interbedded with sandstone. Limestone is light gray, finely crystalline, thin to medium bedded, commonly laminated, and locally stromatolitic. Limestone is 1–10 ft (0.3–3 m) thick. Limestone-rich part of the lower Everton is a common host of paleokarst features that consist of vertical columns of highly fractured or brecciated sandstone collapsed from overlying horizons. Sandstone is quartz arenite containing well-sorted, well rounded, and fine- to medium-grained quartz grains. Sandstone is light tan to white and variably cemented by dolomite or calcite. Poorly cemented sandstone breaks with sugary texture. The sandstone has medium to thick planar beds. The lower part of unit is light- to dark-brownish-gray dolomite grading to sandy dolomite interbedded with sandstone. Dolomite is fine to medium

crystalline, thin to thick bedded, commonly laminated, and may be stromatolitic. Dolomite beds present as intervals 1–10 ft (0.3–3 m) thick. Contact with underlying Powell Dolomite is placed at lowest bed of sandstone or sandy dolomite. Lower part of Everton equivalent to informal “Member B,” Kings River Sandstone Member, and the Sneeds Dolomite Member of the Everton Formation of Suhm (1974). Unit is 100–140 ft (30–43 m) thick. (Description from source map: Ponca Quadrangle).

Oel - Everton Formation: Lower part (Middle Ordovician)
Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 300-400 ft thick. **Lower part:** Interbedded dolostone, sandstone, and limestone. Limestone is restricted to upper part of unit and is interbedded with dolostone and sandstone. Limestone is light gray, finely crystalline, thin to medium bedded, commonly laminated, and contains sparse stromatolite hemispheres as large as 1 ft in diameter. Dolostone, present throughout unit, is light gray to grayish brown, finely to medium crystalline, thin to thick bedded, and commonly laminated and it commonly contains stromatolites. Sandstone is light-tan to white quartz arenite, composed of well-sorted, well-rounded, fine to medium grains, variably cemented by dolomite or calcite. Sandstone intervals, composed of planar, thin to medium beds as thick as 6 ft, are present throughout unit. Sandstone also forms lenses and stringers within limestone and dolostone intervals. Light to dark-brownish-gray dolostone and sandy dolostone interspersed with sandstone are predominant in lower part of unit. Collapse breccia with clasts of planar laminated dolomite and dolomitic sandstone is present. Unit is 250 ft thick where fully exposed near Mt. Hersey to the west-southwest on the Western Grove quadrangle (Glick and Frezon, 1953) but only upper 60 ft is exposed within St. Joe quadrangle. (Description from source map: St. Joe Quadrangle).

Oeu - Everton Formation: Lower part (Middle Ordovician)
Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 300–400 ft thick. **Lower part:** Interbedded dolostone, sandstone, and limestone. Limestone is restricted to upper part of unit and is interbedded with dolostone and sandstone. Limestone is light gray, finely crystalline, thin to medium bedded, and commonly laminated, and contains scattered stromatolite hemispheres as large as 1 ft in diameter. Dolostone, present throughout unit, is light gray to grayish brown, finely to medium crystalline, thin to thick bedded, and commonly laminated, and it commonly contains stromatolites. Sandstone is light-tan to white quartz arenite, composed of well-sorted, well-rounded, fine to medium quartz grains, variably cemented by dolomite or calcite. Sandstone intervals, composed of planar, thin to medium beds as thick as 6 ft, are present throughout unit. Sandstone also forms lenses and stringers within limestone and dolostone intervals. Light to dark-brownish-gray dolostone and sandy dolostone interspersed with sandstone are predominant in lower part of unit. Basal contact with Powell Dolomite is unconformable and locally marked by a 0.5-ft-thick conglomerate containing clasts of Powell in finely crystalline dolomite matrix. Unit is 250 ft thick where fully exposed near Mt. Hersey near Buffalo River in south-central part of area. (Description from source map: Western Grove Quadrangle).

Oel - Everton Formation: Lower part (Middle Ordovician)
Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 250–400 ft thick. **Lower part:** Interbedded dolostone, sandstone, and limestone. Limestone is restricted to upper part of unit and is interbedded with dolostone and sandstone. Limestone is light gray, finely crystalline, thin to medium bedded, commonly laminated, and contains sparse stromatolite hemispheres as large as 1 ft in diameter. Dolostone, present throughout unit, is light gray to grayish brown, finely to medium crystalline, thin to thick bedded, and commonly laminated, and it commonly contains stromatolites. Sandstone is light-tan to white quartz arenite, composed of well-sorted, well-rounded, fine to medium grains, variably cemented by dolomite or calcite. Sandstone intervals, composed of planar, thin to medium beds as thick as 6 ft, are present throughout unit. Sandstone also forms lenses and stringers within limestone and dolostone intervals. Light- to dark-brownish-gray dolostone and sandy dolostone interspersed with sandstone are predominant in lower part of unit. Collapse breccia with clasts of planar laminated dolostone and dolomitic sandstone is present. Unit is 140–250 ft thick (Description from source map: West-Central Buffalo National River Region).

Op - Powell Dolomite (Lower Ordovician)

Opw - Powell Dolomite (Lower Ordovician)
Very fine to fine- grained thin to medium-bedded argillaceous dolostone interbedded with very thin-bedded dolomitic shale. Dolostones are white to light-gray on fresh and weathered surfaces and often laminated. The dolostone contains small quartz geodes, mudcracks and stromatolites. Shale is tan to buff on fresh and weathered surfaces. A trilobite fragment was found at one locality. Locally contains nodular chert or chert fragments and pink dolomite. **Black Ledge Chert** - Approximately 40--60 feet (12-18 meters) above the base of the Powell is a chert referred to as “black ledge” (McKnight, 1935 and Cullison, 1944) because of its dark weathering appearance. The classic “black ledge” is a vuggy, comby drusy quartz that contains gastropod molds. The classic black ledge is often weathered down slope or removed for decorative stone. Most often seen is a massive white to gray chert that weathers orange. This chert forms small glades locally. The basal contact of the Powell is placed at the appearance of banded chert nodules and/or chert breccia in the upper portion of the Cotter Dolomite. The upper contact with the Everton Formation is placed at the last appearance of sandy dolostone. Conformable with the underlying Cotter Dolomite. Ranges from 200 -340 feet (73-103 meters) thick. (Description from source map: Buffalo City Quadrangle).

Op - Powell Dolomite (Lower Ordovician)
Shown in cross sections only. Argillaceous brownish-gray dolostone. Regionally, thickness varies from 40 to 200 ft (McFarland, 1988). (Description from source map: Hasty Quadrangle).

Op -Powell Dolomite (Lower Ordovician)
Argillaceous brownish-gray dolomite. Only the upper few feet of the formation are exposed along Harp Creek drainage (Purdue and Miser, 1916). Its contact with overlying Everton Formation is disconformable and marked by irregular topography and sand filled cracks that penetrate into the Powell Dolomite. Regionally the formation thickness varies from 40 to 200 ft (12 to 60 m) (McFarland, 1988). (Description from source map: Jasper Quadrangle).

Op - Powell Dolomite (Lower Ordovician)
Fine-grained, argillaceous to silty, gray dolomite with dark-gray shale interbeds. Dolomite beds are thin to medium, wavy, commonly laminated and stromatolitic. Contact with overlying Everton Formation is unconformable and beneath it Powell beds may be truncated with slight local angular unconformity. Unit is about 200 ft (60 m) thick in the only complete section exposed in Hemmed-In Hollow. (Description from source map: Ponca Quadrangle).

Opw - Powell Dolomite (Lower Ordovician)
Very fine to fine grained thin to medium bedded argillaceous dolostone interbedded with very thin-bedded dolomitic shale. Dolostones are white to light-gray on fresh and weathered surfaces and often laminated. Shale is greenish-grey to blue-green on fresh and tan to buff weathered surfaces. Locally contains pink dolomite. Overall thickness ranges from approximately 200-420 feet (60-128 meters). **Black Ledge Chert:** Approximately 40-60 feet (12 - 18 meters) above the base of the Powell is a chert referred to as “black ledge” (McKnight, 1935 and Cullison, 1944) because of its dark weathering appearance. Typical “black ledge” is vuggy, comby, and covered in drusy quartz that contains gastropod molds. Thick to massive siliceous beds of red, black, brown and white chert containing the casts of angular clasts are also common in this interval. Thickness ranges from approximately 5-20 feet (1.5-6 meters). (Description from source map: Rea Valley Quadrangle).

Op - Powell Dolomite (Lower Ordovician)
Fine-grained, thin-bedded, argillaceous dolostone. Yellowish gray on fresh surfaces. Weathers to thin, platy blocks. As much as 65 ft of Powell is exposed along Buffalo River where it eroded upthrown side of Cane Branch monocline near Mt. Hersey (Glick and Frezon, 1953). Regionally, formation thickness ranges from 40 to 200 ft (McFarland, 1988). (Description from source map: Western Grove Quadrangle).

Op - Powell Dolomite (Lower Ordovician)

Fine-grained, thin-bedded, argillaceous dolostone with dark-gray shale interbeds. Dolostone beds are medium to thin, wavy, and commonly laminated and stromatolitic. Yellowish gray on fresh surfaces. Weathers to thin, platy blocks. Unit is about 200 ft thick in the only complete section exposed in Hemmed-In Hollow in the western part of the area. (Description from source map: West-Central Buffalo National River Region).

Opblc - Powell Dolomite, black ledge chert (Lower Ordovician)

Black Ledge Chert (Lower Ordovician)
Approximately 40-60 feet (12 - 18 meters) above the base of the Powell is a chert referred to as “black ledge” (McKnight, 1935 and Cullison, 1944) because of its dark weathering appearance. Typical “black ledge” is vuggy, comby, and covered in drusy quartz that contains gastropod molds. Thick to massive siliceous beds of red, black, brown and white chert containing the casts of angular clasts are also common in this interval. Thickness ranges from approximately 5-20 feet (1.5-6 meters). (Description from source map: Rea Valley Quadrangle).

Ou - Lower Ordovician rocks, undivided (Lower Ordovician)

Ou - Lower Ordovician rocks, undivided
Sedimentary rocks shown on cross section only. (Description from source maps: Boxley Quadrangle, Murray Quadrangle, Osage SW Quadrangle and St. Joe Quadrangle).

OCu - Lower Ordovician and Cambrian rocks, undivided (Lower Ordovician and Cambrian)

OCu - Lower Ordovician and Cambrian rocks, undivided
Sedimentary rocks shown on cross section only. (Description from source map: Maumee Quadrangle).

Oc - Cotter Dolomite (Lower Ordovician)

Oc - Cotter Dolomite (Lower Ordovician)
Fine-to medium-crystalline dolostone. Light-gray on fresh surfaces but weathers dark-gray. Contains banded chert nodules or angular chert fragments, quartz druse vugs and laminations. Massive bedded chert is present locally. Approximately 60-180 feet (18-54) of Cotter is exposed. (Description from source map: Buffalo City Quadrangle).

Oc - Cotter Dolomite (Lower Ordovician)
Brownish-gray dolomite with sparse chert nodules. Chert composed of concentric, alternating dark-gray and white bands within elongate nodules that are concentrated in dolomite beds in the upper part of the formation. Only the upper 20–30 ft (6–9 m) of unit are exposed along Hemmed-In Hollow. (Description from source map: Ponca Quadrangle).

Oc - Cotter Dolomite (Lower Ordovician)
Consists of a fine to medium grained crystalline dolostone. Light gray on fresh surfaces but weathers dark-gray and has a “hackly” appearance. The Cotter is noted for concentric light and dark banded chert nodules. It also contains angular chert fragments, quartz druse vugs and laminations. Massive beds of white to translucent chert were observed locally. Approximately 60-180 feet (18-54 meters) of Cotter is exposed in the quadrangle. (Description from source map: Rea Valley Quadrangle).

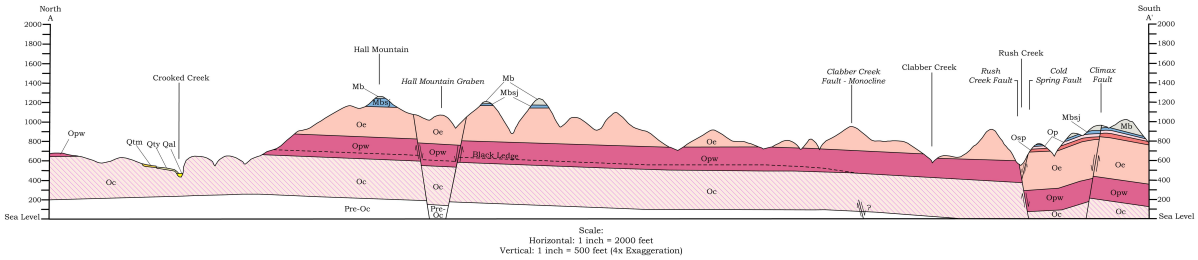
Oc - Cotter Dolomite (Lower Ordovician)
Brownish-gray dolomite with sparse chert nodules. Chert composed of concentric, alternating dark-gray and white bands within elongate nodules that are concentrated in dolomite beds in the upper part of the formation. Only the upper 20–30 ft of unit are exposed along Hemmed-In Hollow (Ponca quadrangle) in the western part of the map area. (Description from source map: West-Central Buffalo National River Region).

Geologic Cross Sections

The geologic cross sections present in the GRI digital geologic-GIS data produced for Buffalo National River, Arkansas (BUFF) are presented below. Note that some cross section abbreviations (e.g., A - A') have been changed from their source map abbreviation in the GRI data so that each cross section abbreviation in the GRI data is unique. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

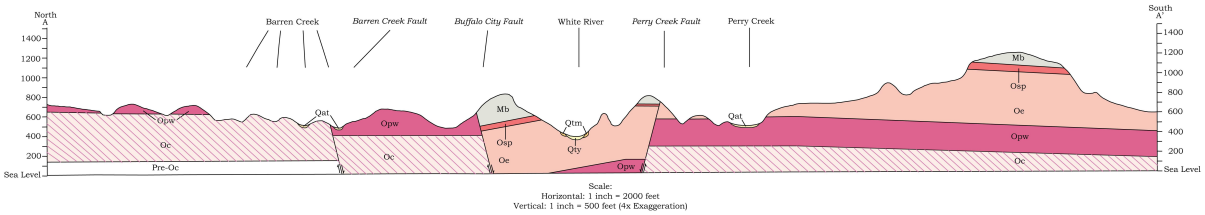
Geologic cross sections on the Hasty, Jasper, Maumee, Ponca, Saint Joe, and Western Grove quadrangles may differ slightly from the GRI digital geologic-GIS data..

Cross Section A-A'



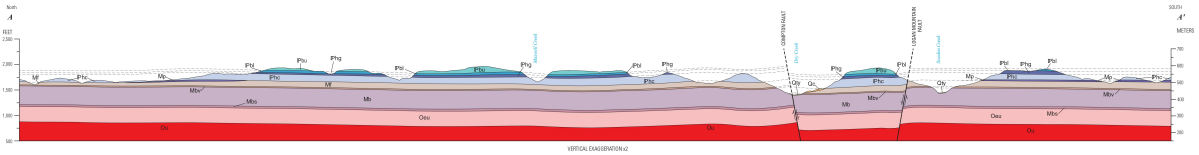
Cross section from source map: Rea Valley Quadrangle. Vertical exaggeration 4x.

Cross Section B-B'



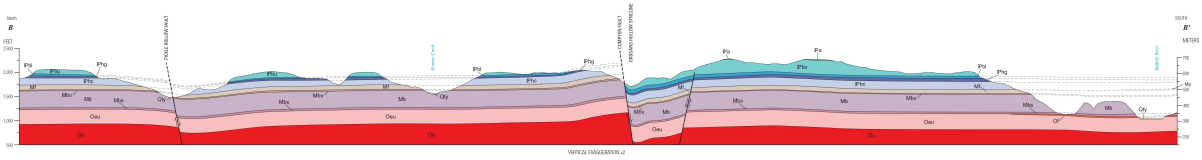
Cross section from source map: Buffalo City Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section C-C'



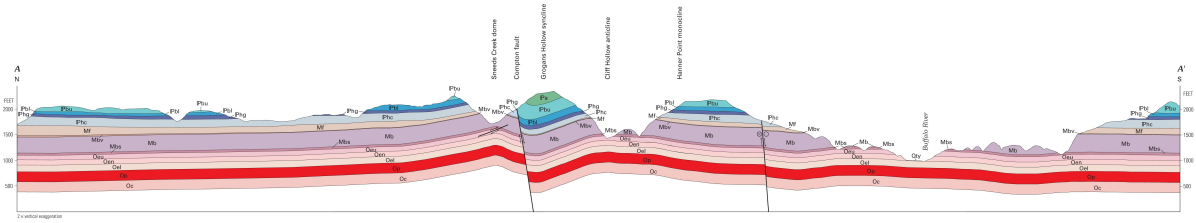
Cross section from source map: Osage SW Quadrangle. Cross section A-A' on source map. Vertical exaggeration 2x.

Cross Section D-D'



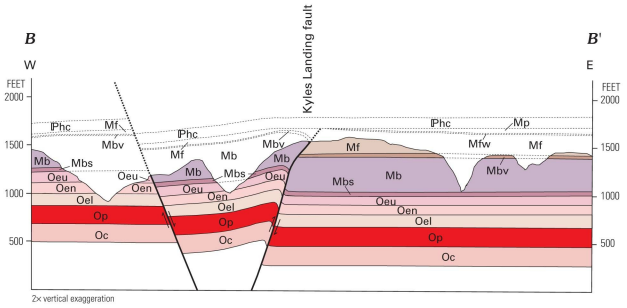
Cross section from source map: Osage SW Quadrangle. Cross section B-B' on source map. Vertical exaggeration 2x.

Cross Section E-E'



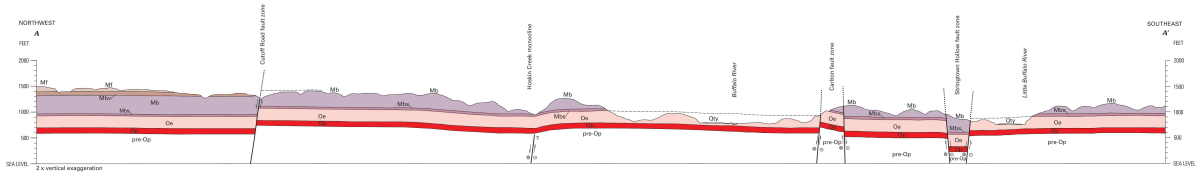
Cross section from source map: Ponca Quadrangle. Cross section A-A' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section F-F'



Cross section from source map: Ponca Quadrangle. Cross section B-B' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

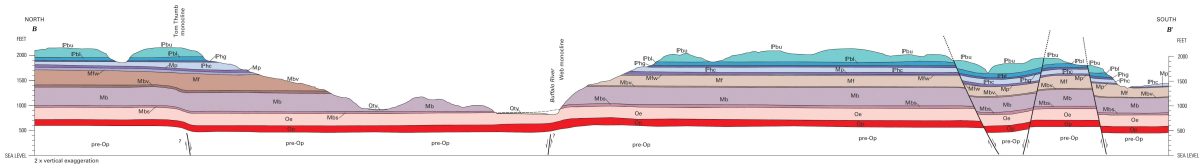
Cross Section G-G'



Cross section from source map: Jasper Quadrangle. Cross section A-A' on source map.The cross

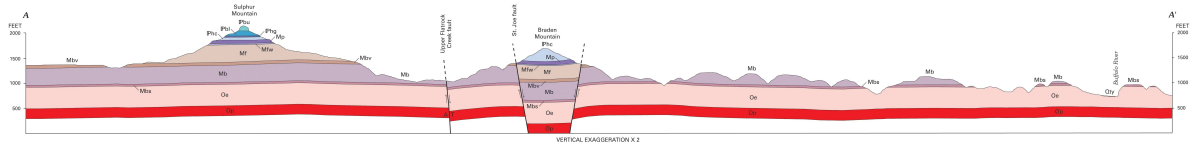
section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section H-H'



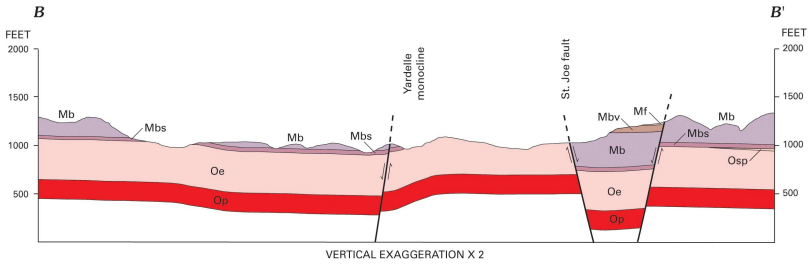
Cross section from source map: Jasper Quadrangle. Cross section B-B' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section I-I'



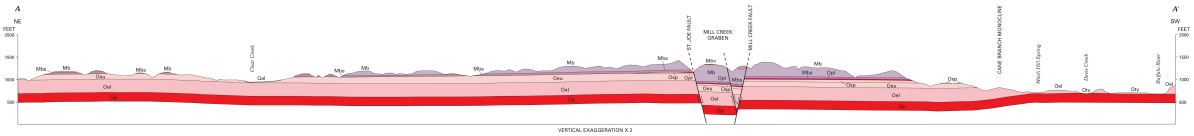
Cross section from source map: Hasty Quadrangle. Cross section A-A' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section J-J'



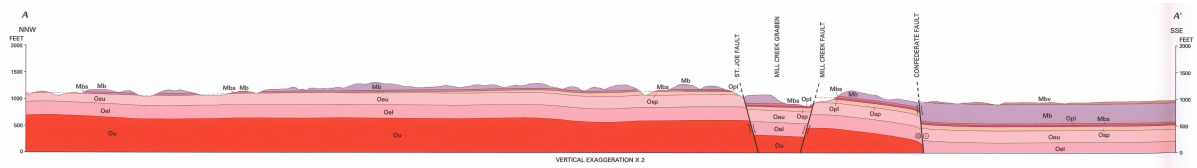
Cross section from source map: Hasty Quadrangle. Cross section B-B' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section K-K'



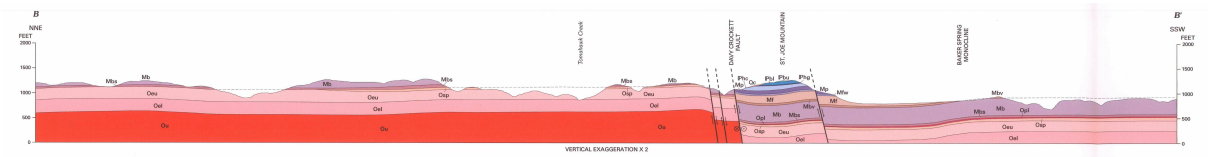
Cross section from source map: Western Grove Quadrangle. Cross section A-A' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section L-L'



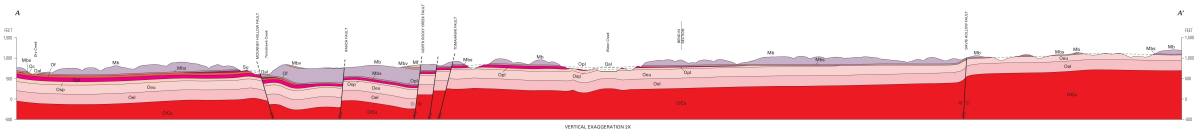
Cross section from source map: St. Joe Quadrangle. Cross section A-A' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section M-M'



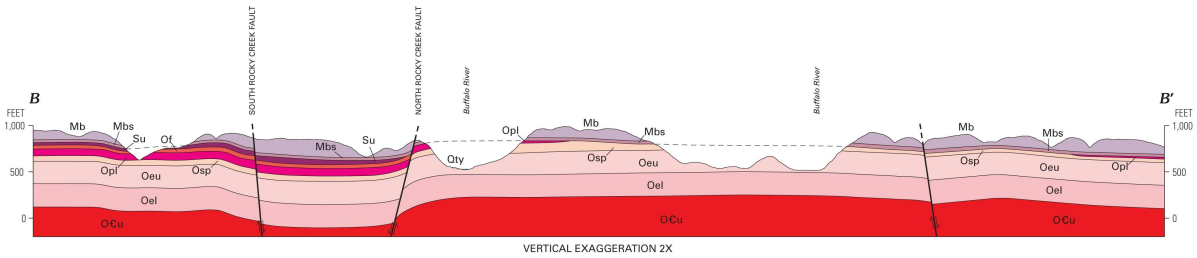
Cross section from source map: St. Joe Quadrangle. Cross section B-B' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section N-N'



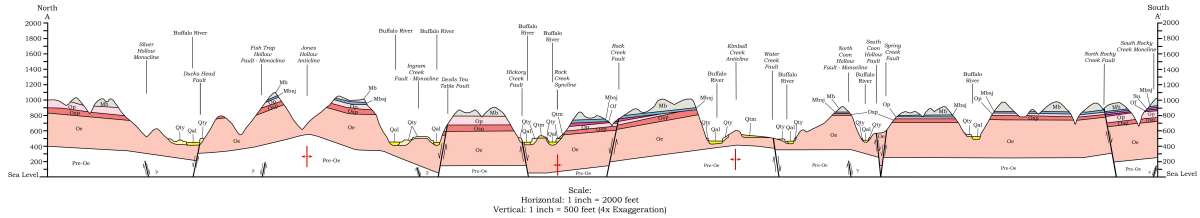
Cross section from source map: Maumee Quadrangle. Cross section A-A' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section O-O'



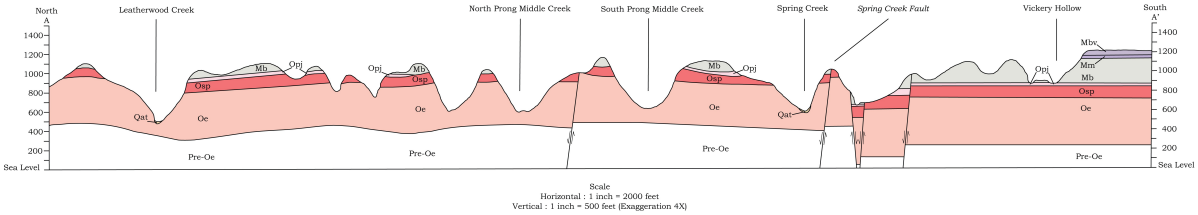
Cross section from source map: Maumee Quadrangle. Cross section B-B' on source map. The cross section may differ slightly from source digital GIS data. Vertical exaggeration 2x.

Cross Section P-P'



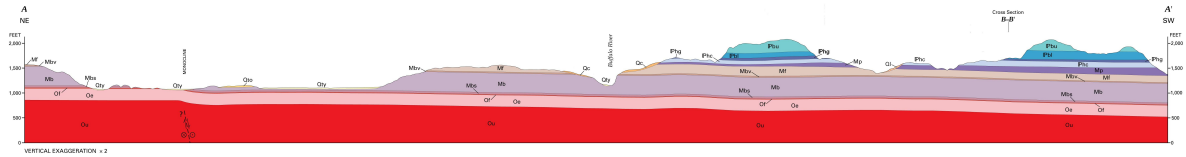
Cross section from source map: Cozahome Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section Q-Q'



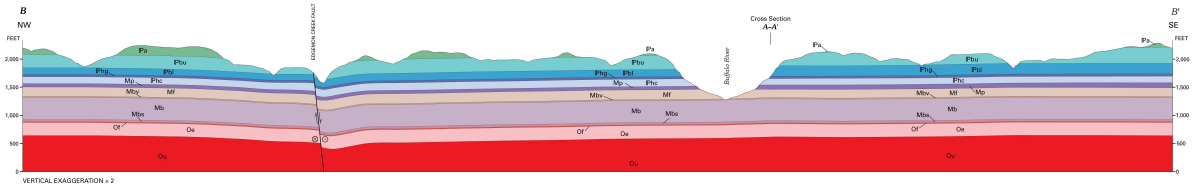
Cross section from source map: Big Flat Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section R-R'



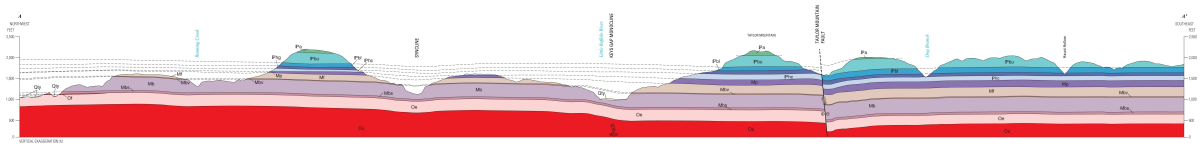
Cross section from source map: Boxley Quadrangle. Cross section A-A' on source map. Vertical exaggeration 2x.

Cross Section S-S'



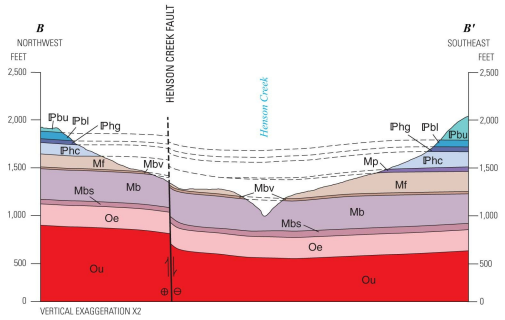
Cross section from source map: Boxley Quadrangle. Cross section B-B' on source map. Vertical exaggeration 2x.

Cross Section T-T'



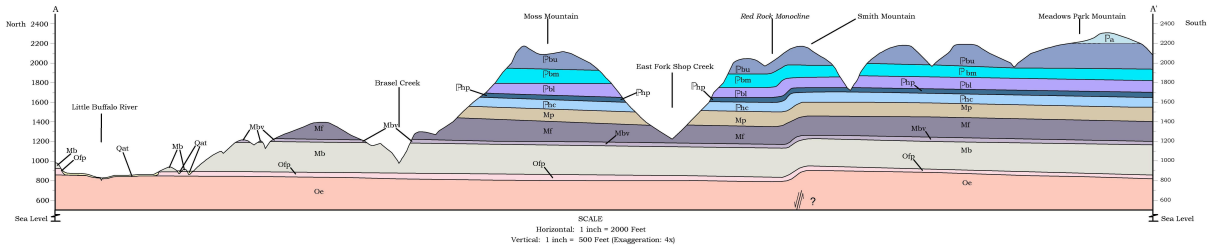
Cross section from source map: Murray Quadrangle. Cross section A-A' on source map. Vertical exaggeration 2x.

Cross Section U-U'



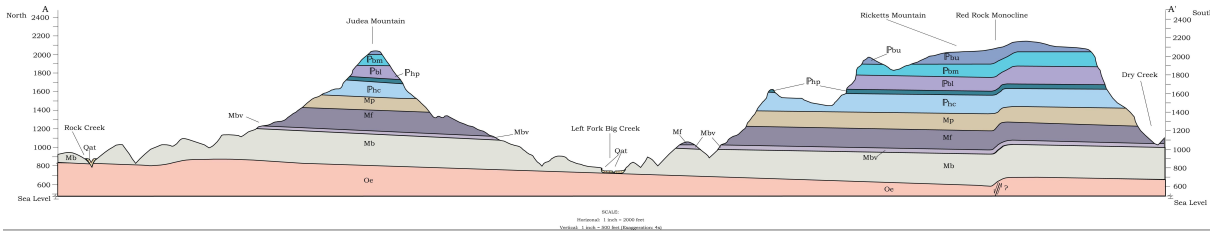
Cross section from source map: Murray Quadrangle. Cross section B-B' on source map. Vertical exaggeration 2x.

Cross Section V-V'



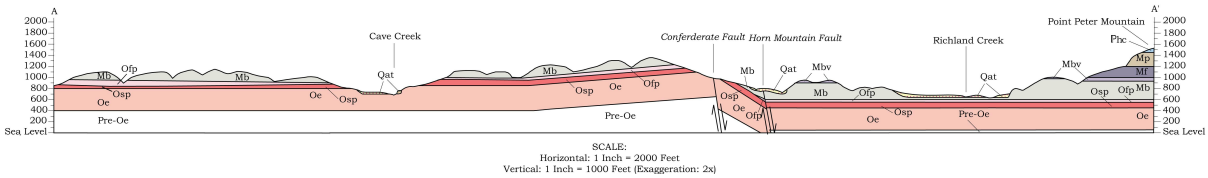
Cross section from source map: Parthenon Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section W-W'



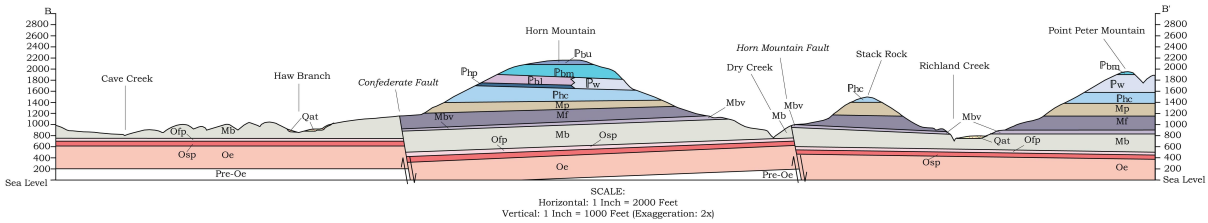
Cross section from source map: Mt. Judea Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section X-X'



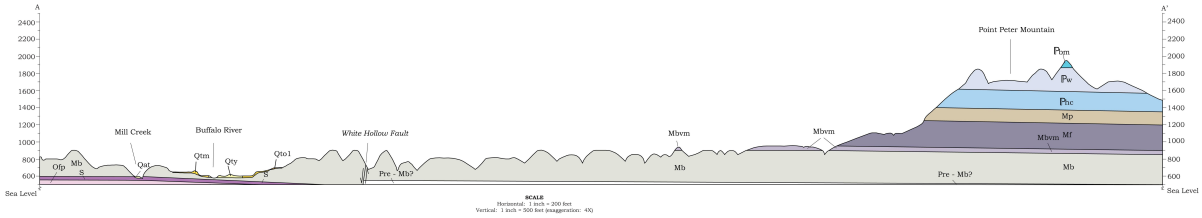
Cross section from source map: Eula Quadrangle. Cross section A-A' on source map. Vertical exaggeration 2x.

Cross Section Y-Y'



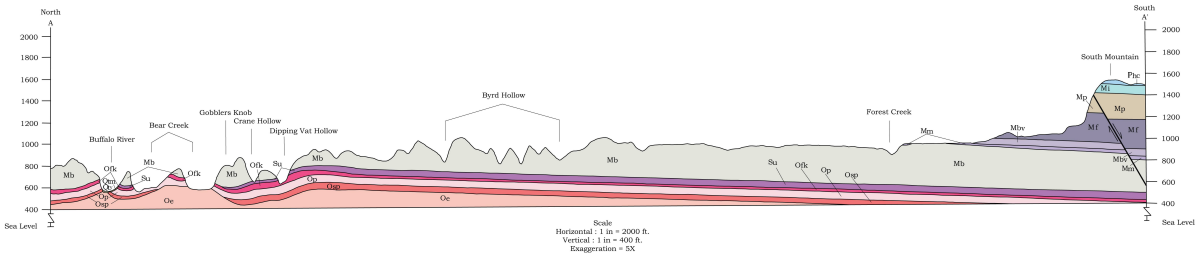
Cross section from source map: Eula Quadrangle. Cross section B-B' on source map. Vertical exaggeration 2x.

Cross Section Z-Z'



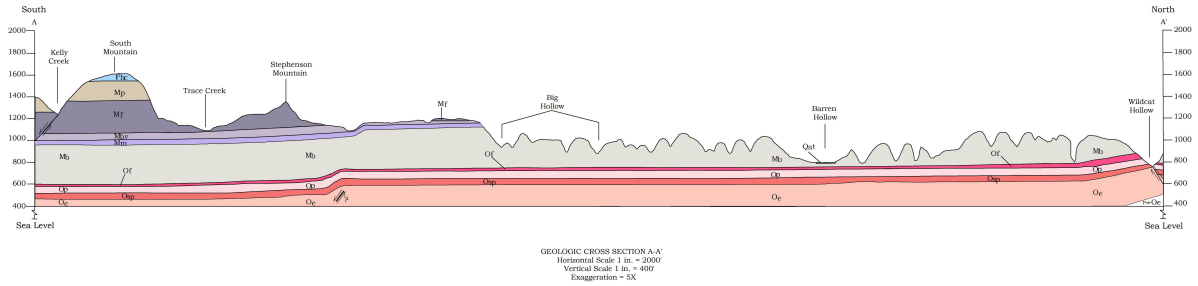
Cross section from source map: Snowball Quadrangle. Cross section A-A' on source map. Vertical exaggeration 4x.

Cross Section AA-AA'



Cross section from source map: Marshall Quadrangle. Cross section A-A' on source map. Vertical exaggeration 5x.

Cross Section BB-BB'

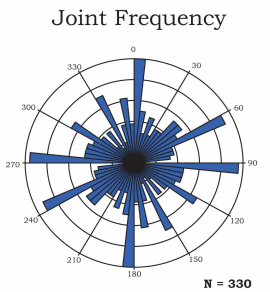


Cross section from source map: Harriet Quadrangle. Cross section A-A' on source map. Vertical exaggeration 5x.

Joint Frequency Diagrams & Structural Data

Joint frequency diagrams associated with joint measurements present in the GRI digital geologic-GIS data produced for Buffalo National River, Arkansas (BUFF) are presented below. Note that all compass quadrant bearings in the source digital-GIS data have been converted to azimuths for consistency. Figure numbers, if indicated, are from the source map.

Big Flat Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Big Flat quadrangle.

Graphic from source map: Big Flat Quadrangle.

Boxley Structural Data

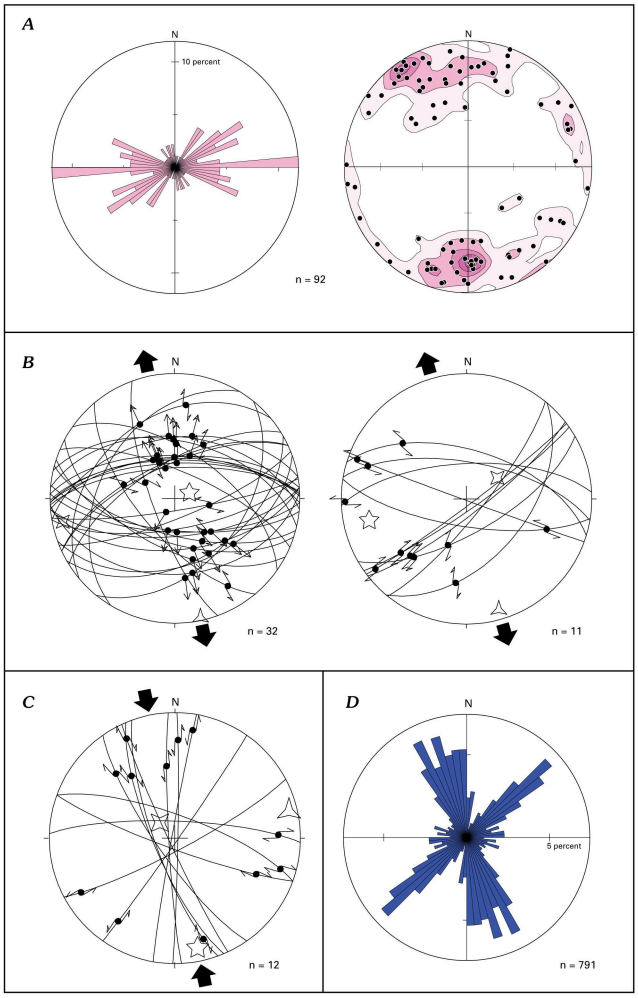
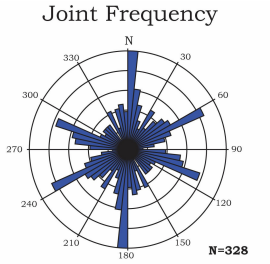


Figure 5. Structural data from the Boxley quadrangle. Number of data are "n". (A) Rose diagram of strike frequency (left) and stereoplot of poles and orientation-density contours (right) for faults in quadrangle. Contour levels are multiples of standard deviations; (B) Subset of striated faults with known slip sense that are compatible with normal (left) and strikeslip (right) paleostress regimes. Arcs and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Small arrows show movement sense of hanging-wall block. Open five-, four-, and three-pointed stars represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, from analysis of Angelier (1990). Large black arrows show azimuth of least horizontal compression; (C) Late-stage faults from site near Edgemon Creek fault that indicate north-northwest compression. Symbols are as in B; and (D) Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Boxley Quadrangle.

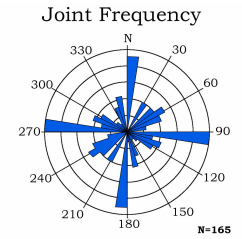
Buffalo City Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Buffalo City quadrangle.

Graphic from source map: Buffalo City Quadrangle.

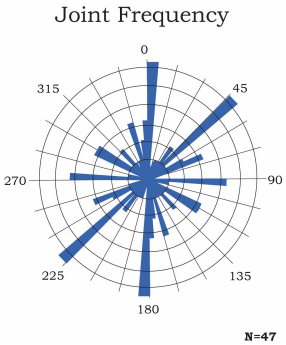
Cozahome Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Cozahome quadrangle.

Graphic from source map: Cozahome Quadrangle.

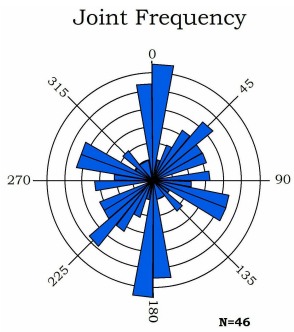
Eula Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Eula quadrangle.

Graphic from source map: Eula Quadrangle.

Harriet Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Harriet Quadrangle.

Graphic from source map: Harriet Quadrangle.

Hasty Structural Data

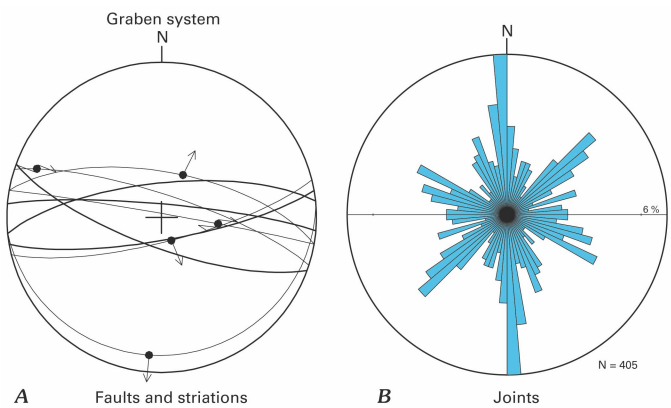


Figure 3. Structural data for the Hasty quadrangle. A, Faults associated with the east-west-trending graben system. Great circles and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Arrows show movement sense of hanging wall. Thick lines designate main fault planes of graben system and thin lines designate associated minor fault planes. B, Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Harriet Quadrangle.

Jasper Joint Frequency Diagram

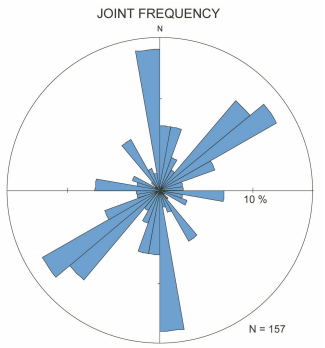
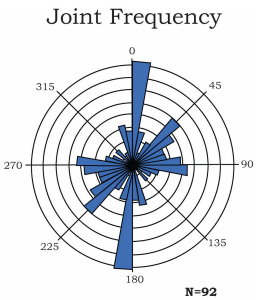


Figure 3. Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Jasper Quadrangle.

Marshall Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded in the Marshall quadrangle.

Graphic from source map: Marshall Quadrangle.

Maumee Structural Data

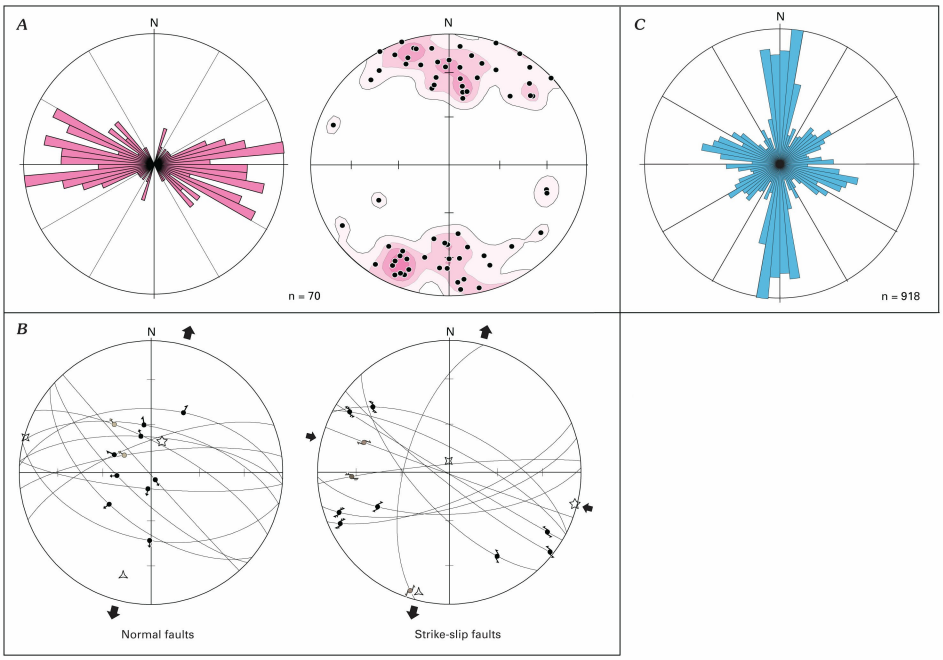
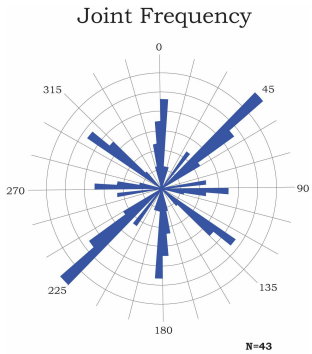


Figure 4. Structural data from the Maumee quadrangle. Number of data are "n". (A) Rose diagram of strike frequency (left) and stereoplot of poles and orientation density contours (right) for fault planes measured in outcrop within quadrangle. Contour levels are multiples of standard deviations. (B) Striated faults with slip sense that are compatible with normal (left) and strike-slip (right) paleostress regimes. Arcs and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Small arrows show movement sense of hanging-wall block. Open five-, four-, and three-pointed stars represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, from analysis of Angelier (1990). Gray slip symbols are faults excluded from calculation due to slip misfits> 45°. Large black arrows show azimuth of least horizontal compression. (C) Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Maumee Quadrangle.

Mt. Judea Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Mt. Judea quadrangle.

Graphic from source map: Mt. Judea Quadrangle.

Murray Structural Data

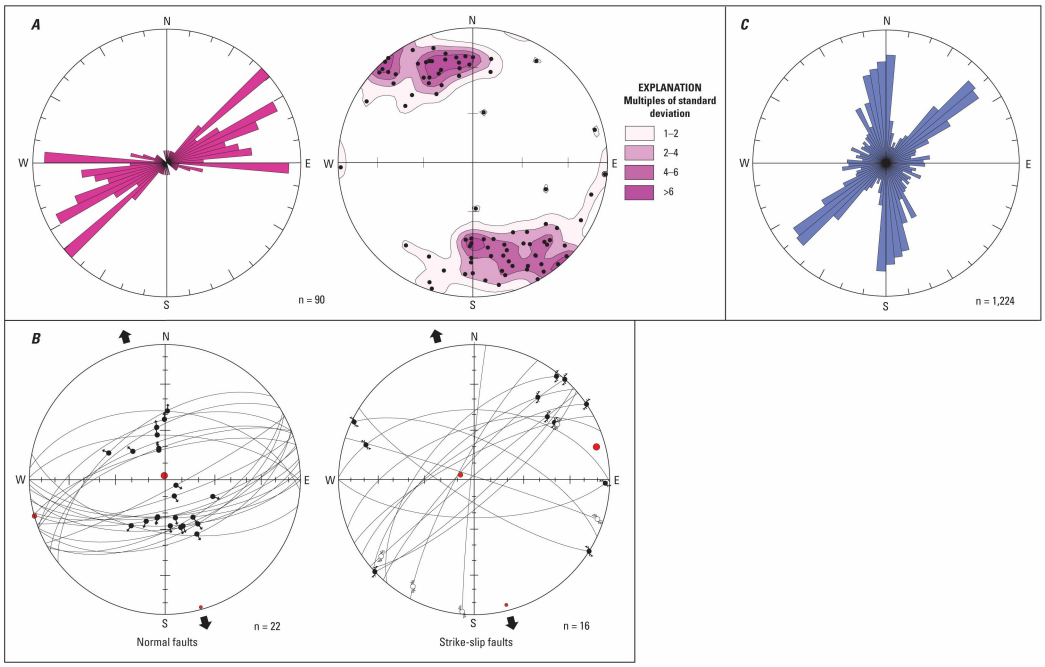
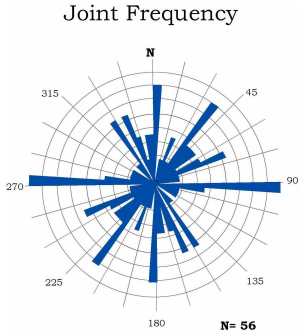


Figure 5. Structural data from the Murray quadrangle. Number of data are "n". A, Rose diagram of strike frequency (left) and stereoplot of poles and orientation density contours (right) for faults in quadrangle. Contour levels are multiples of standard deviations. B, Subset of striated faults with known slip sense that are compatible with normal (left) and strike-slip (right) paleostress regimes. Arcs are lower hemisphere projections of fault planes and solid and open dots are slip lines with components of normal and reverse slip, respectively. Small arrows show movement sense of hanging wall block. Red large, medium, and small filled circles represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, from analysis of Angelier (1990). Large black arrows show azimuth of least horizontal compression. C, Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Mt. Judea Quadrangle.

Parthenon Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded in the Parthenon Quadrangle.

Graphic from source map: Parthenon Quadrangle.

Ponca Structural Data

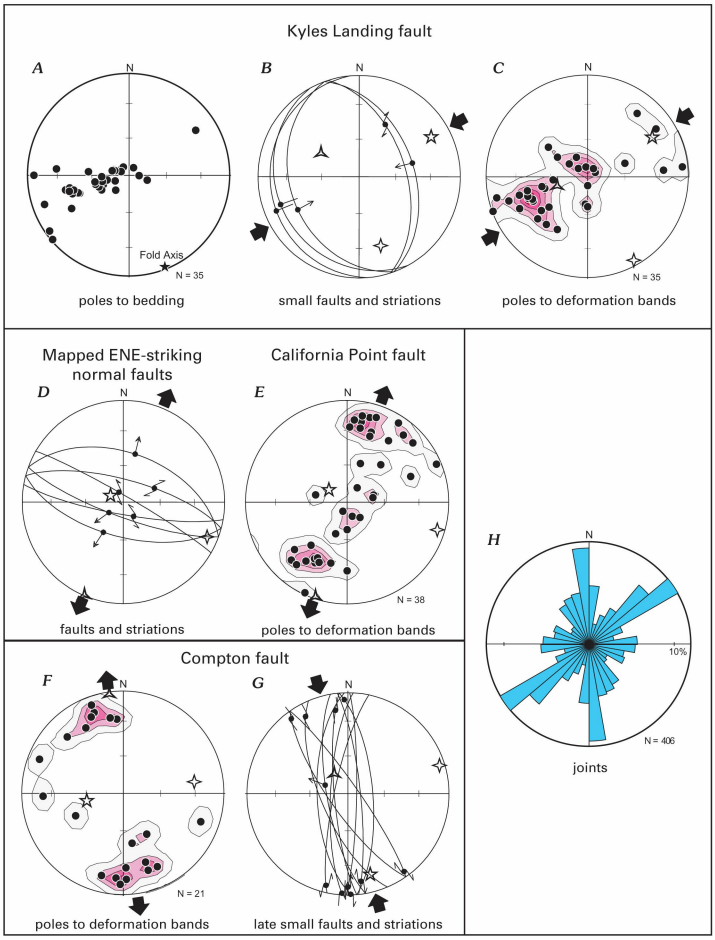
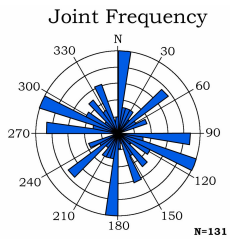


Figure 3. Structural data for the map area. (A) Equal-area projection of poles to bedding adjacent to the Kyles Landing fault, with model fold axis. (B) Striated faults within the hanging wall of the Kyles Landing fault. Great circles and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Small arrows show movement sense, with greater head ornamentation indicating higher confidence on slip determination. Open five-, four-, and three-pointed stars represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, estimated from analysis of Angelier (1990). Large black arrows show azimuth of maximum horizontal compression. (C) Poles and orientation density contours for deformation bands in hanging wall of Kyles Landing fault. Contour levels are multiples of standard deviations. Two density highs define conjugate sets from which orientation of principal stress axes were constructed by bisecting obtuse and acute angles to find maximum and least principal paleostress axes. (D) Striated map-scale faults from en echelon zone trending west-northwest across map area. Large black arrows show azimuth of least horizontal compression. Other conventions as in B. (£) Poles and orientation density contours for deformation bands at a site in footwall of California Point fault. Large black arrows show azimuth of least horizontal compression. Other conventions as in C. (F) Poles and orientation density contours

for deformation bands at a site in hanging wall of the Compton fault. Large black arrows show azimuth of least horizontal compression. Other conventions as in C. (G) Striated small-scale secondary faults from site in hanging wall of the Compton fault. Large black arrows show azimuth of maximum horizontal compression. Other conventions as in B. (H) Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: Ponca Quadrangle.

Rea Vallley Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Rea Valley quadrangle.

Graphic from source map: Rea Valley Quadrangle.

St. Joe Structural Data

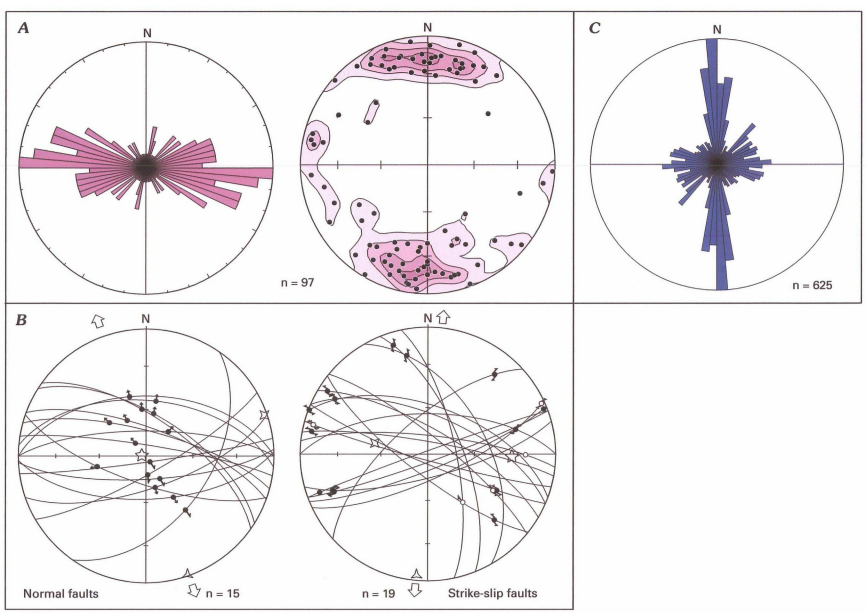
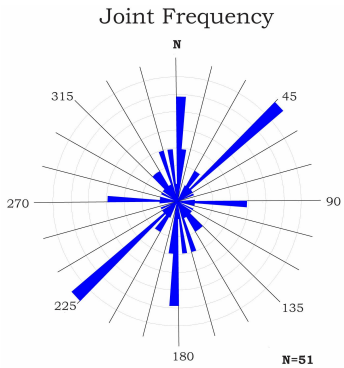


Figure 4. Structural data from the St. Joe quadrangle. Number of data are "n". (A) Rose diagram of strike frequency Oeft) and stereoplot of poles and orientation density contours (right) for faults in quadrangle. Contour levels are multiples of standard deviations. (B) Subset of striated faults with known slip sense that are compatible with normal Oeft) and strike-slip (right) paleostress regimes. Arcs and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Small arrows show movement sense of hanging wall block. Open five-, four-, and three-pointed stars represent orientation of maximum, intermediate, and least principal paleostress axes, respectively,

from analysis of Angelier (1990). Large white arrows show azimuth of least horizontal compression. (C) Rose diagram of strike frequency of joints recorded within the map area.

Graphic from source map: St. Joe Quadrangle.

Snowball Joint Frequency Diagram



Rose diagram of strike frequency of joints recorded within the Snowball quadrangle.

Graphic from source map: Snowball Quadrangle.

Western Grove Joint Frequency Diagram

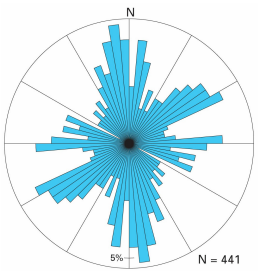


Figure 3. Rose diagram showing strike frequency of joints measured in map area.

Graphic from source map: Western Grove Quadrangle.

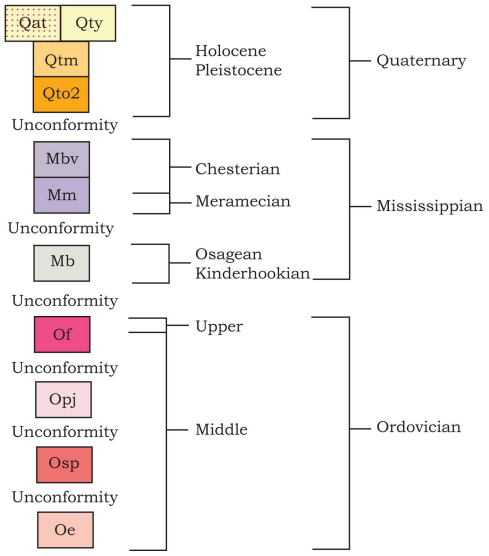
Ancillary Source Map Information

Ancillary source map information present on source maps used for the the digital geologic-GIS data for Buffalo National River is presented below. Geologic cross section graphics, as well as joint frequency and structural data figures and related information is presented in the Geologic Cross Sections and Joint Frequency Diagrams & Structural Data section of this document, and is not repeated in this section.

Big Flat Quadrangle (DGM-AR-00075)

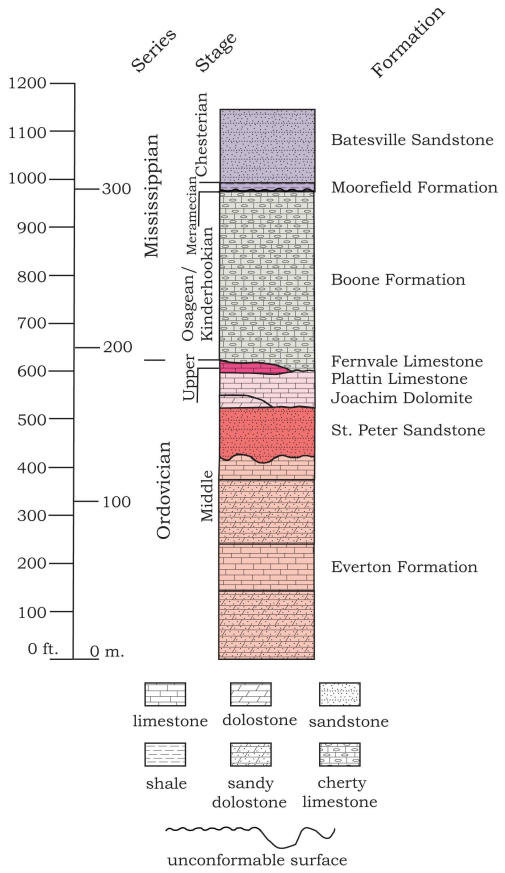
Chandler, A.K., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2011, Geologic Map of the Big Flat Quadrangle, Baxter, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00075, scale 1:24,000. (*GRI Source Map ID 74688*).

Correlation of Map Units



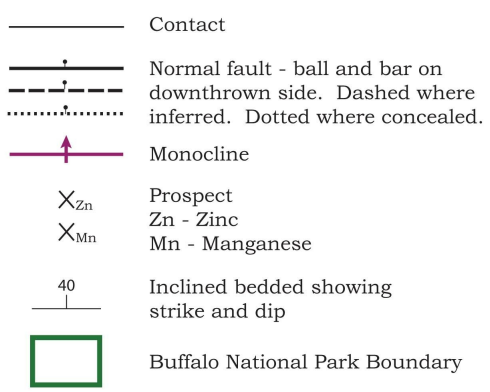
Graphic from source map: Big Flat Quadrangle.

Stratigraphic Column



Graphic from source map: Big Flat Quadrangle.

Symbols

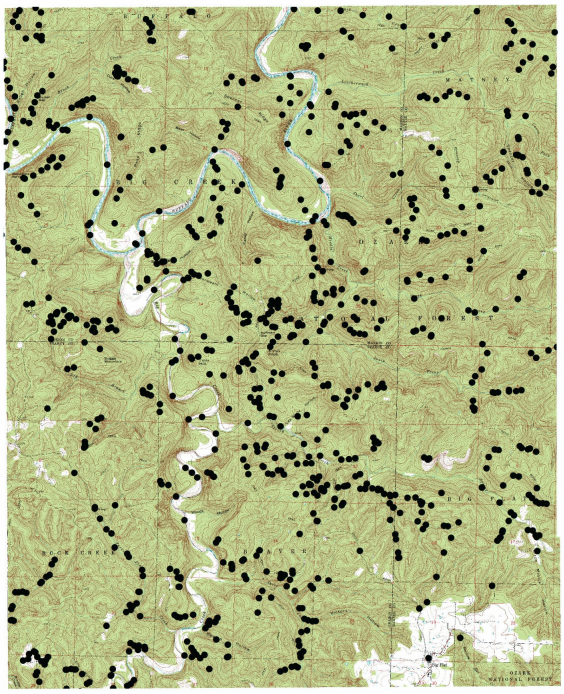


Graphic from source map: Big Flat Quadrangle.

Quadrangle Location Map

Graphic from source map: Big Flat Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Big Flat quadrangle showing location of data collection points.

Graphic from source map: Big Flat Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Big Flat 7.5 minute quadrangle. This quadrangle was previously mapped by Ernest E. Glick in 1976 for the Geologic Map of Arkansas.

Approximately 1100 feet (335 meters) of Middle Ordovician to Lower Mississippian age strata are present in this area. Middle Ordovician strata crop out in the drainages and on steep hillsides. The Upper Ordovician Fernvale Limestone is present only in the southwestern portion of the quadrangle. The Lower Mississippian Boone Formation forms ridges on the heavily dissected Springfield Plateau

surface. The Mississippian Batesville Sandstone forms a plateau surface surrounding the community of Big Flat.

Quaternary terrace and alluvium deposits are present in the valleys of the Buffalo River and its tributaries. Two terrace levels are well developed along the river: a younger and a medial. Very old terraces are located over 200 feet (61 meters) above the Buffalo River near the confluence of Leatherwood Creek.

Normal faults are present along the Spring Creek Fault system and the Fish Trap Fault system. The Spring Creek Fault is downthrown to the south with an offset of approximately 100 feet (30 meters) at the western end, 160 feet (49 meters) near Spring Creek and 60 feet (18 meters) at the eastern end where it terminates in a monocline. The Fish Trap Fault averages 200 feet (61meters) of offset and is downthrown to the north.

About 16 miles of the Buffalo National River are located in this quadrangle and are managed by the National Park Service. Approximately 25 square miles of National Forest are present in the eastern half of the quadrangle and are managed by the National Forest Service.

This area was heavily prospected in the late 1800's and early 1900's for zinc. Zinc mines and prospect pits are present throughout the quadrangle, however they are not shown in the National Park since they are considered sensitive park resources.

Text from source map: Big Flat Quadrangle.

Acknowledments

This map was produced for the National Park Service through the Geologic Resource Inventory Program through contract C2360086145. Special thanks to the National Park Service, U.S. Forest Service, Chris Majors with the Arkansas Game and Fish Commission and to private landowners who graciously allowed access to their property. The Buffalo National River Park boundary came from the National Park Service, Harrison, Arkansas.

Text from source map: Big Flat Quadrangle.

Disclaimer & Contact Information

This map was prepared in a digital format using ArcGis 10, ArcMap software on computers at the Arkansas Geological Survey. The Arkansas Geological Survey does not guarantee the accuracy of this map when used on any other system or with any other software. As mapping continues and is refined, the data presented on this map may be updated. For the latest edition of this publication please contact our office.

For information on obtaining copies of this map and other Arkansas Geological Survey maps and publications call: 501-296-1877. This map is available on our website at: www.geology.ar.gov/geologicmaps/dgm_24k.htm

Text from source map: Big Flat Quadrangle.

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E.E. Glick, 1976, Preliminary geologic map of the Big Flat quadrangle, Baxter, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey Geologic Worksheet, 1:24,000.

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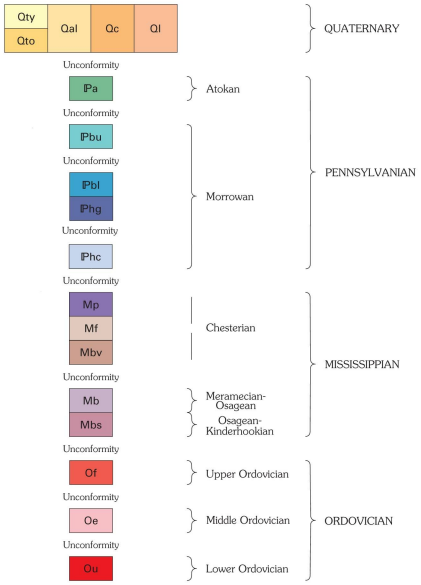
Turner, K.J. and Hudson, M.R., 2010, Geologic map of the Maumee quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey Scientific Investigations Map 3134, 1:24,000.

Text from source map: Big Flat Quadrangle.

Boxley Quadrangle (SIM-2291)

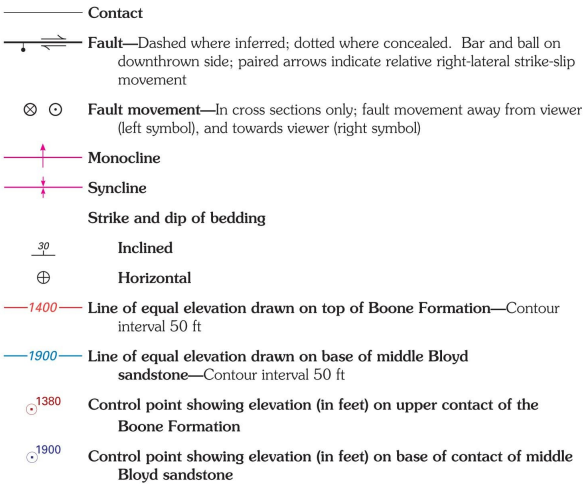
Hudson, M.R., and Turner, K.J., 2007, Geologic Map of the Boxley Quadrangle, Newton and Madison Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2991, scale 1:24,000 (*GRI Source Map ID 74842*).

Correlation of Map Units



Graphic from source map: Boxley Quadrangle.

Symbols



Graphic from source map: Boxley Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Quadrangle Location Map

Graphic from source map: Boxley Quadrangle.

Figure 1: Location of Study area

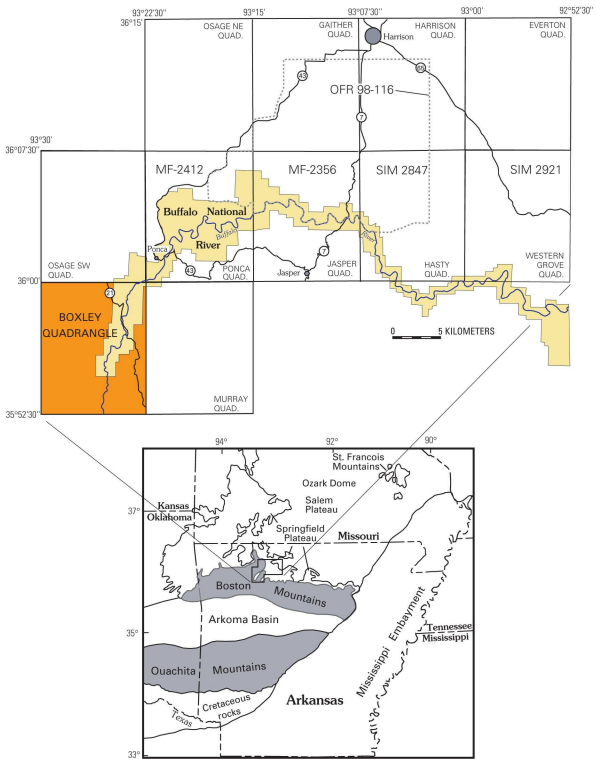


Figure 1. Location of study area within northern Arkansas, adjacent to the western part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998; Hudson and others, 2001, 2006; Hudson and Murray, 2003, 2004) are listed by publication number. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: Boxley Quadrangle.

Figure 2: Stratigraphic Column

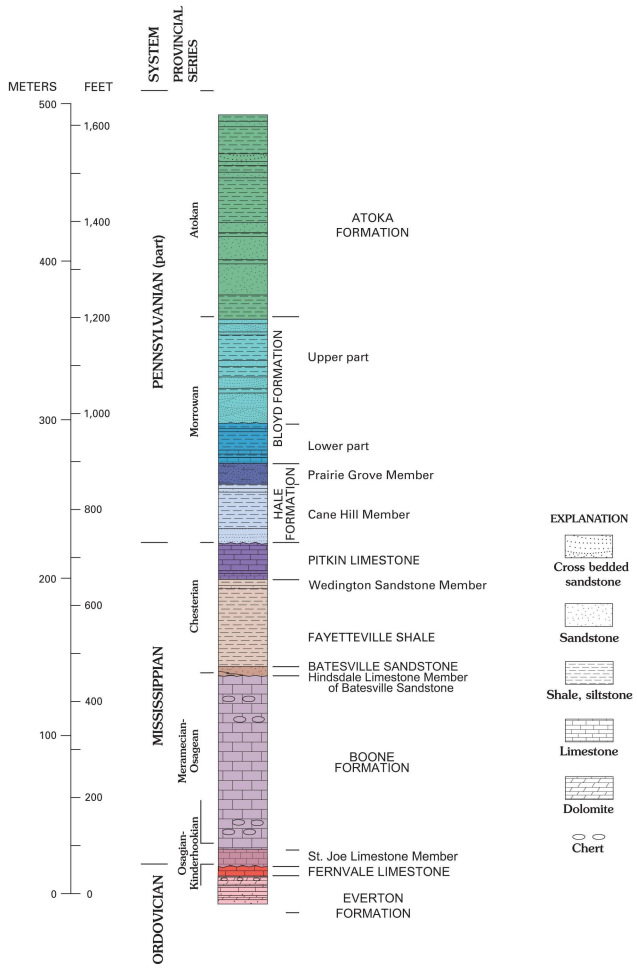


Figure 2. Stratigraphic column of Paleozoic rocks in the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

Graphic from source map: Boxley Quadrangle.

Figure 3: Photographs

Figure 3. Photographs of (A) typical outcrop of thin-bedded sandstone from the lower sandstone interval of the Atoka Formation, and (B) large radiating burrows, fucoids, on base of a bedding-plane block from sandstone of the upper part of Bloyd Formation. Hammer is about 1 ft long. Photographs by M.R. Hudson, 2005.

Graphic from source map: Boxley Quadrangle.

Figure 4: Structural Map

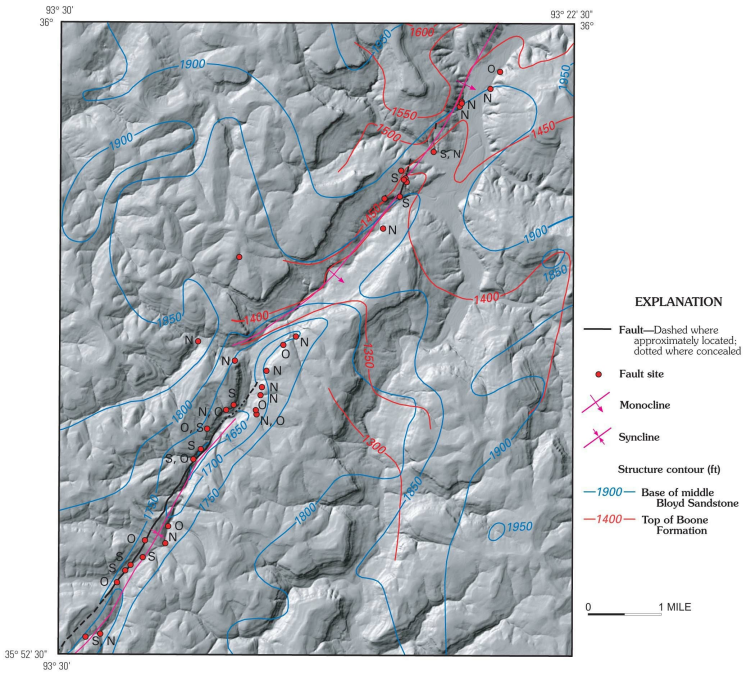


Figure 4. Shaded-relief digital elevation map of quadrangle with locations of structural features and sites where faults were observed. Slip senses for faults at sites are indicated as normal, N (rake 90° to 60°); oblique, 0 (rake 59° to 30°); and strike-slip, S (rake 29° to 0°).

Graphic from source map: Boxley Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Boxley 7.5-minute quadrangle (fig. 1) in the Ozark Plateau region of northern Arkansas. Geologically, the area is on the southern flank of the Ozark dome, an uplift that has the oldest rocks exposed at its center, in Missouri. Physiographically, the Boxley quadrangle is within the Boston Mountains, a high plateau region underlain by Pennsylvanian sandstones and shales (Purdue and Miser, 1916). Valleys of the Buffalo River and its tributaries expose an approximately 1,600-ft-thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds. The Buffalo National River, a park which encompasses the Buffalo River and adjacent land that is administered by the National Park Service, extends through the eastern part of the quadrangle.

Mapping for this study was conducted by field inspection of numerous sites and was compiled as a 1:24,000-scale geographic information system (GIS) database. Locations and elevations of sites were determined with the aid of a global positioning satellite receiver and a hand-held barometric altimeter that was frequently recalibrated at points of known elevation. Hill-shade-relief and slope maps derived from a U.S. Geological Survey 10-m digital elevation model as well as U.S. Geological Survey orthophotographs from 2000 were used to help trace ledge-forming units between field traverses within the Upper Mississippian and Pennsylvanian part of the stratigraphic sequence. Strike and dip of beds were typically measured along stream drainages or at well-exposed ledges. Beds dipping less than 2° are shown as horizontal. Structure contours, constructed on the top of the Boone Formation

and the base of a prominent sandstone unit within the Bloyd Fomation, were hand drawn based on the elevations of control points as well as other limiting information for their maximum or minimum elevations.

Text from source map: Boxley Quadrangle.

Stratigraphy

The study area preserves an approximately 1,600-ft-thick record of early and late Paleozoic deposition on what is now the southern margin of the North American continent. Provincial series for Pennsylvanian and Mississippian units are from McFarland (1988).

The Middle Ordovician Everton Formation is a heterogeneous sandstone and carbonate unit that Suhm (1974) interpreted to have been deposited in barrier island and tidal flat depositional environments. The Everton Formation is unconformably overlain by the Upper Ordovician Fernvale Limestone.

The Mississippian Boone Formation is widespread within the northern part of the quadrangle. The phosphate-nodule-bearing sandstone at the base of the St. Joe Limestone Member (Mbs) is persistent throughout much of northern Arkansas (McKnight, 1935) and was probably deposited in Early Mississippian time as a transgressive lag during sea-level rise (Homer and Craig, 1984). The contact of the main body of the Boone Formation with the St. Joe Limestone Member is gradational and is based on the change to thin bedding and the generally chert-free lithology of the St. Joe Limestone Member. Near the top of the formation an oolite interval as thick as 3 ft is present. The local presence of the Hindsville Limestone Member of the Batesville Sandstone (Mbv), containing angular chert fragments that were probably derived from the underlying Boone Formation, demonstrates a depositional hiatus between the Boone Formation and Batesville Sandstone. Batesville Sandstone thins and the proportion of limestone increases to the south in the quadrangle, suggesting a decreasing sand supply in a marine setting.

The onset of Morrowan deposition reflects sea-level rise following a terminal Mississippian sea-level drop (Sutherland, 1988; Manger and Sutherland, 1992) and as a consequence the base of the Morrowan Cane Hill Member (Phc) of the Hale Formation represents a significant unconformity within the map area. The thinning of the Pitkin Limestone (M p) beneath the unconformity in the northern part of the quadrangle likely is related to Late Mississippian-Early Pennsylvanian erosion, a conclusion supported by the common presence of probable Pitkin Limestone clasts within basal conglomerate lenses of the Cane Hill Member of the Hale Formation. The basal sandstone channels of the Cane Hill Member (Phc) change laterally and upward into thin-bedded, rippled, fine- to very fine grained sandstones and siltstones that were probably deposited in tidal flat environments (Manger and Sutherland, 1992). The study area is within the distribution of thick sand-rich facies of the Prairie Grove Member (PNhg) of the Hale Formation (Sutherland, 1988). Limestone of the Brentwood Limestone Member of the Bloyd Formation is conformable with the Prairie Grove Member such that the contact is commonly gradational. The presence of limestone conglomerates with clasts of sandstone and siltstone as well as fossil fragments indicates a high-energy marine environment during deposition of part of the lower Bloyd Formation. Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation was originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka Formation (Pa) (Henbest, 1953) representing the prominent cliff-forming crossbedded sandstone. Zachry (1977), however, concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it with the informal term "middle Bloyd sandstone" that was deposited in a braided river environment. Within the quadrangle, the presence of a south-trending margin to the main river belt is suggested by the lateral change (for example, in Panther Camp Hollow, sec. 19, T. 15 N., R. 23 W.) from prominent cliff exposures of thick cross-bedded sandstone intervals in the central area to a much thinner sandstone interval with shale interbeds in the northwest part of the area. The middle Bloyd sandstone interval comprises the basal interval of the upper part of

the Bloyd Formation map unit as used here. Moving upsection from the middle Bloyd sandstone interval, siltstone and shale intervals are mixed with fine to coarse sandstones, some containing quartz pebbles similar to the middle Bloyd interval and some extensively bioturbated, indicating a marine transgression above the river deposits.

The Atoka Formation (Pa) is a marine sequence of alternating sandstone and shale that in the southern Ozarks region has generally been interpreted to represent fluvio-deltaic depositional environments (Zachry and Sutherland, 1984). The basal contact is well defined 60 km to the west in Washington County where the Kessler Limestone Member at the top of the Bloyd Formation is unconformably overlain by shale of the Trace Creek Member of the Atoka Formation (Zachry and Sutherland, 1984). In this area, sandstone intervals of the Atoka Formation are principally fine to very fine grained and laterally extensive. The contact between Bloyd and Atoka Formations in the Buffalo River area has been more difficult to define due to the lack of the distinctive limestone lithology of the Kessler Member.

Within the Ponca quadrangle, Hudson and Murray (2003) placed the contact above the level of a thin coal bed approximately 250 ft above the base of the middle Bloyd sandstone. In the Boxley quadrangle, the Bloyd-Atoka contact is placed at a similar level within a shale interval beneath an approximately 100-ft-thick interval of sandstone that underlies a prominent topographic ledge. This sandstone sequence is typical of Atoka facies in being fine to very fine grained, thin to medium bedded with ripple laminations (fig. 3A) and being laterally extensive across the quadrangle. An alternative contact that was considered, about 50 ft lower, would shift the sandstone interval including fucoid trace fossils (fig. 3B) from the upper Bloyd to the Atoka Formation (Pa). This option was not favored because this sandstone interval is more laterally variable in character and includes crossbedded, medium to coarse-grained sandstones with quartz pebbles that are more like the fades in the underlying middle Bloyd sandstone.

Text from source map: Boxley Quadrangle.

Structural Geology

The dominant structural feature of the Boxley quadrangle is a N. 35° E.-trending fault and fold zone that extends across the center of the quadrangle, aligning with parts of the Buffalo River valley in the north and Beech and Edgemon Creeks in the south. Structure contours on the top of the Boone Formation and the base of the middle Bloyd sandstone are more closely spaced and swing into northeast trends along this zone. The 4.5-mi-long, northeast-striking Edgemon Creek fault is in the southwestern part of the zone and has down-to-the-southeast throw of as much as 60 ft; a component of dextral strike-slip offset is also indicated by kinematic data discussed below. Rocks on both sides of the Edgemon Creek fault dip gently toward a syncline axis just southeast of the fault, marking the low point of an approximately 1-mi-wide structural zone having an overall structural relief of as much as 200 ft. The Edgemon Creek fault dies out to the northeast but down-to-southeast throw continues across a northeast-trending monocline that is broken by several shorter faults. This structural zone aligns, and is likely continuous, with a zone of faulted northeast trending monoclines farther to the northeast within the Ponca quadrangle (Hudson and Murray, 2003) that together comprise the southwestern part of the Ponca lineament of McFarland (1988).

Structural data gathered from 92 faults observed within the quadrangle, most too small to show on the map, give insight into the aerial extent of fault deformation as well as the causative stresses. Sites where faults were observed are almost all restricted to the northeast-trending structural zone and include areas where map-scale faults are absent (fig. 4). These faults have a variety of attitudes and have slip senses that vary from normal to strike slip (fig. 4, 5A). The most common faults are east-striking normal faults that dip moderately north or south. Northeast-striking faults that dip steeply to moderately southeast are also common; these faults mostly have dextral-normal oblique-slip sense. Paleo-stress inversions for 55 faults with known slip direction and sense, using the method of Angelier (1990), suggest that most faults formed in transtension with a least principal stress axis oriented

south-southeast and shallow but with intermediate and maximum principal stress axes flipping between near-vertical and east-northeast and shallow (fig. 5B). The spatial restriction of the mixed fault sets to the northeast-trending zone suggests that deformation probably reflects dextral-normal reactivation of an underlying preexisting fault zone within Precambrian basement. The north-south extension accommodated by the zone is compatible with a widespread deformation phase documented elsewhere in the southern Ozark Dome that has been attributed to late Paleozoic flexure of the southern continental margin during progressive loading of the Ouachita orogenic belt (Hudson, 2000). A small set of the observed faults is incompatible with north-south extension and probably related to a later deformation phase (fig. 5C). For example, at a site (lat 35°55.463' N., long 93° 27.453' W.) in the middle Bloyd sandstone adjacent to the Edgemon Creek fault, older east-striking faults are offset by steeply dipping northwest- and north-striking faults with dextral and sinistral senses, respectively. These relations suggest that the structural zone was locally reactivated under a strike-slip regime with north-northwest directed compression, a deformation phase probably related to final closure of the Ouachita orogenic belt to the south (Hudson, 2000; Hudson and Cox, 2003).

Joints measured within the map area (791 total) are near vertical and distributed in several sets (fig. 5D). The dominant sets strike northeast, north-northwest, and northwest. A less prominent joint set strikes east-west. Abutting relationships between joints observed at several field sites indicate that the east-west set is oldest, the northeast set is intermediate in age, and the north-northwest and northwest sets are younger. Joint planes within carbonate formations, such as the Boone Formation, are commonly enlarged due to dissolution.

Text from source map: Boxley Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. We thank D.L. Zachary for discussions about the Pennsylvanian stratigraphy. Helpful reviews were provided by Angela Chandler and Paul Carrara.

Text from source map: Boxley Quadrangle.

Disclaimer & Contact Information

Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This map was produced on request, directly form digital files, on an electronic plotter. For sale by U.S. Geological Survey Information Services Box 25286, Federal Center, Denver, CO 80225 1-88-ASK-USGS. ArcInfo coverages and a PDF for this map are available at http://pubs.usgs.gov

Text from source map: Boxley Quadrangle.

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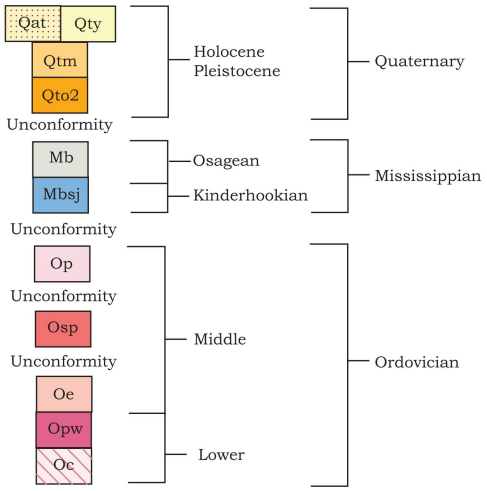
Oklahoma Geological Survey Bulletin 136, p. 9-17.

Text from source map: Boxley Quadrangle.

Buffalo City Quadrangle (DGM-AR-00111)

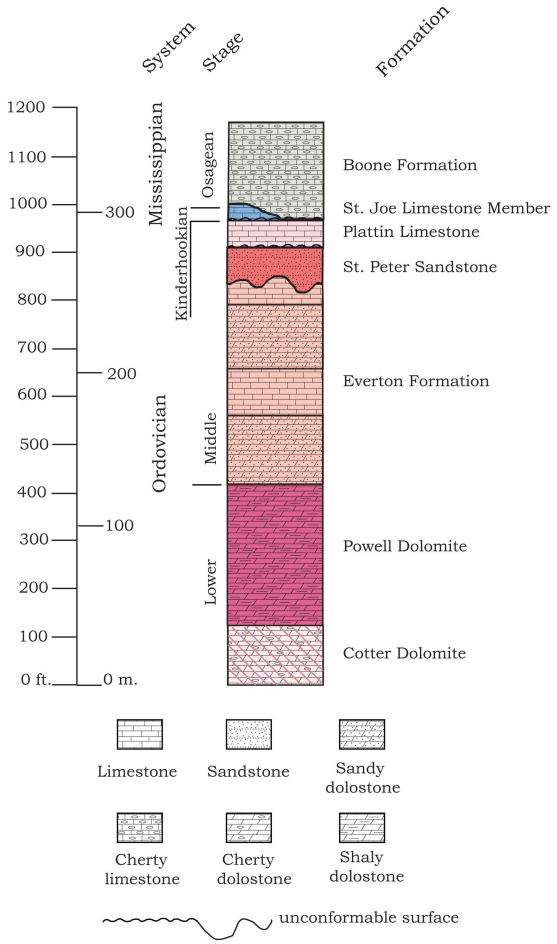
Chandler, A.K., Nondorf, L.M., Johnson, T.C., and Traywick, C.L., 2011, Geologic Map of the Buffalo City Quadrangle, Baxter and Marion Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00111, scale 1:24,000 (*GRI Source Map ID 74674*).

Correlation of Map Units



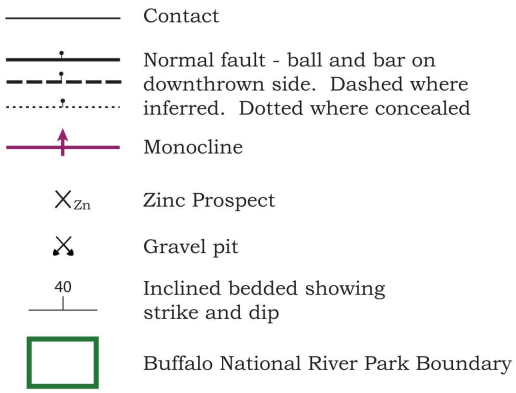
Graphic from source map: Buffalo City Quadrangle.

Stratigraphic Column



Graphic from source map: Buffalo City Quadrangle.

Symbols

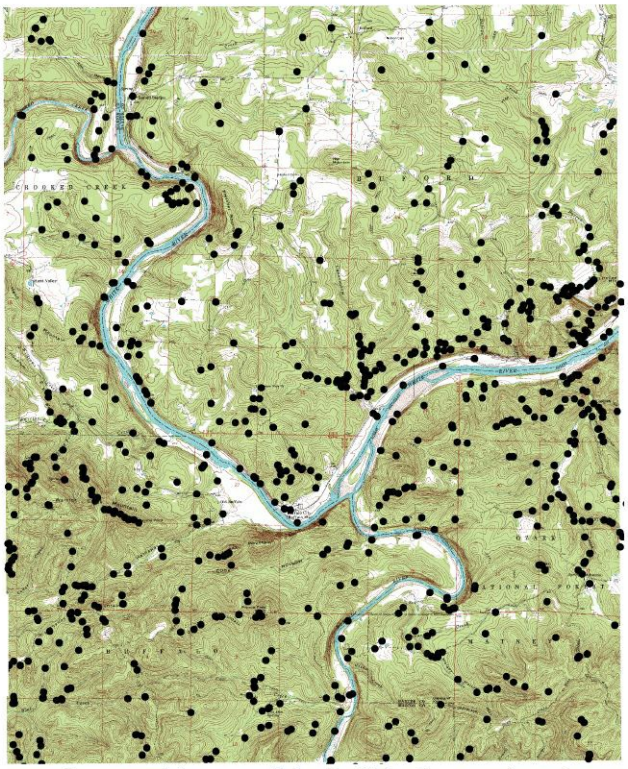


Graphic from source map: Buffalo City Quadrangle.

Quadrangle Location Map

Graphic from source map: Buffalo City Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Buffalo City quadrangle showing location of data collection points.

Graphic from source map: Buffalo City Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Buffalo City 7.5 minute quadrangle. This quadrangle was previously mapped by Ernest E. Glick in 1976 for the Geologic Map of Arkansas

Approximately 1170 feet (356 meters) of Lower Ordovician to Lower Mississippian age strata are present in this area. The Lower-Middle Ordovician formations comprise the surface rock over the

majority of the quadrangle and form the surface of the gently undulating Salem Plateau. Lower Mississippian Boone Formation forms ridges on the dissected Springfield Plateau.

Quaternary terrace and alluvium deposits are present in the valleys of the White and Buffalo Rivers and their tributaries. Two terrace levels are well displayed along the Buffalo River - a younger and medial. Very old terraces are located over 200 feet (61 meters) above the White and Buffalo Rivers.

Normal faults occur along the Barren Creek Fault and the Buffalo City, Perry Creek and Hathaway Mountain Fault Systems. The Barren Creek and Buffalo City Faults are downthrown to the south. The Barren Creek Fault has a displacement of approximately 40-80 feet (12-24 meters). The Buffalo City Fault has a displacement of approximately 300 feet (91 meters). The Perry Creek and Hathaway Mt. Faults are downthrown to the north and have displacements of 280 feet (85 meters) and 180 feet (54 meters) respectively.

Approximately 6 miles (9 kilometers) of the Buffalo National River are located on this quadrangle and are managed by the National Park Service. Almost 14 miles (22 kilometers) of the White River meanders across the quadrangle. An area of 9 square miles (23 square kilometers) of National Forest is located in the southeastern part of the quadrangle and is managed by the National Forest Service.

This area was heavily prospected for zinc in the late 1800's and early 1900's. Zinc mines and prospect pits are present throughout the quadrangle, however locations are not shown within the National Park since they are considered sensitive park resources.

Text from source map: Buffalo City Quadrangle.

Acknowledgments

This map was produced for the National Park Service through the Geologic Resource Inventory Program through contract C2360086145. Special thanks to the National Park Service, U.S. Forest Service, and to private landowners who graciously allowed access to their property. The Buffalo National River Park boundary came from the National Park Service, Harrison, Arkansas.

Text from source map: Buffalo City Quadrangle.

Disclaimer & Contact Information

This map was prepared in a digital format using ArcGis 10, ArcMap software on computers at the Arkansas Geological Survey. The Arkansas Geological Survey does not guarantee the accuracy of this map when used on any other system or with any other software. As mapping continues and is refined, the data presented on this map may be updated. For the latest edition of this publication please contact our office.

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Text from source map: Buffalo City Quadrangle.

References

Cullison, J.S., 1944, The stratigraphy of some Lower Ordovician formations of the Ozark Uplift: University of Missouri School of Mines and Metallurgy Bulletin Technical Series no. 2, vol. XV, 112

p.

Glick, E.E.,1976, Reconnaissance geologic map of the Buffalo City quadrangle: Arkansas Geological Survey Geologic Worksheet, 1:24,000.

McKnight, E.T.,1935, Zinc and lead deposits of northern Arkansas: U.S. Geological Survey Bulletin 853, 311 p.

Purdue, A.H. and Miser, H.D., 1916, Eureka Springs- Harrison Folio: U.S. Geological Survey Geological Atlas of the United States, no. 202.

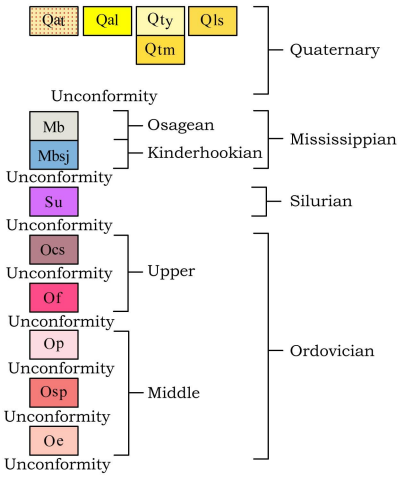
Turner, K.J, and Hudson, M.R., 2010, Geologic map of the Maumee quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey Scientific Investigations Map 3134, 1:24,000.

Text from source map: Buffalo City Quadrangle.

Cozahome Quadrangle (DGM-AR-00187)

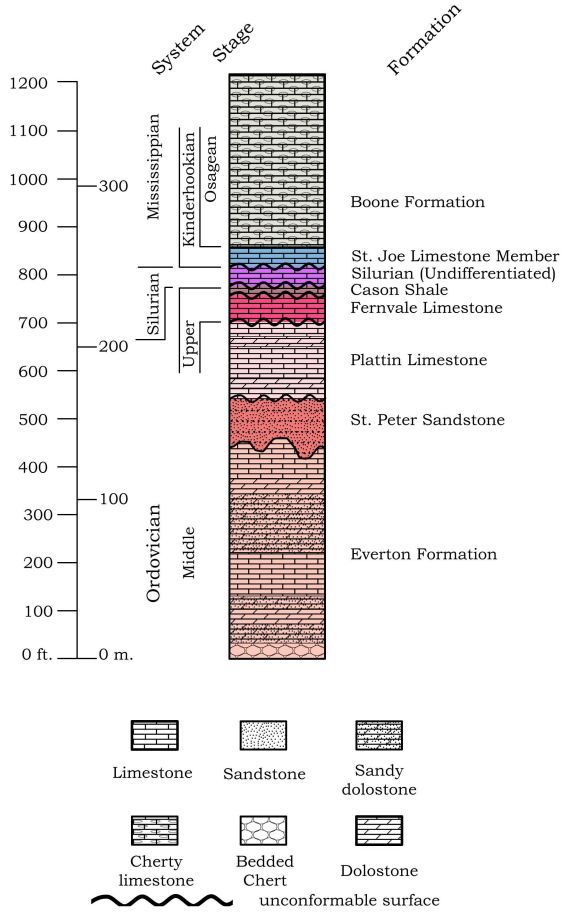
Ausbrooks, S.A., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2012, Geologic Map of the Cozahome Quadrangle, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00187, scale 1:24,000 (*GRI Source Map ID 74675*).

Correlation of Map Units



Graphic from source map: Cozahome Quadrangle.

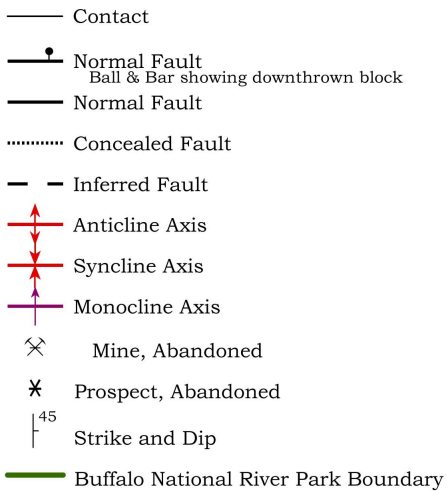
Stratigraphic Column



Paleozoic Rocks within the quadrangle. (Maximum thickness of each unit shown)

Graphic from source map: Cozahome Quadrangle.

Symbols

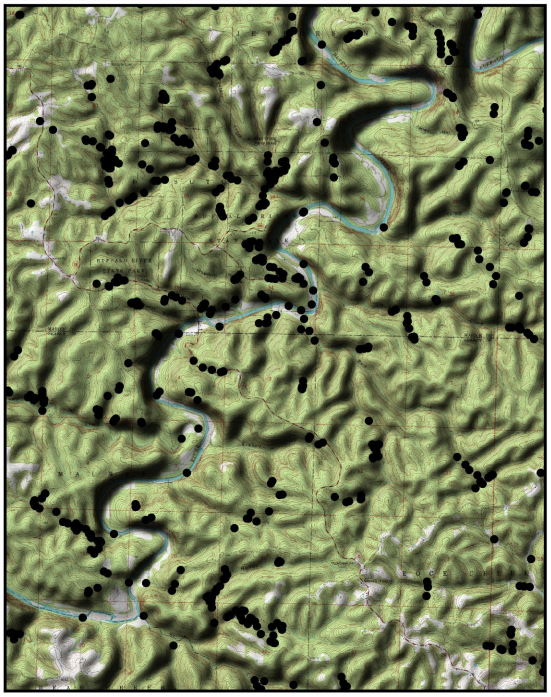


Graphic from source map: Cozahome Quadrangle.

Quadrangle Location Map

Graphic from source map: Cozahome Quadrangle.

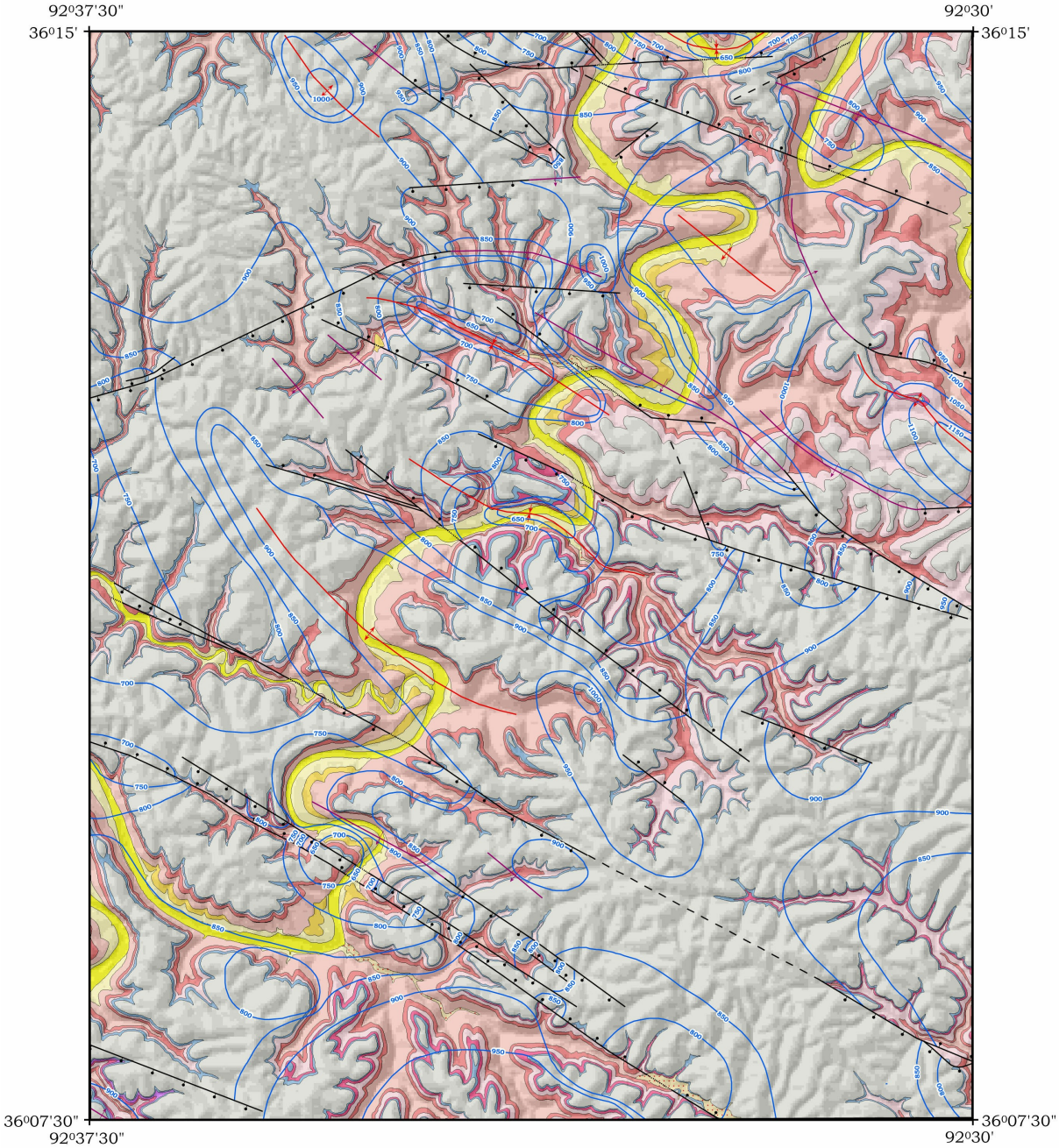
Topographic Map with Data Collection Points



Map of the Cozahome quadrangle showing location of data collection points.

Graphic from source map: Cozahome Quadrangle.

Major Structures and Generalized Structure Contours Map

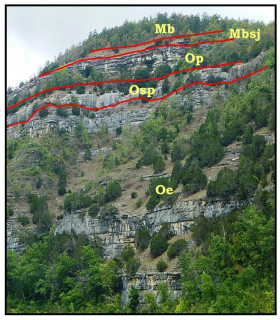


Map of the Cozahome quadrangle showing location of major structures and generalized structural contours on the base of the Boone Formation. Contour interval: 50 Feet (Adapated from McKnight, 1935).

Graphic from source map: Cozahome Quadrangle.

Photographs

Photo 1



Stratigraphic section of Everton Formation (Oe) to Boone Formation (Mb) exposed along the Buffalo National River (BNR) at Ludlow Bluff. This bluff is one of the highest bluffs along the BNR at over 590 feet (180) meters above river level.

Photograph from source map: Cozahome Quadrangle.

Photo 2

Natural Arch in the St. Peter Sandstone (Osp). Note the contact between the St. Peter Sandstone (Osp) and Everton Formation (Oe) in the lower right-hand corner of the photo.

Photograph from source map: Cozahome Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Cozahome 7.5 minute quadrangle. This quadrangle was previously mapped by W.V. Bush and B.R. Haley in 1970 for the Geologic Map of Arkansas (1976). E.T. McKnight (1935) mapped the Cozahome as part of a larger (1:125,000-scale) map focused on the understanding of the lead and zinc deposits of the area. Structural contours on the base of the Boone Formation were adapted from McKnight (1935). This map incorporates previously collected data with new detailed geologic mapping. The contacts and structural features were based on field observations. Data collection points were recorded by using a Global Positioning System (GPS) receiver in conjunction with a U.S. Geological Survey 7.5-minute topographic map. Bedrock

dipping less than 3° was considered horizontal. Bedrock units of less than 20 feet thick were considered “not mappable” at a 1:24,000-scale and were incorporated into adjacent stratigraphic units. Approximately 23 miles (37 kilometers) of the Buffalo National River are located on this quadrangle and are managed by the National Park Service.

Text from source map: Cozahome Quadrangle.

Summary

Stratigraphically, approximately 1200 feet (366 meters) of Middle Ordovician to Mississippian age strata are exposed in this quadrangle. Middle Ordovician strata crop out in the drainages and on steep hillsides. The Upper Ordovician Fernvale Limestone is present predominantly in the southern portion of the quadrangle. The Cason Shale was observed only at two localities. Undifferentiated Silurian Limestone is present in Scott Hollow in the southwest corner. The Mississippian Boone Formation caps the ridge tops and forms the heavily dissected Springfield Plateau surface. Quaternary terrace and alluvium deposits are present in the valleys of Water Creek, the Buffalo River and its tributaries. Two terrace levels are well-developed along the Buffalo River: a younger and a medial.

Regional structure is controlled in large part by an uplifted area (known as the Ozark Dome) centered in southeastern Missouri. From this structural high, the progressively younger rock formations dip southward and form increasingly elevated plateau surfaces (Ozark Plateaus Region) in Arkansas. Locally, certain areas of bedrock have been deformed by both large and small faults and folds. Structural highlights of the Cozahome include several northwest-southeast trending normal faults that are en echelon southwest-northeast across the map. One notable exception is the Caney Hollow Fault-Monocline which trends from the southwest-northeast in the west part of the map. Some of the faults and monoclines of the Rush Lead and Zinc Mining District extend onto the northern part of the map. Several monoclines and fault-to-monoclines are present in the quadrangle. They include the Barney Hollow Fault-Monocline, Caney Hollow Fault-Monocline, Fish Trap Hollow Fault-Monocline, North Coon Hollow Fault- Monocline, Commissary Ridge Fault-Monocline, Ingram Creek Fault-Monocline and Silver Hollow Monocline. The De Soto, Salado, Jones Hollow and Kimball Creek Anticlines form four elongated asymmetrical domes. The Panther Creek, Rock Creek and Silver Hollow Synclines form three elongated asymmetrical basins.

Northeast-southwest trending faults include: North Rocky Creek, South Coon Hollow, Water Creek and Hickory Creek. They are all downthrown to the southwest and their vertical displacement varies from 20-120 feet (6-37 meters). The Spring Creek and Rock Creek Faults are downthrown to the northeast and their vertical displacement varies from 20-120 feet (6-37 meters). The Rush Creek Fault is downthrown to the southwest and splinters into two faults forming a small graben at its terminus. The Rush Creek Fault terminates against the Climax Fault which appears to splinter into the Silver Hollow and Ducks Head Faults. According to McKnight (1935) the Silver Hollow Fault has a maximum vertical displacement of approximately 200 feet (61 meters). The Caney Hollow Fault is downthrown to the southeast and has a maximum vertical displacement of 140 feet (43 meters). This area was heavily prospected for zinc in the late 1800’s and early 1900’s. Zinc mines and prospect pits are present throughout the quadrangle; however, locations are not shown within the National Park since they are considered sensitive park resources.

Text from source map: Cozahome Quadrangle.

Acknowledgments

This map was produced for the National Park, Geologic Resource Inventory Program through contract C2360086145. Special thanks to the National Parks Service, U.S. Forest Service and to private landowners who graciously allowed access to their property. Helpful discussions with K.E. Murray of the U.S. Geological Survey, Denver, CO. provided guidance and insight regarding the Caney Hollow

Fault. Upper Ordivician formation and lithologic unit determination based conodont fauna analysis by Dr. Stephen A. Leslie of James Madison University, Harrisonburg, VA. Additional assistance with field work was provided by David H. Johnston of the Arkansas Geological Survey. The Buffalo National River boundary came from the National Park Service, Harrison, Arkansas.

Text from source map: Cozahome Quadrangle.

Disclaimer & Contact Information

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Text from source map: Cozahome Quadrangle.

References

Bush, W.V. and Haley, B.R., 1970, Reconnaissance geologic map of the Cozahome quadrangle, Marion and Searcy Counties, Arkansas: Arkansas Geological Commission Geologic Worksheet, 1:24,000. One sheet.

Chander, A.K., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2011, Geologic map of the Big Flat quadrangle, Baxter, Marion and Searcy Counties, Arkansas: Arkansas Geological Survey Digital Geologic Map, DGM-AR-00075, 1:24,000. One sheet.

Craig, W.W., 1993, Stratigraphy of the Cason Shale, the Brassfield, St. Clair, and Lafferty Limestones, and the Penters Chert (Upper Ordovician-Lower Devonian) in the Arkansas Ozarks, in Johnson, K. S. (ed.), Hunton Group core workshop and field trip: Oklahoma Geological Survey Special Publication 93-4, p. 135-147.

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McKnight, E.T., 1935, Zinc and lead deposits of northern Arkansas: U.S. Geological Survey Bulletin 853, 311 p.

Purdue, A.H. and Miser, H.D., 1916, Eureka Springs- Harrison Folio, Arkansas-Missouri: U.S. Geological Survey Geologic Atlas of the United States, no. 202, 26 p.

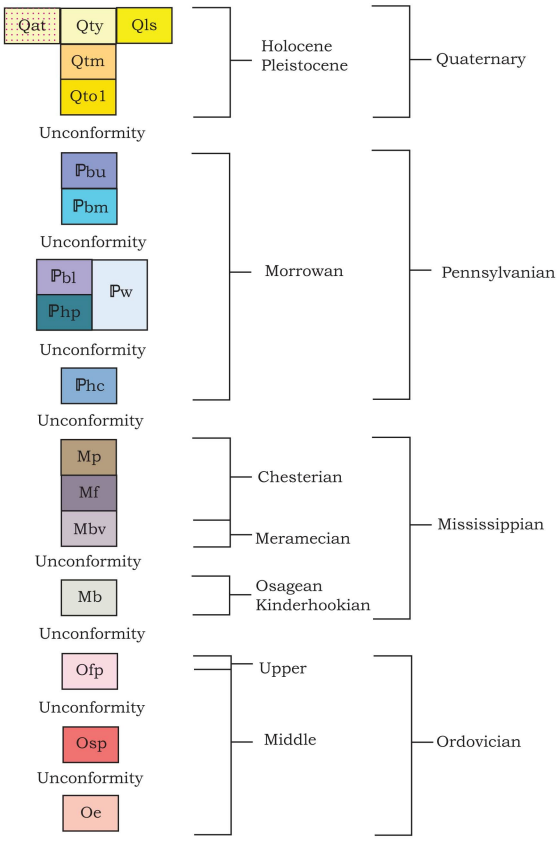
Turner, K.J. and Hudson, M.R., 2010, Geologic map of the Maumee quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey Scientific Investigations Map 3134, 1:24,000. One sheet.

Text from source map: Cozahome Quadrangle.

Eula Quadrangle (DGM-AR-00269)

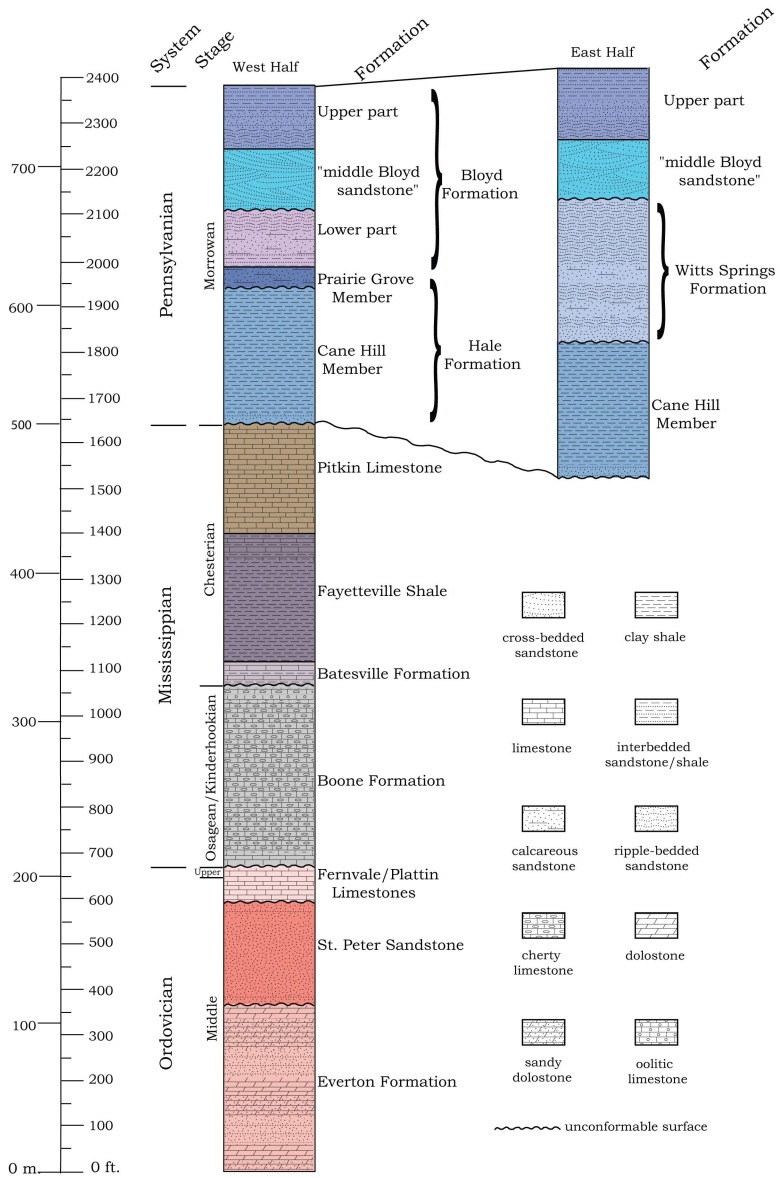
Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Eula Quadrangle, Newton and Searcy Counties, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00269, scale 1:24,000 (*GRI Source Map ID 62271*).

Correlation of Map Units



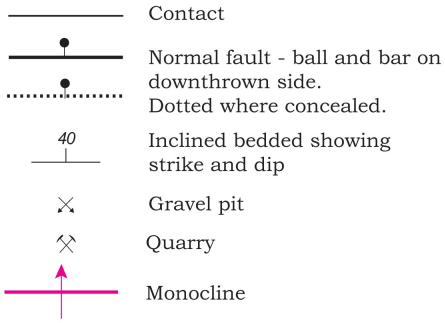
Graphic from source map: Eula Quadrangle.

Stratigraphic Column



Graphic from source map: Eula Quadrangle.

Symbols

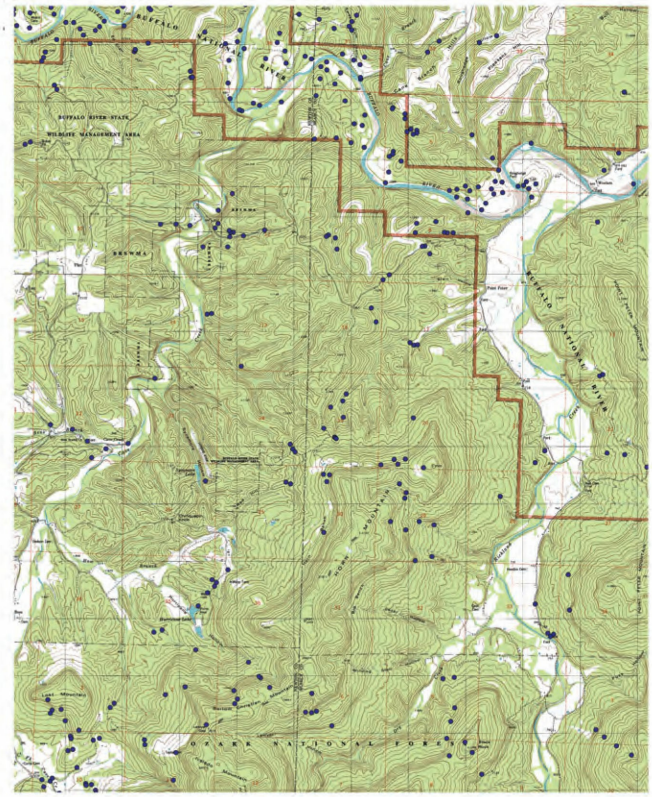


Graphic from source map: Eula Quadrangle.

Quadrangle Location Map

Graphic from source map: Eula Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Eula quadrangle showing location of data collection points.

Graphic from source map: Eula Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Eula quadrangle. This quadrangle was previously mapped at a 1:62,500 scale by Glick and Frezon in 1965 and Haley in 1976 for the Geologic Map of Arkansas. The geology was mapped at a 1:24,000 scale from 2002-2003 for the National Cooperative Geologic Mapping Program through STATEMAP. During 2014-2015, the terrace deposits along the Buffalo National River were mapped with funding provided by the National Park Service. Approximately eight miles of the Buffalo National River are located in this quadrangle and are managed by the National Park Service.

Approximately 2,400 feet (731 meters) of Middle Ordovician to Pennsylvanian age strata crop out in this quadrangle. The Ordovician dolostone, sandstone, and limestone units are present mainly along the Buffalo National River and Cave Creek in the northwestern portion of the map where it they are upthrown due to the Confederate Fault. The Boone Formation forms a dissected Springfield Plateau surface over a portion of the map. Upper Mississippian to Pennsylvanian sandstone, shale, and limestone form steep slopes and bluffs on Horn and Point Peter Mountains.

Quaternary alluvium and terrace deposits are present in the valley of the Buffalo National River and its tributaries. Two terrace levels are well developed along the Buffalo River: a younger and a medial. Older terraces are located 80-100 feet (24-49 meters) above the river in most meander bends.

This area was prospected in the late 1800's and early 1900's for lead and zinc. Mines and prospect pits are present throughout the quadrangle, however, they are not shown in the National Park since they are considered sensitive park resources.

Text from source map: Eula Quadrangle.

Acknowledgments

This map was produced for STATEMAP, Cooperative Agreement Award 02HQAG0017, a matching-funds grants program with the US Geological Survey under The National Cooperative Geologic Mapping Program. Thanks to Corbin Cannon and Danny Rains for their assistance with mapping the terrace deposits along the Buffalo National River. Special thanks to the National Park Service, U.S. Forest Service, Game and Fish Commission, and to private landowners who graciously allowed access to their property.

Text from source map: Eula Quadrangle.

Limitations & Contact Information

This map, like all geologic maps, is based on interpretations which were made from the data available at the time it was created. As work continues and new data is collected, the contacts and structures depicted on this map may be changed.

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Text from source map: Eula Quadrangle.

References

Adams, G.I., Purdue, A.H., Burchard, E.F., and Ulrich, E.O., 1904, Zinc and lead deposits of northern Arkansas with a section on the determination and correlation of formations: U.S. Geological Survey Professional Paper, no. 24, 118p.

Glick, E.E., Frezon, S.E., and Gordon, M.Jr., 1964, Witts Springs Formation of Morrow age in the Snowball quadrangle, north-central Arkansas: *in* Contributions to stratigraphy, U.S. Geological Survey Bulletin 1194-D, p.D1-D16.

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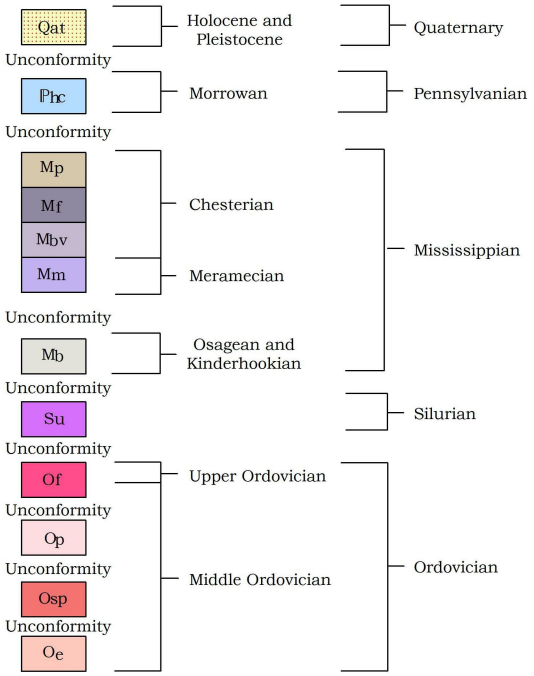
Text from source map: Eula Quadrangle.

Harriet Quadrangle (DGM-AR-00374)

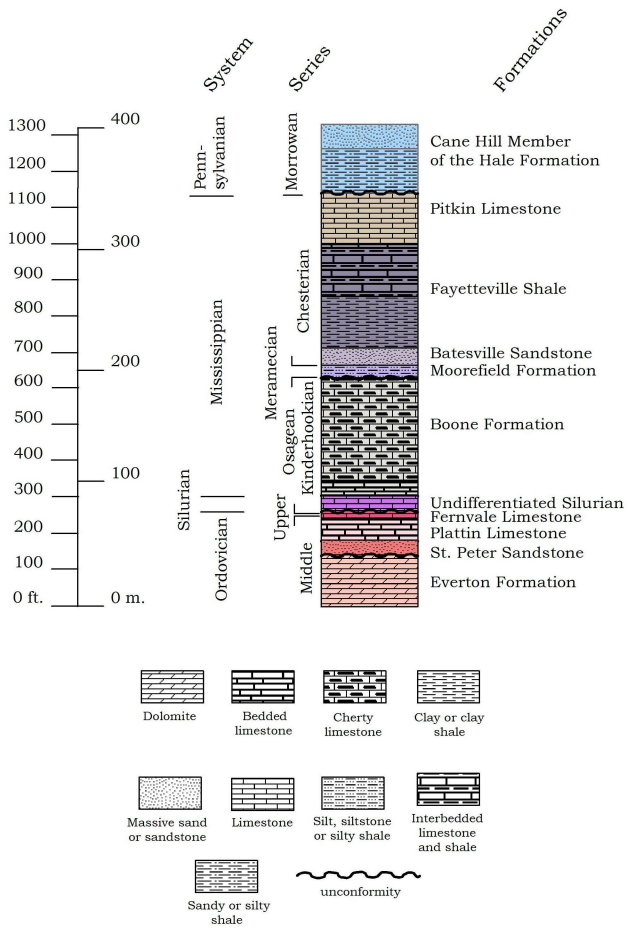
Smart, E.E, and Hutto, R.S., 2008, Geologic Map of the Harriet Quadrangle, Searcy County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00374, scale 1:24,000 (*GRI Source Map ID 75408*).

Correlation of Map Units



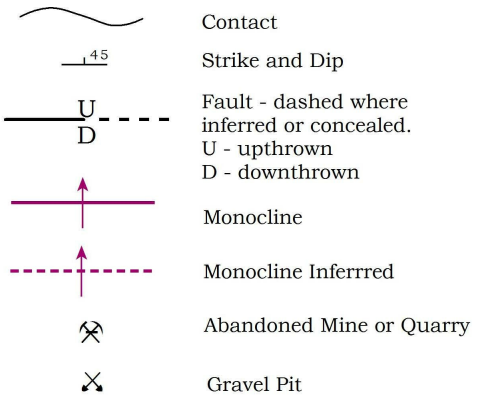
Graphic from source map: Harriet Quadrangle.

Stratigraphic Column



Graphic from source map: Harriet Quadrangle.

Symbols



Graphic from source map: Harriet Quadrangle.

Quadrangle Location Map

Graphic from source map: Harriet Quadrangle.

Map Notes

Introduction

This map graphically summarizes the surface geology of the Harriet 7.5-minute quadrangle. Middle Ordovician to Lower Pennsylvanian age carbonate and clastic sedimentary rocks are exposed in this area. Most of the area lies on the Springfield Plateau with the northern escarpment of the Boston Mountain Plateau starkly evident to the south. The headwaters of Spring Creek and Big Creek, which flow into the Buffalo National River, are the major drainages on the Harriet quadrangle.

The geology of this quadrangle was previously mapped at the 1:24000 scale in 1973 by E. E. Glick. The current map builds on the previous work while using a revised stratigraphy and adding certain stratigraphic refinements and structural details. The contacts and structural features on the map were derived from field observations at numerous sites. Site locations were generated with the aid of a global positioning satellite receiver. Bedrock dipping at less that 2° was considered horizontal. Bedrock formations less than 20' thick were not considered mappable units and were incorporated with adjacent stratigraphic units.

Text from source map: Harriet Quadrangle.

Acknowledgments

This map was produced for The National Cooperative Geologic Mapping Program (STATEMAP), a matching-funds grant program administered by the US Geological Survey, under Cooperative Agreement Award 07HQAG0081. Special thanks to the private landowners who graciously allowed access to their property. Very special thanks to Angela Chandler for her tireless dedication to this mapping project.

Text from source map: Harriet Quadrangle.

Disclaimer and Contact Information

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Text from source map: Harriet Quadrangle.

References

Adams, G.I. et, al, 1904, Zinc and Lead Deposits of Northern Arkansas: U. S. Geological Survey, Professional Paper 24, p. 21.

Croneis, C., 1930, Geology of the Arkansas Paleozoic Area: Arkansas Geological Survey Bulletin 3, p. 1-88, 163-206.

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Hutto, R.S., and Smart, E.E., 2008, Marshall Quadrangle, Seamy County, Arkansas: Arkansas Geological Survey Digital Geologic Map, DGM-AR-00532, 1 sheet.

Hutto, R.S., and Smart, E.E., 2008, Geologic Map of Landis Quadrangle, Searcy, Baxter and Stone Counties, Arkansas: Arkansas Geological Survey Digital Geologic Map, DGM-AR-00475, 1 sheet.

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Miser, H.D., 1922, Deposits of Manganese Ore in the Batesville District, Arkansas: U. S. Geological Survey Bulletin 734, 2'73 p., 1 plate.

Stroud, R.B., Arnot, R.H., Fulkerson, F. B., and Diamond, W. G., 1969, Mineral resources and industries of Arkansas: U. S. Bureau of Mines Bulletin 645, p. 81-85.

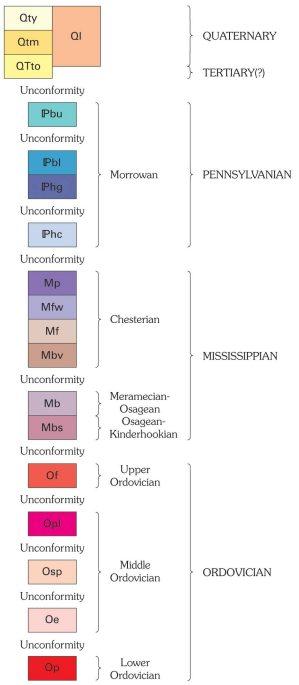
Wise, O.A. and Caplan, W.M., 1988, Silurian Rocks of Northern Arkansas, Geological Society of America Centennial Field Guide - South-Central Section, p. 221-224.

Text from source map: Harriet Quadrangle.

Hasty Quadrangle (SIM-2847)

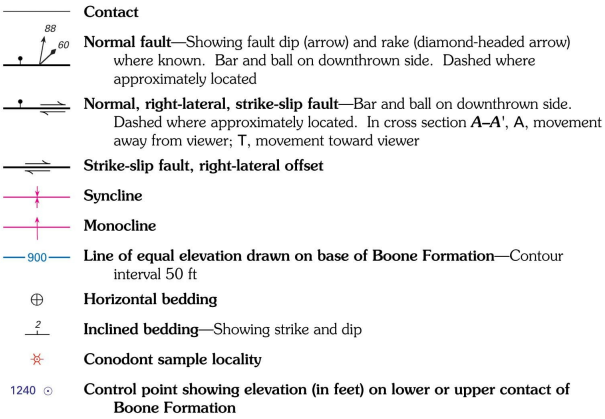
Hudson, M.R., and Murray, K.E., 2004, Geologic Map of the Hasty Quadrangle, Boone and Newton Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2847, scale 1:24,000 (*GRI Source Map ID 68982*).

Correlation of Map Units



Graphic from source map: Hasty Quadrangle.

Symbols



Graphic from source map: Hasty Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Quadrangle Location Map

Graphic from source map: Hasty Quadrangle.

Figure 1: Location of Study Area

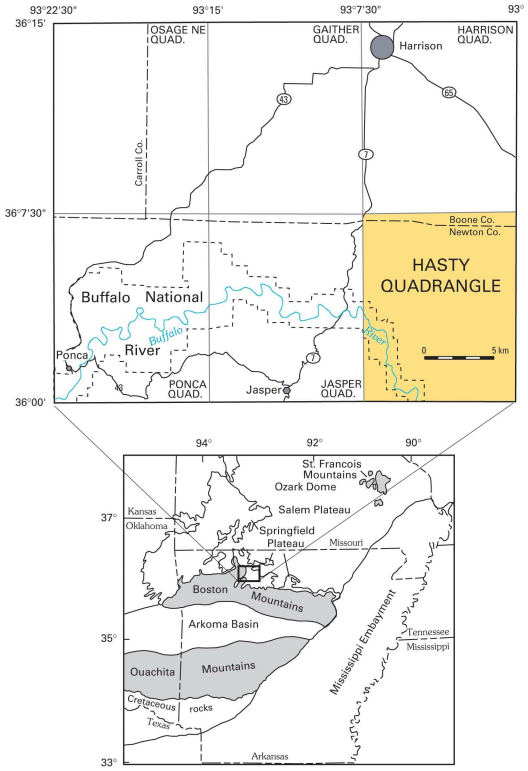


Figure 1. Location of study area within northern Arkansas, adjacent to the western part of Buffalo National river. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: Hasty Quadrangle.

Figure 2: Stratigraphic Column

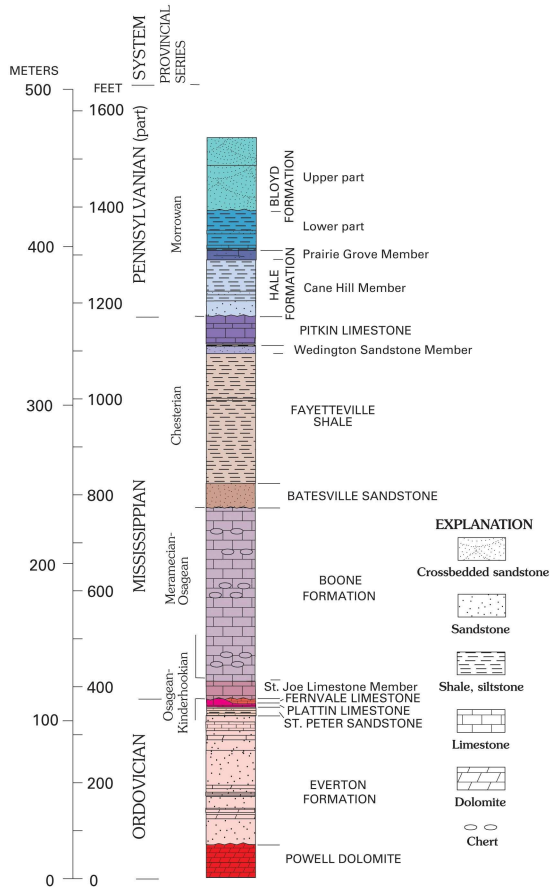


Figure 2. Stratigraphic column for Paleozoic rocks of the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

Graphic from source map: Hasty Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Hasty 7.5-minute quadrangle (fig. 1) in the Ozark Plateaus region of northern Arkansas. Geologically, the area lies on the southern flank of the Ozark dome, an uplift that exposes oldest rocks at its center in Missouri. Physiographically, the Hasty quadrangle lies within the Springfield Plateau, a topographic surface generally held up by Mississippian cherty limestone (Purdue and Miser, 1916). The quadrangle also contains isolated mountains (for example, Sulphur Mountain) capped by Pennsylvanian rocks that are erosional outliers of the higher Boston Mountains plateau to the south. Segments of the Buffalo and Little Buffalo Rivers flow through the southeastern part of the map area; these have enhanced bedrock erosion. Exposed bedrock of this region comprises an approximately 1,600-ft-thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds. The Hasty quadrangle includes part of Buffalo National River, a park encompassing the Buffalo River and adjacent land that is administered by the National Park Service.

The geology of the Hasty quadrangle was first mapped by Purdue and Miser (1916) at 1:125,000 scale. The current map confirms many features of this previous study but it also identifies new structures and uses a revised stratigraphy. A preliminary map of the northeastern part of the quadrangle was previously presented by Hudson (1998) at 1:24,000 scale.

Mapping for this study was conducted by field inspection of numerous sites and was compiled on a 1:24,000 scale-stable topographic base. Locations and elevations of contacts or other sites were determined with the aid of a global positioning satellite receiver and a hand-held barometric altimeter that was frequently recalibrated at points of known elevation. Orthophotos and a hill-shade relief image derived from a U.S. Geological Survey 10-m digital elevation model were used to help trace ledge-forming units between field traverses within the Upper Mississippian and Pennsylvanian part of the stratigraphic sequence. Strike and dip of beds were typically measured along stream drainages or at well exposed ledges to avoid loose rock affected by slope creep. Beds dipping less than 2° are shown as horizontal. Structure contours constructed on the base of the Boone Formation were hand drawn based on elevations of control points on both lower and upper contacts of the Boone Formation as well as other limiting information on their maximum or minimum elevations.

Text from source map: Hasty Quadrangle.

Stratigraphy

The study area preserves a 1,600-ft-thick record of early and late Paleozoic deposition on what is now the southern margin of the North American continent. Stages for Pennsylvanian and Mississippian units are from McFarland (1988).

The Middle Ordovician Everton Formation is a heterogeneous sandstone and carbonate unit that Suhm (1974) interpreted to have been deposited in barrier island and tidal flat depositional environments. The Everton Formation is discontinuously overlain by the Middle Ordovician St. Peter Sandstone and Plattin Limestone and the Upper Ordovician Fernvale Limestone. Identification of an inlier of St. Peter Sandstone within the central part of the quadrangle is based principally on the local roadside exposure of blue-green shale, which is interpreted to be equivalent to the shale-rich middle interval of the St. Peter Sandstone described farther to the east and south (McKnight, 1935; Glick and Frezon, 1953). Sparse conodonts retrieved from a site (lat 36°3.458' N., long 93°3.826' W.) in this blue-green shale indicate a Middle Ordovician Mohawkian age and have morphologies that are more like those of overlying formations than those in the Everton Formation, thus supporting a St. Peter identification (J.E. Repetski, written commun., 2003). Limestone from a site (lat 36°3.451' N., long 93° 3.771' W.) about 40 ft lower in elevation than this shale horizon yielded conodonts that indicate a Middle Ordovician Whiterockian age and have conodont species that are typical of the Jasper Member (Suhm, 1974) of the upper Everton Formation (J.E. Repetski, written commun., 2003). A sample from the Plattin Limestone mapped in the southeastern corner of the quadrangle (lat 36°0.295' N., long 93°1.96' W.) yielded latest Whiterockian to late Mohawkian age range conodonts that are typical for the formation and that are consistent with a Middle Ordovician age (J.E. Repetski, written commun., 2003).

The Mississippian Boone Formation is the most widespread unit at the surface within the quadrangle. The phosphate-nodule-bearing sandstone at the base of the St. Joe Limestone Member is persistent throughout much of northern Arkansas (McKnight, 1935). This sandstone was probably deposited as a transgressive lag during sea-level rise in Late Devonian time (Horner and Craig, 1984). On the eastern side of the quadrangle, the lower part of the St. Joe Limestone Member directly above the basal sandstone is greenish-gray fossiliferous shale that yielded conodonts at a site (lat 36°4.057' N., long 93°0.767' W.) that indicate a late Kinderhookian age (J.E. Repetski, written commun., 2003). The contact of the main body of the Boone Formation with the St. Joe Limestone Member is gradational and is based on the change to thin bedding and the generally chert-free lithology of the St. Joe Limestone Member. Near the top of the formation an oolite interval as thick as 3 ft is common. Braden and Ausbrooks (2003) also recognized this facies in areas to the south and correlated this interval

with the Short Creek Oolite Member of the Boone Formation, which is present in Missouri and Kansas (McKnight and Fischer, 1970).

The onset of Morrowan deposition reflects sea-level rise following a terminal Mississippian sea-level drop (Sutherland, 1988). The variable nature of the basal sandstone interval of the Cane Hill Member of the Hale Formation as well as its content of conglomerate and wood fragments suggests that this interval contains nonmarine valley-fill fluvial deposits. The study area lies at the northeastern margin of the distribution of thick Prairie Grove Member of the Hale Formation (Sutherland, 1988). The Prairie Grove Member in the study area is represented by indistinct planar-bedded or crossbedded, calcite cemented sandstone, 10–20 ft thick, which forms a rounded ledge above the Cane Hill Member and below the capping cliff-former of the middle sandstone of the Bloyd Formation. Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka Formation (Henbest, 1953) representing the prominent cliff-forming crossbedded sandstone. Zachry (1977), however, concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it with the informal term “middle Bloyd sandstone.”

Unconsolidated sediments are preserved as terrace deposits adjacent to the Buffalo and Little Buffalo Rivers at several elevations. The relative age of the deposits can be determined from their height above the river, but there are no constraints on their absolute age. The youngest deposits are almost certainly Quaternary in age, but the oldest deposits, which are 140–180 ft above the river, could potentially be as old as Tertiary (>1.8 Ma).

Text from source map: Hasty Quadrangle.

Structural Geology

Rocks within the map area were mildly deformed by a system of faults and folds. Structure contours on the base of the Boone Formation illustrate the location of structures and their vertical offset. The structure contours conform to elevations at 263 control points located at both lower and upper contacts of the Boone Formation, as well as other information limiting maximum or minimum elevations. A 390-ft thickness for the Boone Formation (including the St. Joe Limestone Member) was used to project the elevation of the basal contact from points on the upper contact, based on the average of five traverses across stratigraphic sections near the Buffalo River (Hudson, 1998) whose thicknesses range from 380 to 405 ft. The vertical offset of structures can be estimated from the elevation difference of formation contacts across the structures, but lateral offset is difficult to measure due to the lack of appropriate markers. Kinematic data indicating fault slip directions are sparse within the quadrangle, but elsewhere in the Buffalo River region (Hudson, 2001) kinematic data indicate that east- to east-southeast-striking faults typically have normal slip whereas northeast-striking faults have oblique slip, with both right-lateral and normal components of offset.

The dominant structural feature of the Hasty quadrangle is a graben system that extends from east to west across the center of the quadrangle. Purdue and Miser (1916) mapped the eastern and western parts of this system as separate grabens. This study illustrates that the northern bounding fault is continuous across the area, with a curvilinear map trace. McKnight (1935) called the eastern extension of this northern fault the St. Joe fault and that name is adopted here. The southern boundary of the graben system within the quadrangle is formed by two normal faults that partly overlap in sec. 7, T. 16 N., R. 19 W. Where observed, the main planes of faults forming the graben system dip steeply (72°–83°); where slip striations have been preserved on these faults or nearby smaller faults, they mostly have high rake angles that indicate a predominant normal sense of slip (fig. 3*A*). Strata within the graben system reach their maximum depth beneath and just west of Braden Mountain, and they rise to shallower levels both to the east where the southern boundary faults overlap and to the west where the graben merges with the northeast-striking Carlton fault zone on the adjacent Jasper quadrangle (Hudson and others, 2001). The western part of the graben system was

called the Braden Mountain graben by Hudson (1998). The 260-ft thickness of the Cane Hill Member of the Hale Formation preserved within the graben at Braden Mountain is much thicker than its 80–140 ft thickness preserved elsewhere in the quadrangle, suggesting that the graben was active as a growth structure during Early Pennsylvanian deposition of the Cane Hill Member.

The northeast-striking Stringtown Hollow fault and Upper Flatrock Creek fault have throws that are down to the northwest and southeast, respectively, but it is likely that these faults have components of right-lateral strike slip movement in addition to vertical movement. The down-to-the-northwest sense of throw on the Stringtown Hollow fault where it crosses the Buffalo River is the opposite of its sense on the Jasper quadrangle to the southwest (Hudson and others, 2001), but it is common for fault zones with dominant strike-slip displacement to change sense of throw along their length (Sylvester, 1988). The main fault plane for the Stringtown Hollow fault was not directly observed within the quadrangle, but small left-lateral faults with northwest strike that were observed at one location within the fault zone (lat 36°3.23' N., long 93°6.92' W.) are interpreted to be antithetic shears to the main, right-lateral fault zone. The Upper Flatrock Creek fault has consistent down-to-the-southest throw as great as 100 ft. It is at least 5 mi long and it continues to the northeast off the edge of the quadrangle. The southwest extension of the Upper Flatrock Creek fault is uncertain past sec. 35, T. 17 N., R. 20 W. Where the Upper Flatrock Creek fault crosses Davis Creek, a syncline is developed within Batesville Sandstone on the downthrown, southeastern side of the fault.

The structure contours also illustrate the effects of several broad domes and monoclinal folds, across which the Boone Formation varies as much as 200 ft in elevation. The Yardelle monocline on the eastern edge of the quadrangle has the greatest relief and is expressed by consistent north to north-northeast dips of as great as 27°. Just to the north, a northeast-trending monocline exposes Everton Formation on its upthrown, northwestern side along Davis Creek. The East Fork monocline continues northward at least 2 mi beyond the north edge of the quadrangle (Hudson, 1998).

Away from monocline limbs, dips of bedding measured throughout the quadrangle are typically low and variable in direction. These dispersed attitudes can be attributed in part to local subsidence caused by karst dissolution within the abundant limestone and dolostone rock units.

Joints measured within the map area (405 total) are near vertical and distributed in several sets (fig. 3 *B*). The dominant sets strike north and northeast. Less prominent joint sets strike west-northwest and northwest. Joint planes within limestone and dolostone formations, such as the Boone Formation, are commonly enlarged due to dissolution.

Text from source map: Hasty Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. Special thanks go to the many private owners who allowed access onto their land during this study. We thank D.N. Mott, C. Bitting, A.K. Braden, and S.M. Ausbrooks for helpful discussions on the geology, karst features, and hydrology of the area during the course of the study. Analyses of conodonts from four samples by J.E. Repetski of the U.S. Geological Survey helped establish or verify stratigraphic assignments. Helpful reviews were provided by J.D. McFarland and S. C. Lundstrom.

Text from source map: Hasty Quadrangle.

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Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This map was produced on request, directly from digital files, on an electronic plotter.

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Text from source map: Hasty Quadrangle.

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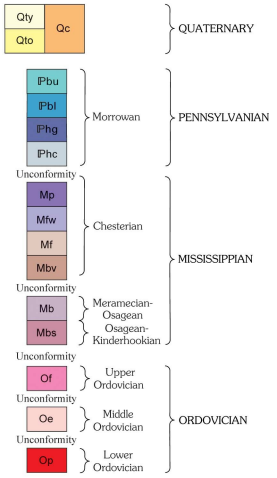
Text from source map: Hasty Quadrangle.

Jasper Quadrangle (MF-2356)

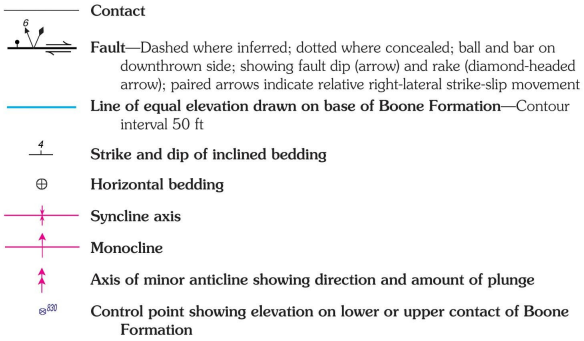
Hudson, M.R., Murray, K.E., and Pezzutti, Deborah, 2001, Geologic Map of the Jasper Quadrangle, Newton and Boone Counties, Arkansas: U.S. Geological Survey, Miscellaneous Field Studies Map, MF-2356, scale 1:24,000 (*GRI Source Map ID 3807*).

Correlation of Map Units



Graphic from source map: Jasper Quadrangle.

Symbols



Graphic from source map: Jasper Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Quadrangle Location Map

Graphic from source map: Jasper Quadrangle.

Figure 1: Location of Study Area

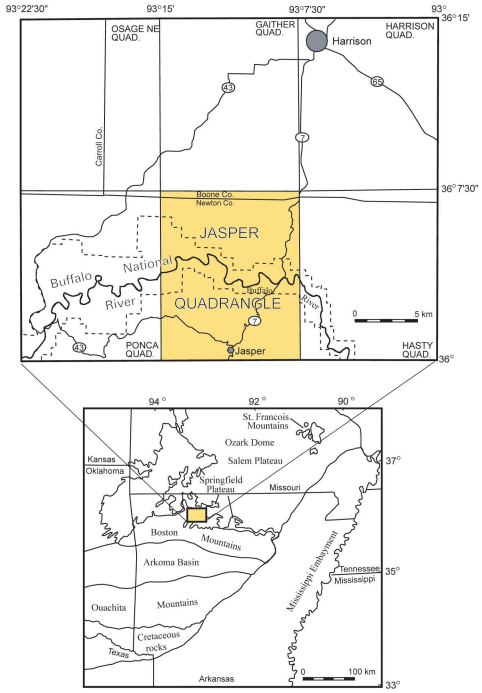


Figure 1. Location of study area within northern Arkansas, in and adjacent to the western part of Buffalo National River. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: Jasper Quadrangle.

Figure 2: Stratigraphic Column

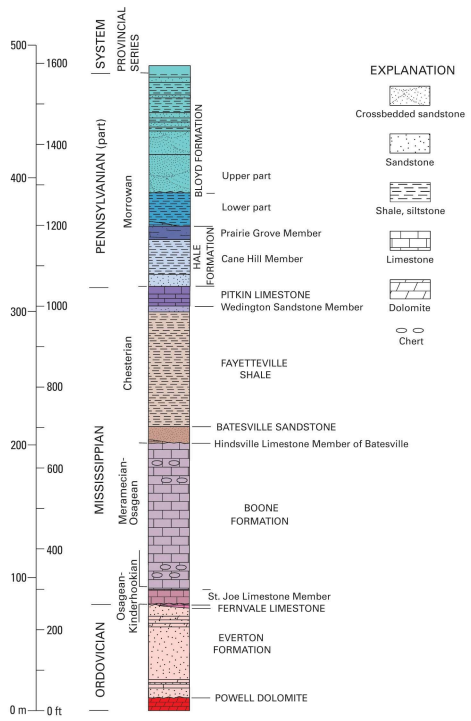


Figure 2. Stratigraphic column for Paleozoic rocks of the map area. Provincial series are from Murdue and Miser (1916) and McFarland (1988).

Graphic from source map: Jasper Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Jasper 7.5-minute quadrangle (fig. 1) in the Ozark Mountains region of northern Arkansas. The quadrangle spans the transition between physiographic provinces of the Boston Mountains to Springfield Plateau and it contains segments of the Buffalo and Little Buffalo Rivers. The exposed bedrock of this region comprises an approximately 1,600 ft (490 m) thick sequence of Ordovician, Mississippian and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds.

The geology of the Jasper quadrangle was first mapped by Purdue and Miser (1916) at 1:125,000 scale and later by Henderson (1972) at 1:24,000 scale. The current map confirms many features of these previous studies but it also identifies new structures and employs a revised stratigraphy. The northern part of the map was previously released by Hudson (1998) at 1:24,000 scale.

Text from source map: Jasper Quadrangle.

Structural Geology

Rocks within the map area were mildly deformed by a system of faults and folds. Structure contours on the base of the Boone Formation illustrate the location of structures and their vertical offset. The structure contour map conforms to elevations at 283 control points located at both lower and upper contacts of the Boone Formation, as well as other information limiting maximum or minimum elevations. For most of the area, a 390 ft (119 m) thickness for the Boone Formation (including the St. Joe Limestone Member) was used to project the elevation of the basal contact from points on the upper contact, based on the average of several traverses across stratigraphic sections near the Buffalo River (Hudson, 1998). In the southwest corner of the quadrangle near Jasper, however, the Boone thickness decreases to less than 350 ft (107 m) and the structure contour map was adjusted accordingly.

The vertical offset of structures can be estimated from the elevation difference of formation contacts across the structures, but lateral offset is difficult to measure due to the lack of appropriate markers. Kinematic data suggests that strike-slip offset was important across some of these structures. Fault striations that are sparsely preserved on planes of mapped faults or on adjacent, parallel, small-scale faults were used to infer the slip direction in some locations. Slip sense for striated faults was inferred either from offset of bedding or from asymmetric minor fault-plane features. In general, the slip data indicate that east- to east-southeast-striking faults have normal slip whereas northeast-striking faults have oblique slip with both right lateral and normal components of offset. The Carlton fault zone exhibits both of these characters, having a central northeast-striking segment with right-oblique sense that changes southward into an east-striking segment with dominantly normal slip. At its north end, the Carlton fault zone merges with the Braden Mountain graben whose bounding normal faults continue eastward from the quadrangle edge (Purdue and Miser, 1916; Hudson, 1998). The northeast-striking Stringtown Hollow fault zone is also interpreted to have right-oblique normal slip. This fault zone steps left and loses stratigraphic offset to the southwest. Farther southwest, near Jasper, northeast-striking faults that were previously mapped to have discrete stratigraphic offset of the Boone Formation by Purdue and Miser (1916) and Henderson (1972) were not observed in this study. Instead, the structure contours in this area define a shallow, northeast-trending, elongate trough, which may have developed over a buried, left-stepping continuation of the Stringtown Hollow fault zone.

The structure contour map also illustrates the effects of several broad domes and monoclinal folds, across which the Boone Formation varies as much as 200 ft (61 m) in elevation. Several observations suggest that these monoclines probably formed by drape over buried faults. The Hoskins Creek monocline aligns with the right-lateral Elmwood fault system that continues northeast of the quadrangle (Hudson, 1998). Small-scale strike-slip faults were observed within the Hoskins Creek monocline, suggesting that this fold accommodated strain from an underlying fault that had lateral as well as vertical displacement. Small strike-slip and normal faults also were observed locally within the northfacing Web monocline, suggesting that it probably formed over a west-northwest-striking transtensional fault. The west-northwest-trending Tom Thumb monocline that affects both the Boone Formation and, more broadly, the Pitkin Limestone, is not evident in the sandstone at the base of the upper Bloyd Formation. This relation suggests that this fold probably developed before Early Pennsylvanian time. Other structures, such as the Carlton fault, equally offset all exposed Paleozoic rocks and thus must be no older that Early Pennsylvanian.

Dips of bedding measured throughout the quadrangle are mostly low and variable in direction. These dispersed attitudes can be attributed in part to local subsidence caused by karst dissolution within the abundant limestone and dolomite rock units. In contrast, bedding attitudes within the limbs of monoclines generally have concordant directions and dips greater than 5.

Joints measured within the map area (157 total) are distributed in two dominant strike sets (fig. 3), north and northeast. Less prominent joint sets strike east-southeast and southeast. Joint planes within limestone and dolomite formations, such as the Boone Formation, are commonly enlarged due to dissolution.

Text from source map: Jasper Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. Special thanks go to the many private owners who allowed access onto their land during this study. We thank D.N. Mott, C. Bitting, J.D. MacFarland, III, J.V. Brahana, and T.J. Aley for helpful discussions on the geology, karst features, and hydrology of the area during the course of the study. Helpful reviews were provided by W.R. Page and J.C. Cole.

Text from source map: Jasper Quadrangle.

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Text from source map: Jasper Quadrangle.

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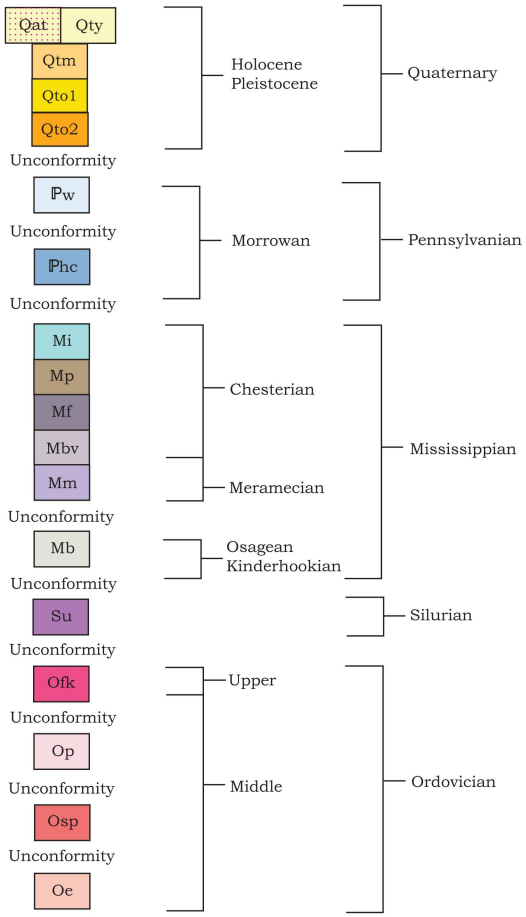
Text from source map: Jasper Quadrangle.

Marshall Quadrangle (DGM-AR-00532)

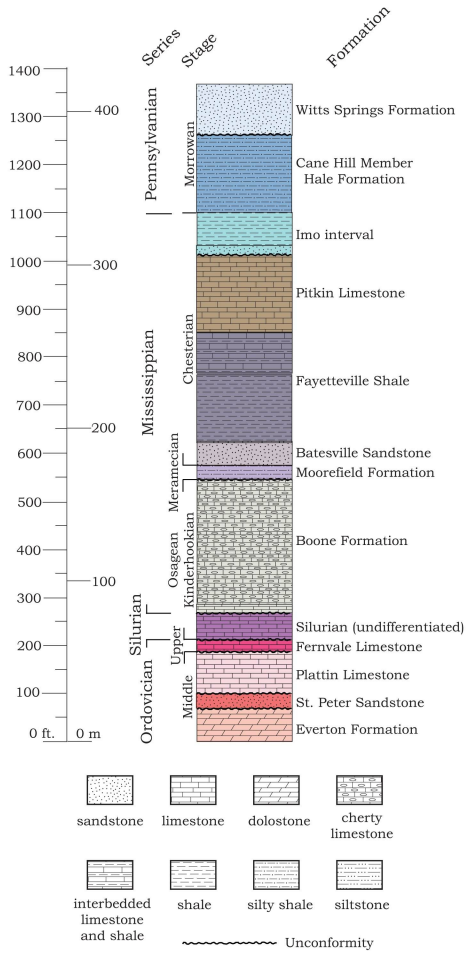
Hutto, R.S., and Smart, E.E., 2008, Geologic Map of the Marshall Quadrangle, Searcy County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00532, scale 1:24,000 (*GRI Source Map ID 75407*).

Correlation of Map Units



Graphic from source map: Marshall Quadrangle.

Stratigraphic Column



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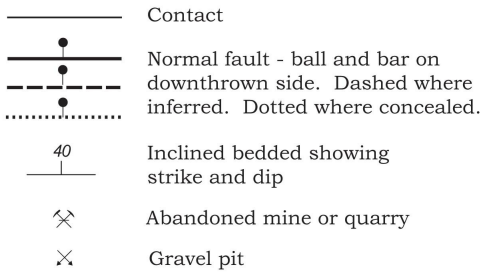
Symbols



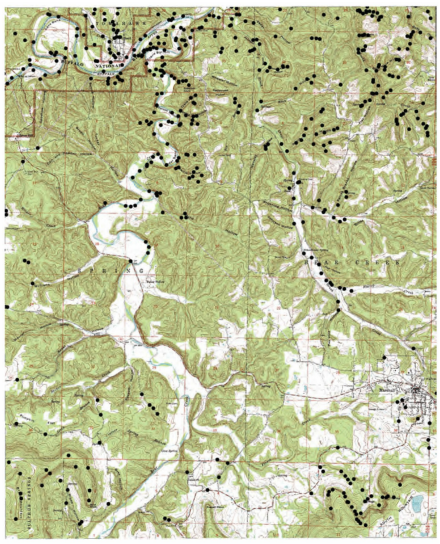
Graphic from source map: Marshall Quadrangle.

Quadrangle Location Map

Quadrangle Location

Graphic from source map: Marshall Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Marshall quadrangle showing location of data collection points.

Graphic from source map: Marshall Quadrangle.

Map Notes

Introduction

This map graphically summarizes the bedrock geology of the Marshall 7.5-minute quadrangle. In this area over 1,200 feet (366 meters) of Middle Ordovician to Lower Pennsylvanian carbonate and clastic sedimentary rocks are exposed. Bedrock is typically overlain by a veneer of unconsolidated residuum, colluvium or alluvium. The mapped area lies mostly on the Springfield Plateau, but includes the northern edge of the Boston Mountains Plateau. The Boston Mountains Plateau, formed on Early Pennsylvanian rocks, is the highest plateau surface of the Ozark Dome, a structural high centered in southeastern Missouri that affects all the bedrock in northern Arkansas. This plateau has a very distinct escarpment which can be viewed from the Highway 65 road-cut just south of Marshall. West of Marshall, the Springfield Plateau surface can be seen spreading out to the horizon and deeply incised by steep-sided drainages. It is formed on the Boone Formation 600 to 700 feet (183 to 213 meters) below the Boston Mountains Plateau.

Two of the larger drainages in this area are Bear Creek and Brush Creek, which flow north and into the Buffalo River which cuts across the northwestern corner of the quadrangle. Alluvial and terrace deposits along these two drainages are only shown in where they do not overlap the Ordovician through Silurian section on the northern half of the map to better show the detail of these hummocky units. Recent discoveries of old and very old terrace deposits about a mile north of the current channel of the Buffalo River near Gilbert, indicate that an ancient meander bend cutoff may have existed there. An event of this type would have resulted in a period of rapid downcutting stranding additional.

The area within the thick, brown line is part of the Buffalo National River which is administered by the National Park Service. The lowest elevation on the Marshall quadrangle is on the Buffalo River at the northern edge of the map. Bryan Mountain on the southwestern corner is the highest point.

The geology of the northwestern corner of this area was mapped in 1953 by Maher and Lantz. The entire quadrangle was mapped at the 1:24,000-scale in 1965 by Clardy and Woodward and in 1973 by Glick for the 1:500,000-scale Geologic Map of Arkansas. The current map builds on the previous work using revised stratigraphy and adding structural details. The contacts and structural features on the map were derived from field observations made at numerous sites from July 2007 through April 2008. Additional data were collected in 2014-15 to delineate terraces along the Buffalo River. Data collection sites were located with the aid of a global positioning satellite receiver. Bedrock dipping at less than 2° is depicted as horizontal.

Text from source map: Marshall Quadrangle.

Acknowledgments

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Text from source map: Marshall Quadrangle.

Limitations & Contact Information

This map, like all geologic maps, is based on interpretations which were made from the data available at the time it was created. As work continues and new data is collected, the contacts and structures depicted on this map may be changed.

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Text from source map: Marshall Quadrangle.

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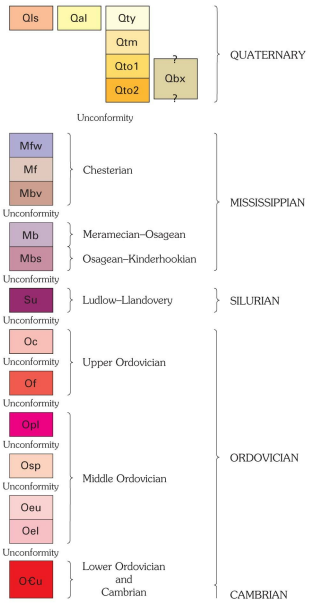
Text from source map: Marshall Quadrangle.

Maumee Quadrangle (SIM-3134)

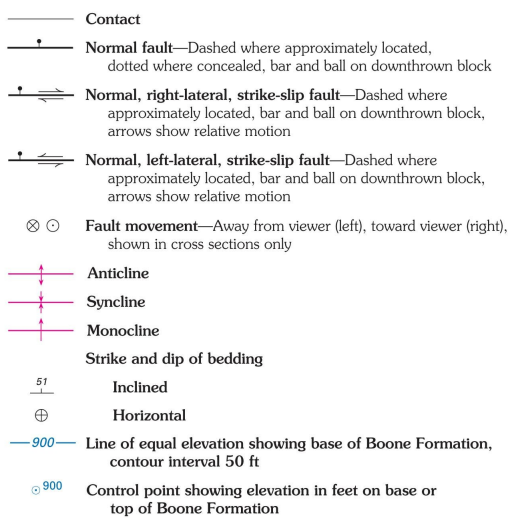
Turner, K.J., and Hudson, M.R., 2010, Geologic Map of the Maumee Quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3134, scale 1:24,000 (*GRI Source Map ID 74689*).

Correlation of Map Units



Graphic from source map: Maumee Quadrangle.

Explanation



Graphic from source map: Maumee Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Quadrangle Location Map

Graphic from source map: Maumee Quadrangle.

Figure 1: Location of Study Area

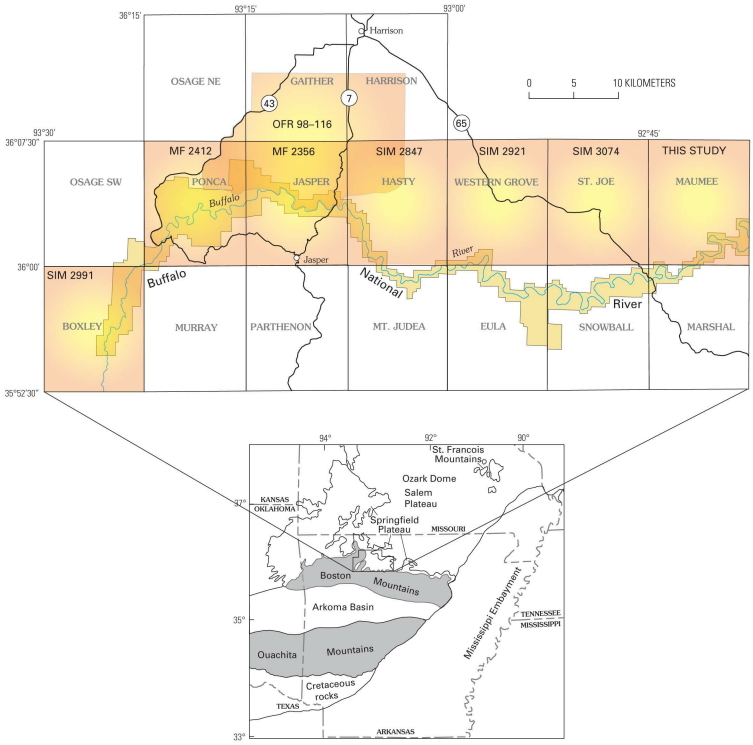


Figure 1. Location of study area within northern Arkansas, adjacent to the western part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998; Hudson and others, 2001; Hudson and Murray, 2003, 2004; Hudson and others, 2006; Hudson and Turner, 2007, 2009) are listed by publication number. U.S. Geological Survey publication series abbreviations are: Open-File Report (OFR), Miscellaneous Field Studies Map (MF), and Scientific Investigations Map (SIM). Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: Maumee Quadrangle.

Figure 2: Stratigraphic Column

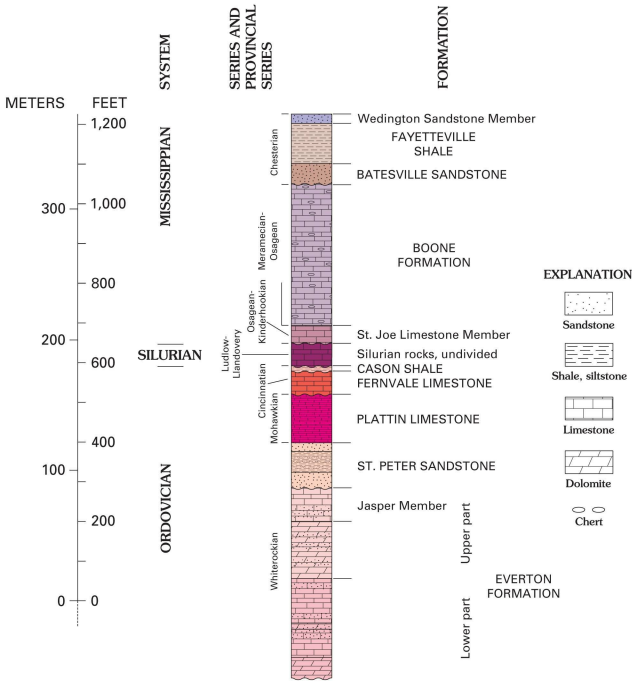


Figure 2. Stratigraphic column for Paleozoic rocks within the quadrangle. Provincial series are from Purdue and Miser (1916), Craig (1993), and McFarland (1988).

Graphic from source map: Maumee Quadrangle.

Figure 3: Structural Features Map

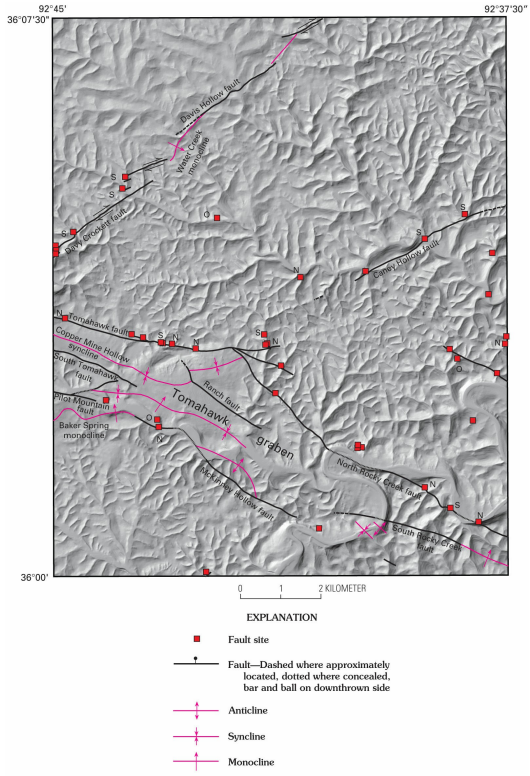


Figure 3. Shaded-relief digital elevation map of quadrangle with structural features and sites where faults (squares) were observed. Where determined, slip senses for faults at sites are indicated as normal, N (rake 90° to 60°); oblique, 0 (rake 59° to 30°); and strike-slip, S (rake 29° to 0°).

Graphic from source map: Maumee Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Maumee 7.5-minute quadrangle (fig. 1) in northern Arkansas. The map area is in the Ozark plateaus region on the southern flank of the Ozark dome (fig. 1). The Springfield Plateau, composed of Mississippian cherty limestone, overlies the Salem Plateau, composed of Ordovician carbonate and clastic rocks, with areas of Silurian rocks in between. Erosion related to the Buffalo River and its tributaries, Tomahawk, Water, and Dry Creeks, has exposed a 1,200-ft-thick section of Mississippian, Silurian, and Ordovician rocks (fig. 2) mildly deformed by faults and folds. An approximately 130-mile-long corridor along the Buffalo River forms the Buffalo National River that is administered by the National Park Service.

McKnight (1935) mapped the geology of the Maumee quadrangle as part of a larger 1:125,000-scale map focused on understanding the lead and zinc deposits common in the area. Detailed new mapping for this study was compiled using a Geographic Information System (GIS) at 1:24,000 scale. Site location and elevation were obtained by using a Global Positioning Satellite (GPS) receiver in conjunction with a U.S. Geological Survey 7.5-minute topographic map and barometric altimeter. U.S. Geological Survey 10-m digital elevation model data were used to derive a hill-shade-relief map used along with digital orthophotographs to map ledge-forming units between field sites. Bedding attitudes were measured in drainage bottoms and on well-exposed ledges. Bedding measured at less than 2°

dip is indicated as horizontal. Structure contours constructed for the base of the Boone Formation are constrained by field-determined elevations on both upper and lower formation contacts.

Text from source map: Maumee Quadrangle.

Stratigraphy

The 1200-ft-thick stratigraphic section of Paleozoic rocks (fig. 2) records deposition in a continental shelf environment during the Ordovician, Silurian, and Mississippian Periods. Provincial series terms determined for Mississippian and Silurian units are from McFarland (1988) and Craig (1993), respectively, and are based mostly on conodont biostratigraphy. The Buffalo River and its major tributaries have exposed the Paleozoic units and have recorded Quaternary deposition in the preserved terrace levels.

Limestone in the lower part of the Everton Formation (Oel) is restricted to the northwest portion of the quadrangle where it has been exposed by erosion of a structural high. The limestones host a karst aquifer that discharges groundwater from an artesian spring along Water Creek. Dolomitic rocks in the upper part of the Everton Formation (Oeu) grade upward into the basal sandy limestone of the Jasper Member (Glick and Frezon, 1953; Suhm, 1974), which reaches a maximum thickness of 80 ft on the eastern edge of the quadrangle. The Jasper Member thins and pinches out to the north and west in the quadrangle. The St. Peter Sandstone (Osp), Plattin Limestone (Opl), and Fernvale Limestone (Of) all reach maximum thicknesses in the southeast corner of the quadrangle but are mostly absent in the northwest part. We observed the Cason Shale (Oc) at three localities in the quadrangle, although McKnight (1935) documented additional exposures within the quadrangle. At the type-section east of the map area near Batesville, Ark., the upper part of the Cason Shale is Silurian because it overlies the Silurian Brassfield Limestone and contains Silurian fauna (Craig and others, 1984; Craig, 1993), but Craig (1975) demonstrated that in its western outcrops, including this quadrangle, only the Ordovician part of the Cason Shale is present.

Silurian rocks (Su) are restricted to the southern half of the quadrangle and continue into the Marshall quadrangle to the south (McKnight, 1935; Maher and Lantz, 1953; Hutto and Smart, 2008). Silurian rocks are generally preserved in pre-Mississippian structural lows; their limited extent resulted from multiple episodes of erosion prior to deposition of the Boone Formation (Mb) (McKnight, 1935; Craig, 1993). Differentiation of Silurian rocks from Fernvale Limestone (Of) is difficult but Fernvale outcrops are typically moss covered, friable, lack micritic facies, and contain characteristic stylolitic partings.

Although the Mississippian Boone Formation (Mb) overlies Silurian rocks (Su) in the southern part of the quadrangle, the major unconformity at the base of the Boone Formation progressively truncates underlying rocks north and west across the quadrangle, eventually placing basal St. Joe Limestone Member (Mbs) above the eroded upper part of the Middle Ordovician Everton Formation (Oeu) (cross section *A–A'*). The basal contact of the Boone Formation is often marked by the presence of phosphate nodules in the sandstone or shaley horizons. Horner and Craig (1984) suggest this andstone was deposited as a transgressive lag during Late Devonian time.

The Batesville Sandstone (Mbv) marks a change to dominantly clastic sedimentation from mostly carbonate sedimentation in the underlying Boone Formation (Mb). Sandstone blocks are commonly found in sinkholes developed from the karstification of the Boone Formation. Sandstone blocks found around some larger sinkholes and faults in the quadrangle are interpreted as remnant block deposits (Qbx) and not indicative of the basal contact. Thicknesses for the Boone Formation of 365 ft and 375 ft are documented in wells from the towns of St. Joe, Ark., to the west (well records from Arkansas Geological Survey, Little Rock, Ark.) and Marshall, Ark., to the southeast (Maher and Lantz, 1952; 1953), respectively. In the areas mapped as Qbx however, numerous sandstone blocks are present that cannot be in situ without a greatly reduced thickness of the Boone Formation. We interpret the blocks to have been trapped in closed depressions created by sinkholes and as the underlying limestone was dissolved, reducing the total thickness of the Boone Formation, the erosion resistant sandstone blocks remain. The relation between remnant blocks and faults is unknown. Fayetteville

Shale (Mf) overlies the Batesville Sandstone but is only preserved in the Tomahawk graben system. The Fayetteville Shale hosts the only mappable landslide deposit (Qls).

Four levels of terrace deposits are preserved along the Buffalo River. Relative age is indicated by elevation above river level with the oldest at the highest elevation. Dating of archeological materials and analysis of soil characteristics by Guccione and Guendling (1988) suggest an age of Holocene and late Pleistocene for young terrace deposits (Qty) and medial terrace deposits (Qtm) are likely late Pleistocene. Old terrace deposits (Qto1) are Quaternary (< 2.6 Ma; Head and others, 2008; Walker and Geissman, 2009) but have not been studied in detail. Old terrace deposits correlate to similar terrace deposits about 80–120 ft above base-flow level of the Buffalo River on the Western Grove (Hudson and others, 2006), Hasty (Hudson and Murray, 2004), Jasper (Hudson and others, 2001) and Ponca quadrangles (Hudson and Murray, 2003) to the west (fig. 1). Very old terrace deposits (Qto2) are significantly higher than any other terrace deposit at 230–260 ft above base-flow level. These deposits are located on narrow point bars and are suspected to be correlative with a similar mapped terrace on the Western Grove quadrangle (Hudson and others, 2006) (fig. 1).

Text from source map: Maumee Quadrangle.

Structural Geology

Rocks within the map area were deformed by faults and folds, and structure contours on the base of the Boone Formation illustrate the location and relative offset of these structures. The structure contours conform to elevations at 565 control points located at both lower and upper contacts of the Boone Formation, as well as other information limiting maximum or minimum elevations of these contacts. A 370-ft average thickness for the Boone Formation (Mb), including the St. Joe Limestone Member (Mbs), was used to project the elevation of the basal contact from points on the upper contact. This average thickness is constrained by well data documenting approximately 375 ft of Boone Formation southeast in the town of Marshall (Maher and Lantz, 1952; 1953) and a well that penetrated about 365 ft in the town of St. Joe to the west (well records from the Arkansas Geological Survey, Little Rock, Ark.). The average thickness determined for the Boone Formation in this quadrangle is 20 ft less than a 390-ft average thickness determined from surface stratigraphic sections of the Boone Formation farther to the west in the Buffalo River watershed (Hudson, 1998) that was used in construction of structure contours for published geologic maps farther to the west (fig. 1).

Several regionally extensive faults and folds are present within the Maumee quadrangle. The Tomahawk, South Tomahawk, and Pilot Mountain faults correspond to faults previously named by McKnight (1935) in the western part of the quadrangle and the North Rocky Creek and South Rocky Creek in the southeastern part of the quadrangle. As a result of our new detailed geologic mapping, we have revised fault traces from those of McKnight (1935). We mapped several newly recognized faults, including the Ranch, McKinney Hollow, and Caney Hollow faults.

Some structural features mapped as folds by McKnight (1935) are reinterpreted as combined fault and fold zones. A N 50° E-trending structural zone with a down-to-southeast throw of about 200 ft extends across the northwestern part of the quadrangle and was named the Water Creek monocline by McKnight (1935). This zone contains several left-stepping en echelon faults of N 55° E to N 68° E strike, the longest of which is the northeastern extension of the Davy Crockett fault from the adjacent St. Joe quadrangle (Hudson and Turner, 2009). In the center of the zone, the Davis Hollow fault elevated the lower part of the Ordovician Everton Formation, the lowest stratigraphic level in the quadrangle, to the surface in its footwall. At its southwestern end the Davis Hollow fault loses throw but is interpreted to continue across Water Creek on the basis of an abrupt start of a dolostone and sandstone cliff of upper part of Everton Formation (Oeu) to the south and a silicified zone holding up a bedrock knob southwest of the creek. However, dips as great as 25° southeast of this fault accommodate most of the throw and mark the limb of the Water Creek monocline. The Caney Hollow fault is a NE-striking fault and associated fold located at the intersection of Water Creek and White Oak Hollow in the east-central part of the quadrangle. This is named for exposures in the Caney

Hollow drainage just to the east of the quadrangle boundary (S. Ausbrooks, Arkansas Geological Survey, oral commun., 2010). Beds dip as steeply as 40° SE adjacent to the fault, and folding contributes significantly to the overall down-to-southeast throw across the structure. A small dome southwest of the Caney Hollow fault (Sec. 3, T. 16 N., R. 16 W.) may have formed as a result of flexure related to termination of a right-lateral component of the Caney Hollow fault.

The Tomahawk graben of McKnight (1935) is a system of west-northwest- to northwest-trending faults and associated folds that form a broad down-dropped zone across the southern part of the quadrangle (fig. 3). The northern margin of this zone is formed by the Tomahawk and North Rocky Creek faults. Although a portion of the North Rocky Creek fault is concealed beneath the Buffalo River and alluvium, we interpret it to be continuous from the Rocky Creek area, northwest to its intersection with the Tomahawk fault. The southern margin of the graben system is defined by down-to-north faults and monoclines. The South Rocky Creek fault dies into a monocline at its eastern end and is discontinuous with the McKinney Hollow fault that dies into the Baker Spring monocline at its western end. The graben system is internally deformed by the South Tomahawk, Pilot Mountain, and Ranch faults and several folds including the Copper Mine Hollow syncline marking the lowest structural axis.

Fault data collected at numerous sites within the quadrangle (fig. 3) indicate the typical orientations and slip senses for faults (fig. 4*A*) and give insight into the causative stresses responsible for deformation. Many of these faults are small displacement cataclastic faults, deformation bands (Aydin and Johnson, 1978), preferentially developed in well-sorted Ordovician sandstones of the St. Peter Sandstone (Osp). Frequency maxima demonstrate common orientations of faults that dip moderate to steeply either to the south to southsoutheast or to the north to northeast. A subset of faults whose slip senses could be determined are predominantly normal or strike slip (fig. 4*B*). Dips of normal faults vary from north to north-northeast or south to southwest. Among strike-slip faults, those with right-lateral sense mostly strike east-northeast and dip southeast, whereas those with left-lateral sense mostly strike southeast and dip northeast or southwest. Paleostress inversions for these normal and strike-slip faults, using the method of Angelier (1990), mostly fit stress regimes with a least principal stress axis oriented south-southwest and near horizontal, and with intermediate and maximum principal stress axes flipping between near vertical and east-southeast and near horizontal (fig. 4*B*). From these data we interpret that northeast-striking fault zones in the quadrangle have right-lateral slip as well as down-to-thesoutheast throw, whereas east-southeast to southeast-striking faults have dominantly normal slip but may also have components of left-lateral slip. Similar coordinated movements among normal and strike-slip faults have been documented elsewhere in the southern Ozark dome, and their dominantly north-south extension accommodated late Paleozoic flexure of the southern continental margin as it was loaded by the adjacent Ouachita orogenic belt (Hudson, 2001).

Whereas most of the faulting in the quadrangle is probably late Paleozoic in age, the outcrop distribution of pre-Mississippian rocks suggests effects of older deformation. The progressive truncation of Silurian rocks (Su), Upper Ordovician Fernvale Limestone (Of), and Middle Ordovician Plattin Limestone (Opl) and St. Peter Sandstone (Osp) beneath the Mississippian unconformity suggests the presence of a broad pre-Mississippian uplift centered northwest of the quadrangle. McKnight (1935) suggested that this progressive truncation might be linked to uplift across the Water Creek monoclinal zone, but detailed mapping in this and adjacent quadrangles (Hudson and others, 2006; Hudson and Turner, 2009) demonstrates a more regionally extensive east-northeast trend of these stratigraphic truncations, distinct from the N 50° E Water Creek monoclinal zone. In a second example, the northern margin of the Tomahawk graben system probably was active before Mississippian deposition. Silurian rocks (Su) and Upper Ordovician Fernvale Limestone (Of) are thickest in the hanging wall of the North Rocky Creek fault but are thin to absent in footwall exposures (cross section *B–B'*), suggesting that this west-northwest-trending zone had pre-Mississippian activity (McKnight, 1935). Northeast of North Rocky Creek fault, thickening, thinning, and removal of the Plattin Limestone (Opl) indicate this paleohigh area was an irregular surface with localized domes and basins and one small steep-limbed syncline (SE ¼, Sec. 15, T. 16 N., R. 16 W.) prior to being planed off during pre-Mississippian erosion.

Joints measured within the map area (918 total) are near vertical and distributed in several sets (fig. 4 *C*). The dominant set strikes north. Less prominent joint sets strike west-northwest and northeast.

Joint planes within limestone and dolostone formations, such as the Boone (Mb) and Everton Formations (Oeu and Oel), are commonly enlarged due to dissolution.

Text from source map: Maumee Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. Helpful discussions with M.E. Berry of the U.S. Geological Survey, Denver, Colo. provided guidance and insight into classification of surficial deposits. Thoughtful reviews by W. R. Page of the U.S. Geological Survey and S. Ausbrooks of the Arkansas Geological Survey improved the map. Special thanks go to the many private owners who allowed access onto their land during this study.

Text from source map: Maumee Quadrangle.

Disclaimer & Contact Information

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Text from source map: Maumee Quadrangle.

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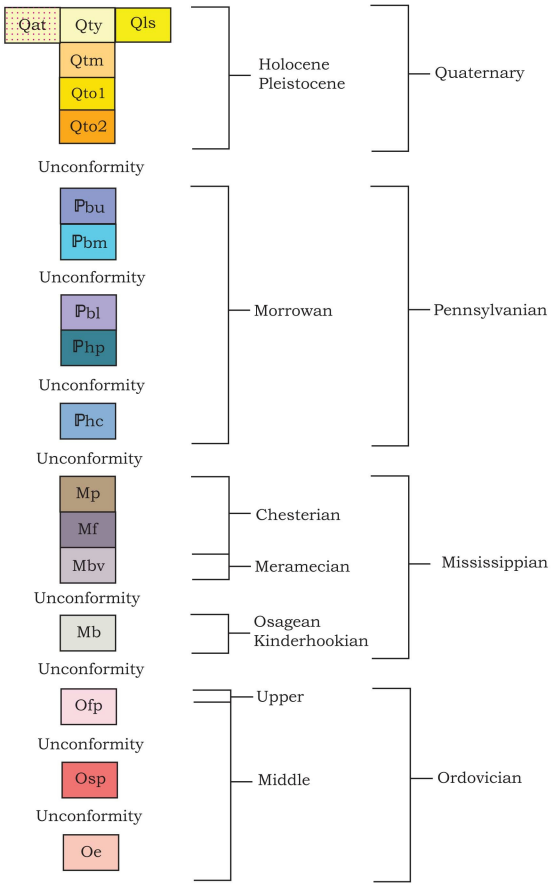
Text from source map: Maumee Quadrangle.

Mt. Judea Quadrangle (DGM-AR-00590)

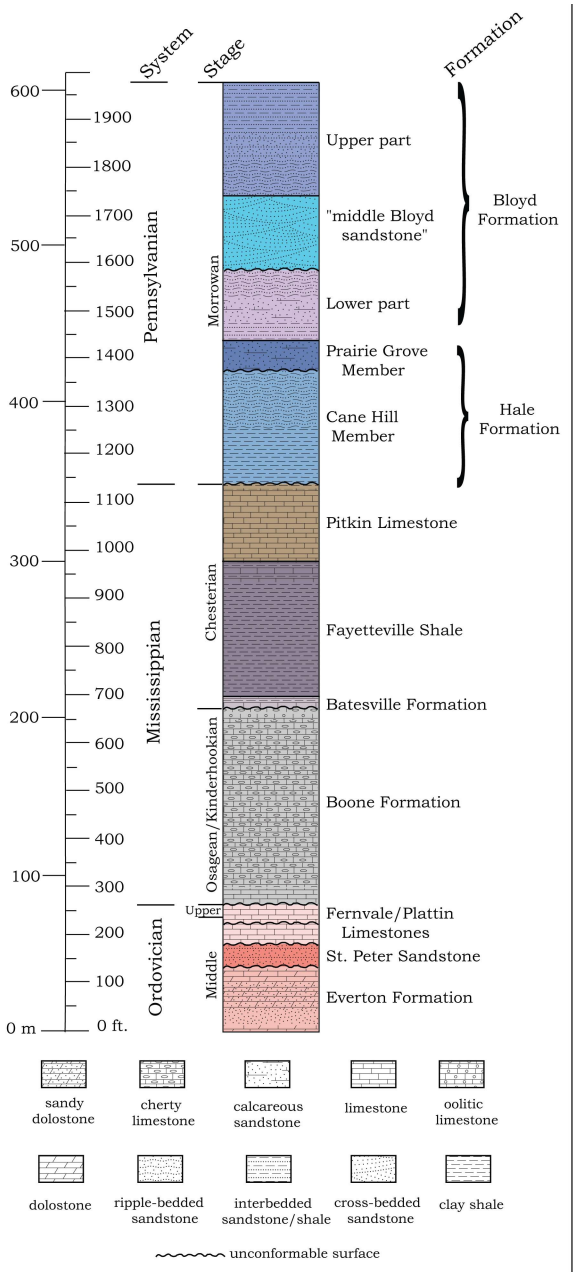
Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Mt. Judea Quadrangle, Newton County, Arkansas: Arkansas Geological Commission, Digital Geologic Quadrangle Map, DGM-AR-00590, scale 1:24,000 (*GRI Source Map ID 60913*).

Correlation of Map Units



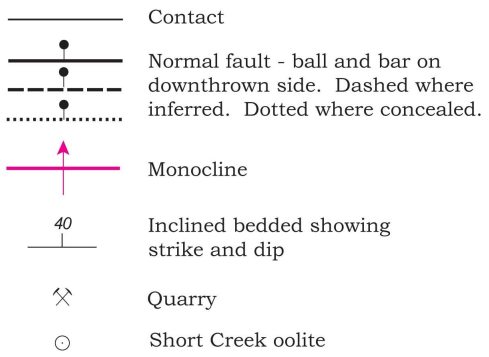
Graphic from source map: Mt. Judea Quadrangle.

Stratigraphic Column



Graphic from source map: Mt. Judea Quadrangle.

Symbols

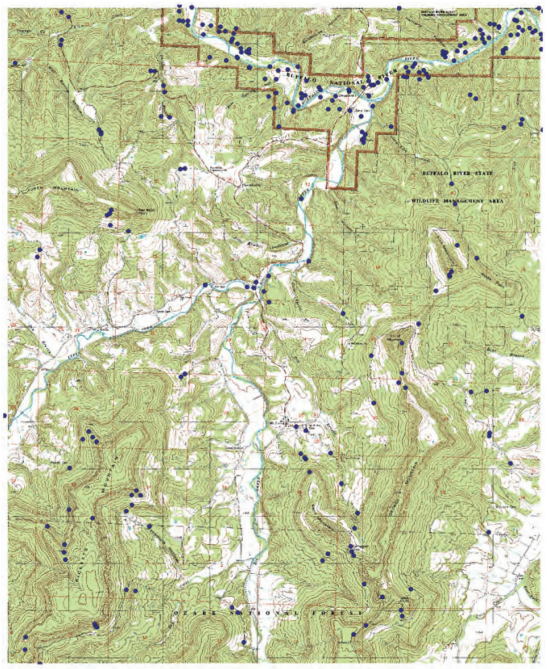


Graphic from source map: Mt. Judea Quadrangle.

Quadrangle Location Map

Graphic from source map: Mt. Judea Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Mt. Judea quadrangle showing location of data collection points.

Graphic from source map: Mt. Judea Quadrangle.

Photograph

Very old terrace cobbles located 200 feet (60m) above the river in Sec. 35, T 16N, R20 W.

Photograph from source map: Mt. Judea Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Mt. Judea quadrangle. This quadrangle was previously mapped at 1:62,500 scale by Glick, in 1976, for the Geologic Map of Arkansas. From 2002-2003, this quadrangle was mapped for the National Cooperative Geologic Mapping Program through STATEMAP. During 2014-2015, the terrace deposits along the Buffalo National River were mapped with funding provided by the National Park Service. Approximately six miles of the Buffalo National River are located in this quadrangle and are managed by the National Park Service.

Approximately 2100 feet (518 meters) of Middle Ordovician Morrowan-age strata crop out in this area. The Middle Ordovician St. Peter Sandstone is present only in the northeastern corner of the map. Middle and Upper Ordovician and Silurian limestones are present locally along the Buffalo National River. The Lower Mississippian Boone Formation forms the Springfield Plateau surface on the majority of the quadrangle. Upper Mississippian to Morrowan sandstone, shale, and limestone form steep sided mountains on the edge of the Boston Mountains escarpment in the quadrangle.

Quaternary terrace and alluvium deposits are present in the valley of the Buffalo National River and its tributaries. Two terrace levels are well developed along the river: a younger and a medial. Older terraces are located 80-160 feet (24-49 meters) above the river in most meander bends. Locally, very old terrace deposits are preserved approximately 200 feet (61 meters) above the river.

Text from source map: Mt. Judea Quadrangle.

Acknowledgements

This map was produced for STATEMAP, Cooperative Agreement Award 02HQAG0017, a matching-funds grants program with the US Geological Survey under The National Cooperative Geologic

Mapping Program. Thanks to Corbin Cannon and Danny Rains for their assistance with mapping the terrace deposits along the Buffalo National River. Special thanks to the National Park Service, U.S. Forest Service, Game and Fish Commission, and private landowners who graciously allowed access to their property.

Text from source map: Mt. Judea Quadrangle.

Limitations & Contact Information

This map, like all geologic maps, is based on interpretations which were made from the data available at the time it was created. As work continues and new data is collected, the contacts and structures depicted on this map may be changed.

For the latest edition of this and other AGS maps and publications, please call Publication Sales at 501-296-1877, or visit the Vardelle Parham Geology Center, 3815 West Roosevelt Road, Little Rock, Arkansas 72204. This map is available at: http://www.geology.ar.gov/geologicmaps/dgm_24k.htm.

Text from source map: Mt. Judea Quadrangle.

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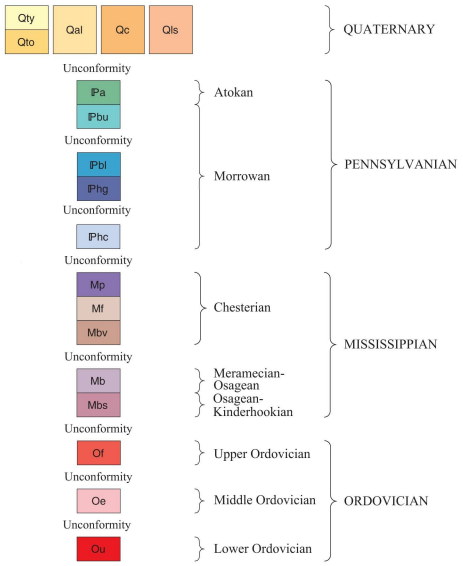
Text from source map: Mt. Judea Quadrangle.

Murray Quadrangle (SIM-3360)

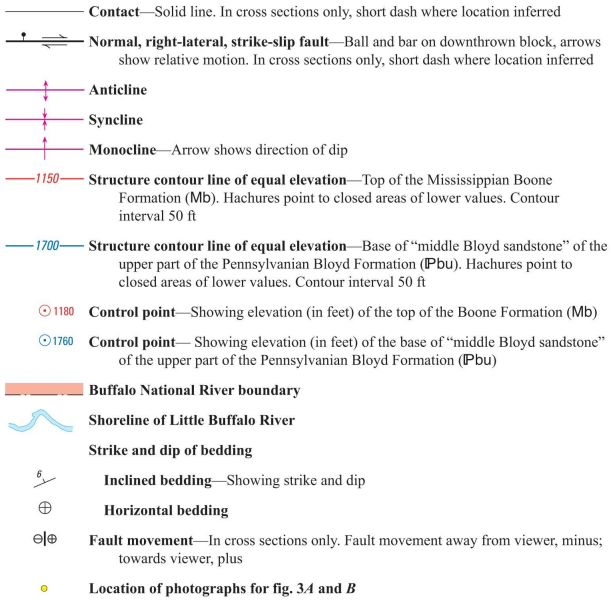
Hudson, M.R., and Turner, K.J., 2016, Geologic Map of the Murray Quadrangle, Newton County, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3360, scale 1:24,000 (*GRI Source Map ID 76081*).

Correlation of Map Units



Graphic from source map: Murray Quadrangle.

Map Explanation



Graphic from source map: Murray Quadrangle.

Quadrangle Location Map

Graphic from source map: Murray Quadrangle.

Figure 1: Location of Study Area

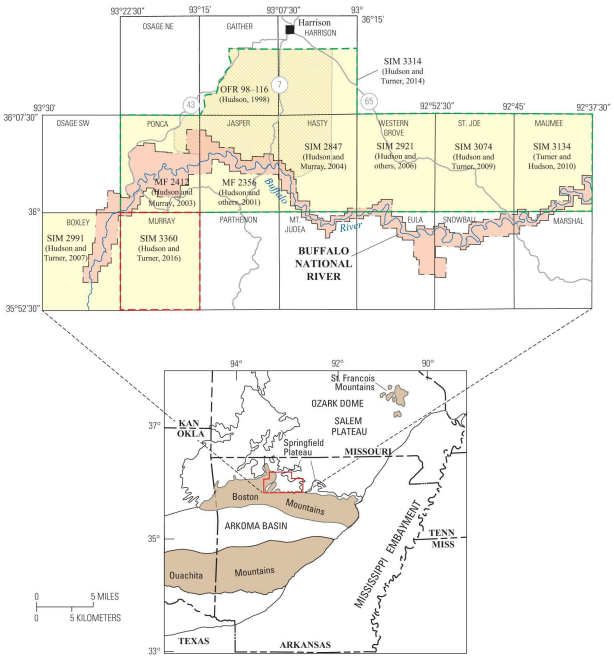


Figure 1. Location of study area in northern Arkansas, adjacent to the western part of Buffalo National River are highlighted in yellow and their publication numbers are shown. Lower regional map shows geologic and selected physiographic provinces of Arkansas and adjacent areas. The Ozark Plateaus region includes Salem and Springfield Plateaus and Boston Mountains physiographic provinces. U.S. Geological Survey Scientific Investigations Map 3314 in dashed green outline. This report in dashed red outline.

Graphic from source map: Murray Quadrangle.

Figure 2: Stratigraphic Column

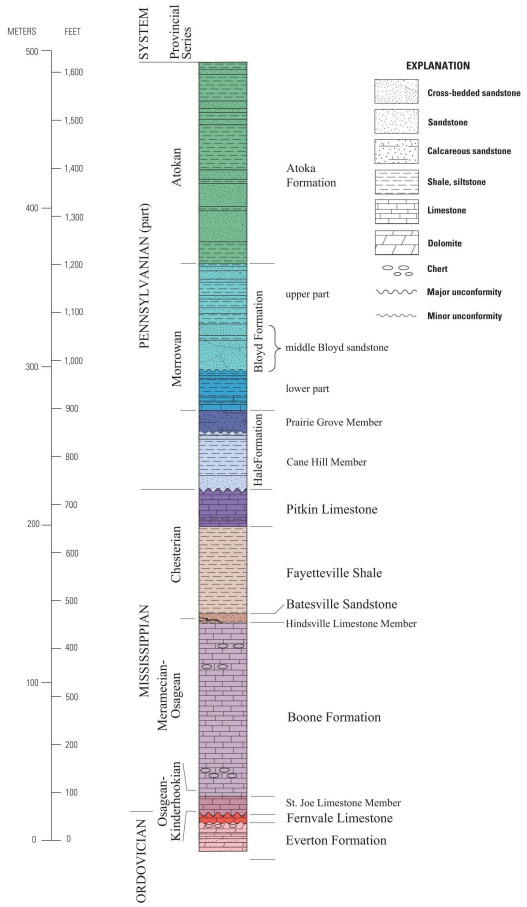


Figure 2. Stratigraphic column for Paleozoic rocks representative of the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

Graphic from source map: Murray Quadrangle.

Figure 3:Photographs

Figure 3. A, Photograph of an exposure along Stepp Creek in the southern part of the quadrangle of crinoid-bearing limestone clasts of probable Mississippian Pitkin Formation origin that are included in the basal conglomerate of overlying Pennsylvanian Cane Hill Member of Hale Formation (PNhc). Global positioning satellite receiver is 4 in long for scale. B, Conjugate normal faults with small offset (<4 in) cutting middle Bloyd sandstone ledges (base of Pbu). Photographs by M.R. Hudson, 2013.

Graphic from source map: Murray Quadrangle.

Figure 4: Structural Features Map

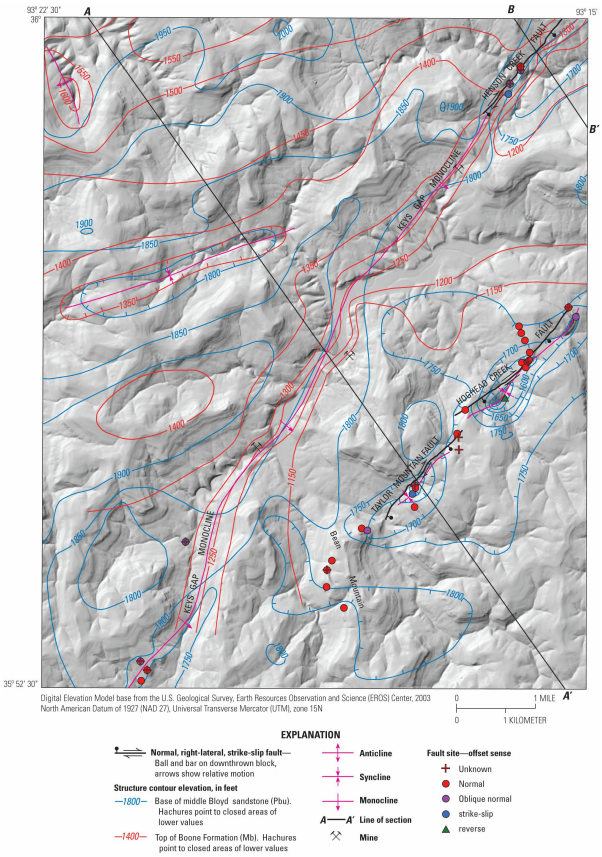


Figure 4. Shaded-relief digital elevation map of quadrangle with location of structural features and sites where faults were observed. Slip senses for faults at sites are indicated as normal (rake 90° to 60°), oblique (rake 59° to 30°), strike-slip (rake 29° to 0°) or reverse (rake > 30°). Also shown are approximate location of former lead-zinc mine sites of Little Buffalo River district, as described by McKnight (1935).

Graphic from source map: Murray Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Murray 7.5-minute quadrangle (fig. 1) in the Ozark Plateaus region of northern Arkansas. The Ozark Plateaus region, also referred to as “the Ozarks,” is an uplifted region extending south of the Missouri River and extending into northern Arkansas and into eastern Oklahoma. Geologically, the map area is on the southern flank of the Ozark dome, an uplift that has the oldest rocks exposed at its center, in Missouri. Physiographically, the Murray quadrangle is within the Boston Mountains, a high plateau region underlain by Pennsylvanian sandstones and shales (Purdue and Miser, 1916). Valleys of the Buffalo River and Little Buffalo River and their tributaries expose an approximately 1,600-ft-thick (488-m-thick) sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds. The Buffalo National River, a park which encompasses the Buffalo River and adjacent land that is administered by the National Park Service, is present at the northwestern edge of the quadrangle.

Mapping for this study was carried out by field inspection of numerous sites and was compiled as a 1:24,000-scale geographic information system (GIS) database. Locations and elevation of sites were determined with the aid of a global positioning satellite receiver and a hand-held barometric altimeter that was frequently recalibrated at points of known elevation. Hill-shade relief and slope maps derived from a U.S. Geological Survey (USGS) 10-meter (m) digital elevation model as well as orthophotographs (U.S. Geological Survey, 2003) were used to help trace ledge-forming units between field traverses within the Upper Mississippian and Pennsylvanian part of the stratigraphic sequence. Strike and dip of beds were typically measured along stream drainages or at well-exposed ledges. Structure contours, constructed on the top of the Mississippian Boone Formation (Mb) and the base of a prominent sandstone unit within the Bloyd Formation (Pnbu), were drawn based on the elevations of field sites on these contacts as well as other limiting information for their minimum elevations above hilltops or their maximum elevations below valley bottoms.

Text from source map: Murray Quadrangle.

Stratigraphy

The study area preserves an approximately 1,600-ft-thick record of early and late Paleozoic deposition on what is now the southern margin of the North American continent. Provincial series for Pennsylvanian and Mississippian units are from McFarland (1988).

The Middle Ordovician Everton Formation (Oe) is a heterogeneous sandstone and carbonate unit that Suhm (1974) interpreted to have been deposited in barrier island and tidal flat depositional environments. The Everton Formation is unconformably overlain by the Upper Ordovician Fernvale Limestone (Of) that was deposited as a shallow-water carbonate shelf sand (Craig, 1975).

The Mississippian Boone Formation (Mb) is widespread within the northern part of the quadrangle. The phosphate-nodule-bearing sandstone at the base of the St. Joe Limestone Member (Ms) of the Boone Formation is persistent throughout much of northern Arkansas (McKnight, 1935) and was probably deposited in the Early Mississippian as a transgressive lag during sea-level rise (Horner and Craig, 1984). The contact of the main body of the Boone Formation with the St. Joe Limestone Member is gradational and is based on the change to the thin bedding and the generally chert-free lithology of the St. Joe Limestone Member. Near the top of the Boone Formation an oolite interval as thick as 3 ft is present.

Locally, the Hindsville Limestone Member of the Batesville Sandstone contains angular chert fragments that were probably derived from the underlying Boone Formation and demonstrates a depositional hiatus between the Boone Formation and Batesville Sandstone (Mbv). Continued Chesterian transgression allowed accumulation of the black, organic-rich Fayetteville Shale (Mf) in a deep shelf setting followed by regression and deposition of the upward coarsening Pitkin Limestone (Mp) (Handford, 1986).

The onset of Morrowan deposition reflects a sea-level rise following a terminal Mississippian sea-level drop (Sutherland, 1988; Manger and Sutherland, 1992). Consequently, the base of the Morrowan Cane Hill Member (Pnhc) of the Hale Formation represents a significant unconformity within the map area. The thinning and local absence of the Pitkin Limestone beneath this unconformity in the northern part of the quadrangle is likely due to Late Mississippian-Early Pennsylvanian erosion. This conclusion is supported by the common presence of probable limestone clasts (probably of the Pitkin Limestone) within basal conglomerate lenses of the Cane Hill Member of the Hale Formation. A 20-ft-thick mixed interval of limey sandstone, crinoidal limestone, and black shale at top of the Pitkin Limestone is well exposed along Stepp Creek (35.878°N., 93.312°W.) in the southern part of quadrangle and is preserved below a basal Cane Hill Member conglomerate bed with large limestone clasts (fig. 3*A*). This sandy limestone interval may be correlative with latest Mississippian lower Imo Formation (Gordon, 1964), which has been mapped to the south and east of the map area (Smith and

Hutto, 2007; Angela Chandler and Richard Hutto, Arkansas Geological Survey, personal commun., 2014). The basal sandstone channels of the Cane Hill Member grade laterally and upward into thin bedded, rippled, fine- to very fine grained sandstones and siltstones that were probably deposited in tidal flat environments (Manger and Sutherland, 1992). The study area is within the distribution of thick sand-rich facies of the Prairie Grove Member (Pnhg) of the Hale Formation (Sutherland, 1988).

Limestone of the Brentwood Limestone Member of the Bloyd Formation is not mapped separately and is included in the lower part (Pnbl) of the Bloyd. It is conformable with the underlying Prairie Grove Member (Pnhg) such that the contact is commonly gradational. The presence of limestone conglomerates with clasts of sandstone and siltstone as well as fossil fragments indicates a high-energy marine environment during deposition of part of the lower part of the Bloyd Formation. Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation (Pnbu) were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka Formation (Henbest, 1953) representing the prominent cliff-forming cross-bedded sandstone. Zachry (1977), however, concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it with the informal term “middle Bloyd sandstone” that was deposited in a braided river environment. The middle Bloyd sandstone interval comprises the basal interval of the upper part of the Bloyd Formation map unit as used here. Upsection from the middle Bloyd sandstone interval, siltstone and shale intervals are mixed with fine to coarse sandstones with some containing quartz pebbles similar to the middle Bloyd interval and some extensively bioturbated indicating a marine transgression above the river deposits. The interval of calcite cemented sandstone or bioclastic limestone in the upper part of the section indicates a brief incursion of a shallow marine environment.

The Atoka Formation (Pna) is a sequence of alternating marine sandstone and shale that has generally been interpreted to represent fluvio-deltaic depositional environments in the southern Ozarks region (Zachry and Sutherland, 1984). The basal contact is well defined 38 miles (mi) to the west in Washington County where the Kessler Limestone Member at the top of the Bloyd Formation is unconformably overlain by shale of the Trace Creek Member of the Atoka Formation (Zachry and Sutherland, 1984). There, sandstone intervals of the Atoka Formation are principally fine- to very fine-grained and laterally extensive. The contact between the Bloyd and Atoka Formations in the Buffalo River area has been more difficult to define due to the absence of a distinctive underlying limestone. Within the Ponca 7.5-minute quadrangle, Hudson and Murray (2003) placed this contact above the level of a thin coal bed approximately 250 ft above the base of the middle Bloyd sandstone. In the Boxley 7.5-minute quadrangle, the Bloyd-Atoka contact was placed at a similar level above the middle Bloyd sandstone within a shale interval beneath an approximately 100-ft-thick interval of laterally extensive ripple laminated fine- to very fine-grained, thin to medium bedded sandstone that underlies a prominent topographic ledge (Hudson and Turner, 2007). We have continued with this convention in the Murray quadrangle, but also note the presence of a sandy limestone interval observed at two locations (35.888°N., 93.300°W. and 35.911°N., 93.290°W.) in the southern part of the quadrangle that are 140–180 ft above the middle Bloyd sandstone. The Kessler Limestone Member in Washington County is an oolitic limestone bearing algal nodules (Henbest, 1953) whose lithology is different from the sandy bioclastic limestone interval that we observed in this quadrangle; thus we do not think they are correlative.

Text from source map: Murray Quadrangle.

Structural Geology

Structure contours on the top of the Mississippian Boone Formation and the bottom of the prominent middle Bloyd sandstone of the upper part of the Pennsylvanian Bloyd Formation illustrate how faults and folds in two main structural zones deformed rocks within the map area. Structure contours conform to elevations at 99 and 138 control sites on the Boone Formation and Bloyd Formation reference contacts, respectively; other limiting information was used for their minimum elevations above hilltops or their maximum elevations below valley bottoms. Structure contours for the Boone

Formation are not extended into the southeastern parts of the quadrangle where no control sites were available.

The dominant structural feature of the quadrangle is a N.32°E.-trending fault and fold zone that transects the quadrangle and drops strata to the southeast (fig. 4). The northeastern part of this structural zone is formed by the N.40°E.-trending Henson Creek fault and adjacent dipping strata. Along cross section *B–B′*, throw of the Boone Formation-Batesville Sandstone contact across Henson Creek fault is about 100 ft with lowering of an additional 150 ft by folding that mostly affects the downthrown southeastern block of the fault. The Henson Creek fault is interpreted to continue northward to merge with the southern end of the N.55°E.-trending Carlton fault (Hudson and Turner, 2014a), although poor bedrock exposure in the Panther Creek drainage within the Jasper 7.5-minute quadrangle obscures this connection. To the south, the Henson Creek fault terminates into the Keys Gap monocline that continues southwestward, aligning with parts of the Little Buffalo River valley in the center of the quadrangle and continuing along Thomas Creek in the south. It is likely that faults like the Henson Creek fault lie at depth beneath the Keys Gap monocline (cross section *A–A′*). Structure contours demonstrate that both the top of the Boone Formation and the base of the middle Bloyd sandstone drop to the southeast across the Henson Creek fault and Keys Gap monocline but that the middle Bloyd sandstone drops less. Northwestward thinning of the intervening Late Mississippian Fayetteville Shale and Pitkin Limestone as well as erosional truncation of the Pitkin Limestone beneath the basal Pennsylvanian unconformity (cross Sections *A–A′* and *B–B′*) takes up most of the difference between flexure of the Mississippian and Pennsylvanian reference horizons. This change of unit thickness suggests that the Keys Gap monocline-Henson Creek fault structural zone was active as early as the Late Mississippian. In the Ponca quadrangle to the north, thickness variations of Upper Mississippian strata as well as overlap of the Kyles Landing fault by the Early Pennsylvanian Cane Hill Member of the Hale Formation were also recognized (Hudson and Murray, 2003) and were attributed to a latest Mississippian phase of tectonic activity (Hudson and Turner, 2014b).

A second N.40°E. trending structural zone that lies about 2 mi to the southeast of the Keys Gap monocline is composed of the en echelon Hoghead Creek and Taylor Mountain faults (fig. 4). Both Hoghead Creek and Taylor Mountain faults have maximum down-to-the-southeast throw near the center of their map lengths, with displacement dying out rapidly at the tips. Narrow northeast-trending synclines lie immediately southeast of both faults in their downthrown southeastern sides.

Two additional gentle folds are recognized within the quadrangle. A shallow east-northeast- trending syncline extends from Beckham Creek on the east to Arrington Creek on the western edge of the quadrangle and is expressed in structure contours on both Mississippian and Pennsylvanian reference horizons. A small north-northwest-trending domal anticline at the head of Dry Creek at the northwestern corner of the quadrangle is defined by a local rise of the top of the Boone Formation.

Structural data gathered from ninety faults observed within the quadrangle, most too small to portray on the map, show the extent of fault deformation as well as give insight into the causative stresses. Sites where faults were observed are coincident with the two northeast-trending structural zones, but extend beyond areas where map-scale faults are recognized (fig. 4). The greatest frequency of observed small faults cut the middle Bloyd sandstone (fig. 3*B*) along the structural zone containing the Hoghead Creek and Taylor Mountain faults, although the zone of small-scale faulting continues to the southwest of the Taylor Mountain fault onto the northern hillsides of Bean Mountain. A similar zone of small faults cuts the middle Bloyd sandstone at the southwestern end of the Keys Gap monocline; other faults observed along the Keys Gap monocline-Henson Creek fault zone mostly cut Boone Formation.

Faults have a variety of attitudes and slip senses that mostly vary from normal to strike slip (figs. 4 and 5*A*). The most common faults are east-northeast-striking normal faults that dip moderately north or south. Northeast-striking faults with dextral sense and west-northwest-striking faults with sinistral sense are also present. Two reverse faults too small to map were observed southeast of the Hoghead Creek fault (fig. 4) and may accommodate localized shortening during formation of its adjacent syncline. Paleostress inversions for thirty-eight faults with known slip direction and sense, using the

method of Angelier (1990), suggest that most faults formed in transtension with a least principal stress axis oriented south-southeast and shallowly inclined but with intermediate and maximum principal stress axes flipping between near-vertical and east-northeast and shallow (fig. 5*B*). This north-south extension that affected strata at least as young as Morrowan (fig. 3*B*) is similar to widespread deformation documented elsewhere in the southern Ozark dome that has been attributed to flexure of the southern continental margin during progressive loading of the Ouachita orogenic belt (Hudson, 2000). The recurrent activity of the structural zones in this quadrangle is evidenced by their influence on Late Mississippian stratal thicknesses and their subsequent focusing of post Morrowan north-south extension as well as the northeast trend of these zones. This is common for basement structural weaknesses throughout the mid-continent area (Marshak and Paulsen, 1996), and suggests that these structural zones may overlie preexisting Precambrian basement structural weaknesses.

Joints are common in bedrock units throughout the quadrangle. Measured joints (1,221 total) are near vertical and distributed in several sets (fig. 5*C*). The dominant sets strike northeast and north. A less prominent joint set strikes northwest. Joint planes within carbonate formations, such as the Boone Formation, are commonly enlarged due to dissolution.

Text from source map: Murray Quadrangle.

Economic Geology

Within the quadrangle, lead and zinc were mined from ores of galena and zinc carbonate intermittently in the early 1900s as the southern part of the Little Buffalo River district (McKnight, 1935). Each of three mines (now abandoned) within the quadrangle lies along the Keys Gap monocline (fig. 4) and all extracted ore was from the upper part of the Boone Formation in zones of fracturing and small faults (McKnight, 1935), indicating that there was a structure control on mineralizing fluids.

The organic-rich Fayetteville Shale (Mf) is a target for shale-oil hydraulic fracturing (fracking) farther south in Arkansas with over 6,000 oil and gas well drilled as of 2016 (Arkansas Geological Survey, 2016).

Text from source map: Murray Quadrangle.

Acknowledgments

This work was carried out as a cooperative project between the U.S. Geological Survey and the National Park Service.

Text from source map: Murray Quadrangle.

Contact Information

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Text from source map: Murray Quadrangle.

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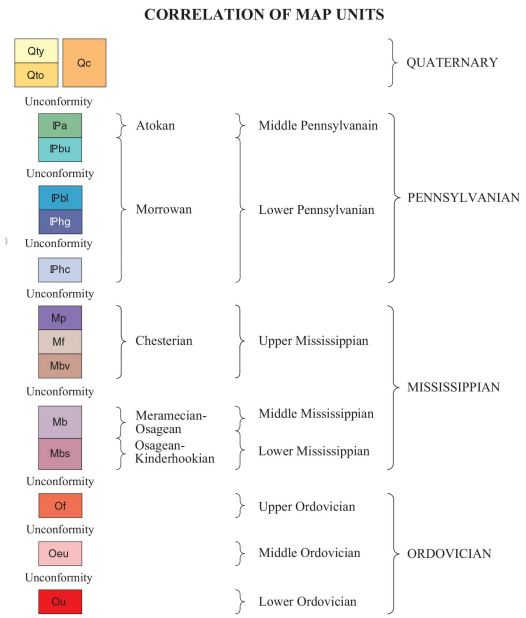
Text from source map: Murray Quadrangle.

Osage SW Quadrangle (SIM-3400)

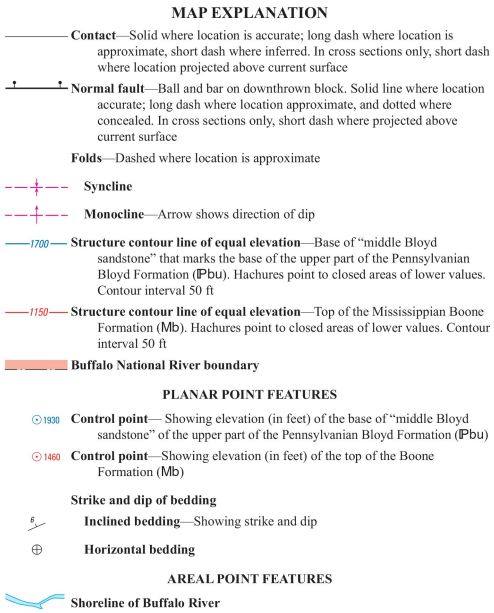
Hudson, M.R., and Turner, K.J., 2018, Geologic Map of the Osage SW Quadrangle, Newton, Madison, and Carroll Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3400, scale 1:24,000 (*GRI Source Map ID 76151).*

Correlation of Map Units



Graphic from source map: Osage SW Quadrangle.

Map Explanation



Graphic from source map: Osage SW Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the U.S. Geological Survey (USGS) Osage Southwest 7.5-minute quadrangle (fig. 1) in the Ozark Plateaus region of northern Arkansas. Geologically, the area is on the southern flank of the Ozark dome, an uplift with the oldest rocks exposed at its center in the St. Francois Mountains in Missouri. Physiographically, the Osage Southwest quadrangle is located within a transitional area between the Boston Mountains to the south and the Springfield Plateau to the north (fig. 1). Exposed within the quadrangle is an approximately 1,460-feet (ft)-thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds. The southeasternmost corner of the map area falls within the Buffalo National River—a park which encompasses the Buffalo River and adjacent land that is administered by the National Park Service. The majority of the quadrangle is privately owned land.

Geologic mapping for this study was compiled at 1:24,000-scale in a geographic information system (GIS) database. The ScienceBase data release, including GIS and other files that support this report, is available at https://doi.org/10.5066/P98DH5SP (Turner and Hudson, 2018). Locations and elevation of sites were determined with the aid of a global positioning satellite receiver and a handheld barometric altimeter that was frequently recalibrated at points of known elevation. Contacts were traced between traverses using shaded relief and slope maps derived from U.S. Geological Survey 10-meter (m) digital elevation model (accessed January 2014, at https://nationalmap.gov) and 1-m resolution light detection and ranging (lidar) datasets (accessed April 2017, from https://nationalmap.gov). Strike and dip of beds were typically measured along stream drainages or at well-exposed ledges. Beds dipping less than 2° are shown as horizontal. Structure contours were manually constructed at the top of the Mississippian Boone Formation (Mb) and the base of a prominent Pennsylvanian sandstone unit that marks the base of the upper part of the Bloyd Formation (*bu) to conform to elevations of control points and projection of bedding attitudes.

Text from source map: Osage SW Quadrangle.

Stratigraphy

The 1,460-ft-thick composite stratigraphic section and intervening unconformities exposed within the quadrangle record early and late Paleozoic deposition and erosion on the southern margin of the North American continent. Paleozoic rocks were exposed during Quaternary erosion associated with incision by the Buffalo River, and tributaries to the Kings River.

The Middle Ordovician Everton Formation (Oeu) is a heterogeneous sandstone and carbonate unit that Suhm (1974) interpreted to have been deposited in barrier island and tidal flat depositional environments. The Everton Formation in the map area correlates with the upper part of the formation mapped in the Ponca 7.5' quadrangle (Hudson and Murray, 2003) east of the map area, which is dominantly dolomitic with the exception of limestone and limey sandstone beds in the Jasper Member. Following deposition of the Everton Formation, the area was positioned on a shallow shelf environment and recurrent intervals of marine to subaerial transitions occurred throughout Middle and Late Ordovician time resulting in deposition and variable stripping of marine deposits (Frezon and Glick, 1959; Craig and others, 1984). Within the map area, the Everton Formation is unconformably overlain by Upper Ordovician Fernvale Limestone (Of); deposits between the Everton and Fernvale, exposed farther east in the Buffalo River area (McKnight, 1935; Hudson and Turner, 2014a), were removed prior to Fernvale deposition. The Fernvale Limestone is a coarsely crystalline, bioclastic limestone formed in an open, subtidal environment (Craig, 1975; Craig and others, 1984).

Following deposition of the Fernvale Limestone, the Ozark region was mildly warped (Frezon and Glick, 1959) resulting in a regional unconformity above shallowly south-dipping Ordovician units. Above the unconformity is a distinctive phosphate-nodule-bearing sandstone at the base of the Lower Mississippian St. Joe Limestone Member of the Boone Formation (Mbs). The sandstone is present throughout much of northern Arkansas (McKnight, 1935) and is interpreted as a transgressive lag deposit formed during Early Mississippian sea-level rise (Horner and Craig, 1984). The St. Joe Limestone Member grades upward from generally chert-free, red to pink, and thin bedded limestone into massive, chert-rich beds of the main body of the Boone Formation (Mb). The Boone Formation is a widespread unit throughout the region and is prone to karstification.

The Batesville Sandstone (Mbv) overlies the Boone Formation and is composed of sandstone and minor limestone. The basal Hindsville Limestone Member (not mapped separately) is only locally present but contains angular chert fragments probably eroded from the underlying Boone Formation (fig. 3C). The angular chert fragments indicate a depositional hiatus and period of erosion, which resulted from sea level fall following deposition of the Boone Formation (Handford, 1995). Sandstones of the Batesville Sandstone (Mbv) are interpreted as having been deposited in delta front and shoreface environments that prograded into the area from the northeast during Chesterian sea level rise (Glick, 1979).

Continued deepening of the sea associated with Chesterian transgression resulted in deposition of black, fissile shales of the Fayetteville Shale (Mf) that conformably overlie the Batesville Sandstone. Subsequent shallowing of the sea is indicated by deposition of the calcite-cemented Wedington Sandstone Member (not mapped separately) in the upper part of the Fayetteville Shale, followed by deposition of the Pitkin Limestone (Mp) (Handford, 1986). Throughout most of the quadrangle, Pitkin Limestone is absent; however, where overlain by Pitkin Limestone, Fayetteville Shale varies in thickness from 170 ft in the southwest to about 60 ft in the northwest. Thinning of the Fayetteville Shale in the northwest part of the map could be explained by either a local erosional event that occurred prior to deposition of the Pitkin Limestone, or, alternatively, significantly less accumulation of the shale in the northwest part of the map. Hudson and Turner (2014b) report variations in Upper Mississippian strata in the Buffalo River area, which they suggest could be related to tectonism.

Regression of the sea in Late Mississippian resulted in a major unconformity eroded into Upper

Mississippian strata (Sutherland, 1988; Manger and Sutherland, 1992). This period of erosion is supported by the pinchout of the Pitkin Limestone, thinning of the Fayetteville Shale, and the presence of Archimedes-bearing Pitkin Limestone clasts in basal conglomerate lenses of the Cane Hill Member of the Lower Pennsylvanian Hale Formation (*hc), which were deposited above the unconformity (for example, Purdue and Miser, 1916; Hudson and Turner, 2016).

Sandstone and siltstone channels of the Cane Hill Member (*hc) vary laterally and stratigraphically and are interpreted as tidally influenced successions with lenses of storm-deposited calcareous sandstones (Manger and Sutherland, 1992). Following a period of erosion, alternating thick sand-rich bioclastic facies and thin shales of the Prairie Grove Member of the Hale Formation (*hg) represent deposition in a shelf environment in a series of rapidly alternating transgressive pulses (Sutherland, 1988).

The Brentwood Limestone Member of the Bloyd Formation, included here in what we refer to as the lower part of the Bloyd Formation (*bl), is gradational with the underlying Prairie Grove Member of the Hale Formation. The presence of limestone conglomerate with sandstone and siltstone clasts and fossil fragments indicates a high-energy marine environment during deposition of part of the lower part of the Bloyd Formation. Sandstone and shale of the upper part of the Bloyd Formation were originally called Winslow Formation by Purdue and Miser (1916), and the prominent cliff-forming cross-bedded sandstone was correlated with the basal Greenland Sandstone Member of the Atoka Formation (Henbest, 1953). However, Zachry (1977) concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation, farther west. The sandstone, informally designated the “middle Bloyd sandstone,” is interpreted as a braided river deposit (Zachry, 1977). The middle Bloyd sandstone is the basal interval of the upper part of the Bloyd Formation map unit (*bu) as used here. Overlying the middle Bloyd sandstone, the unit consists of siltstone and shale mixed with fine to coarse sandstones that record deposition in a marine environment consistent with correlative deposits of the Dye Shale Member farther to the west (Zarchary, 1977). Some sandstone beds in the upper part of the Bloyd Formation are extensively bioturbated and contain quartz pebbles similar to pebbles in the middle Bloyd sandstone indicating a marine transgression following deposition of the braided river deposits of the middle Bloyd sandstone. A marine transgression is further supported by the presence of a limey sandstone with shell impressions and crinoid ossicles observed about 110 ft above the base of the middle Bloyd sandstone along the eastern edge of the quadrangle (¼ NW, ¼ NW, sec. 13, T. 16 N., R. 23 W.). Occurrences of limestone and limey sandstone were observed 140–180 ft above the base of the middle Bloyd sandstone in the Murray quadrangle to the southwest (Hudson and Turner, 2016).

The Atoka Formation (*a) is composed of alternating beds of marine sandstone and shale that, in the southern Ozarks region, is interpreted as fluvio-deltaic deposits (Zachry and Sutherland, 1984). In this area, sandstone intervals of the Atoka Formation are principally very fine to fine grained and laterally extensive. The basal contact is well exposed approximately 30 miles west of the map area in Washington County where the Kessler Limestone Member at the top of the Bloyd Formation is unconformably overlain by shale of the Trace Creek Member of the Atoka Formation (Zachry and Sutherland, 1984). The contact between the Bloyd and Atoka Formations in the Buffalo River area is problematic due to the absence of the distinctive limestone lithology of the Kessler Limestone Member. The basal Atoka contact within the quadrangle is inferred based on its stratigraphic position in the adjacent Boxley and Ponca 7.5' quadrangles. Within the Ponca quadrangle, Hudson and Murray (2003) placed the contact above a thin coal bed approximately 250 ft above the base of the middle Bloyd sandstone. In the Boxley quadrangle to the south, Hudson and Turner (2007) placed the Bloyd-Atoka contact at a similar level within a shale interval beneath an approximately 100-ft-thick interval of sandstone that holds up a prominent topographic ledge. This sandstone sequence is typical of Atoka facies in the region as it contains thin- to medium-bedded, very fine to fine-grained sandstone with ripple laminations.

Text from source map: Osage SW Quadrangle.

Structural Geology

The dominant structural feature of the Osage Southwest quadrangle is the N.70□ E.- to N.80□ E-trending Compton fault and associated parallel folds that extend across the center of the quadrangle. Structure contours on top of the Boone Formation and base of the middle Bloyd sandstone are more closely spaced and are subparallel to the fault near the east-northeast trending zone (fig. 4). The Compton fault dips to the south-southeast and has normal-sense offset. Cumulative displacement of strata is greatest along the eastern map boundary where as much as 350 ft of displacement is observed across the fault and the associated longitudinal hanging wall syncline adjacent to the south side of the fault, the Grogans Hollow syncline (cross section B–B'). Rocks on the northern footwall of the fault dip gently to the north. The Compton fault continues eastward into the Ponca quadrangle, although its surface trace is now mapped slightly north of that shown by previous mapping (Hudson and Murray, 2003; Hudson and Turner, 2014a) based on the change from north dips in the footwall to the steep south dip of the proximal hanging wall. Where Grogans Hollow turns northwest, a northeast-trending down-to-northwest fault branches from the Compton fault into its footwall, decreasing the throw across the Compton fault to the west. Along the south side of Cockran Hollow, the middle Bloyd sandstone is not displaced by faulting but rather dips steeply to the south as a monoclinal flexure. In contrast, a lower limestone bed in the Cane Hill is steeply dipping and is displaced by faulting indicating that propagation of the Compton fault was restricted to a structural level below the level of the Bloyd Formation in this area. The Compton fault is interpreted to continue to the west where it is concealed below younger terrace and active-channel alluvial deposits (Qty) along Dry Creek. The Compton fault coincides with an east-west-oriented fault, or series of faults, shown by Middendorf and others (1997) to extend an additional 18 mi west of the Osage Southwest quadrangle boundary.

A parallel zone of down-to-north monoclinal folds and small-offset normal faults lies about 2 km south of the Compton fault. The Logan Mountain fault is the longest fault along this structural zone and starts in the upper reaches of Dry Creek and extends to the west past the quadrangle boundary. Cumulative displacement across the Logan Mountain fault including dipping beds on either side of the fault is as much as 120 ft with displacement increasing to the west. Together, the Compton fault and the paired southern fault and fold zone form an incipient graben.

The trace of the west-northwest striking Pickle Hollow fault in the north-central part of the quadrangle is mostly covered by younger terrace and active-channel alluvial deposits (Qty) but it drops the top of the Boone Formation (Mb) about 100 ft to the south. Structural offset at the eastern and western extents of the fault is accommodated by down-to-south monoclinal flexure of strata above the fault that is likely buried at depth. Purdue and Miser (1916) identified the Pickle Hollow fault, but they show the fault to extend about 1 mi east of Kenner Creek where we interpret a monocline with no discreet fault offset. West of the trace of the Pickle Hollow fault, strata are dropped to the south by a monoclinal flexure as strata of the Bloyd Formation are not displaced by faulting. Northeast of Dinsmore, the Boone Formation and Batesville Sandstone drops as much as 80 ft to the south across the monocline.

Ordovician rocks are exposed in the southeast corner of the quadrangle, in the Buffalo River valley. These rocks rise about 200 ft to the northwest into Whitley Creek valley and about 100 ft in Lost Valley (Clark Creek) in the upthrown limb of a broad east-northeast-trending monocline that represents the southwest continuation of the Adds Creek monocline on the Ponca quadrangle (Hudson and Murray, 2003). This monocline is part of a zone of faulted, northeast-trending monoclines that extends both farther to the northeast within the Ponca quadrangle (Hudson and Murray, 2003) and to the southwest within the Boxley quadrangle (Hudson and Turner, 2007) that together compose the southwestern part of the Ponca lineament (McFarland, 1988).

Structural data gathered from 52 faults observed within the quadrangle, most too small to show on the map, give insight into causative stresses responsible for fault deformation. Sites where faults were observed are mostly restricted to the east-northeast-trending structural zone of the Compton fault or opposing paired fault and fold zones (fig. 4). These faults predominantly strike east-northeast and have normal-slip sense (figs. 4 and 5A). Paleostress inversions for a subset of faults with known slip direction and sense, using the method of Angelier (1990), suggest that most faults formed in tension

with a least principal stress axis oriented south and shallow (fig. 5B). Joints measured within the map area (1,038 total) are near vertical and distributed in several sets (fig. 5C). The dominant sets strike northeast, north-northwest, and northwest.

Text from source map: Osage SW Quadrangle.

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Text from source map: Osage SW Quadrangle.

Parthenon Quadrangle (DGM-AR-00680)

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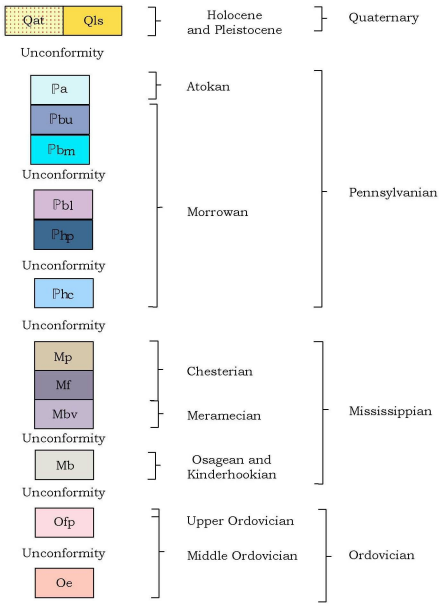
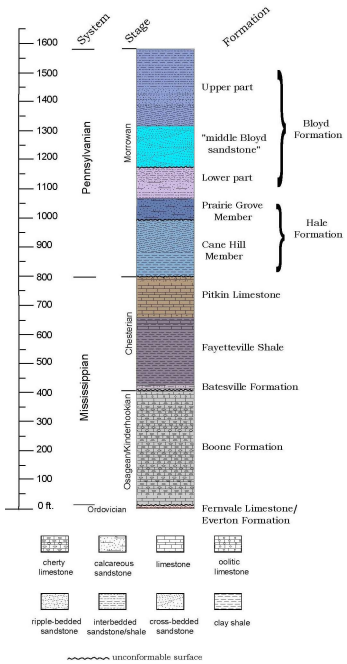
Correlation of Map Units



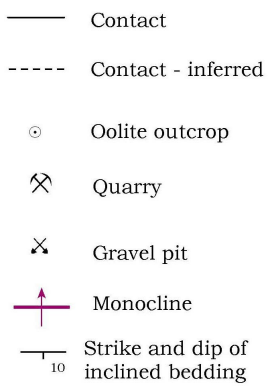
Graphic from source map: Parthenon Quadrangle.

Stratigraphic Column



Graphic from source map: Parthenon Quadrangle.

Symbols



Graphic from source map: Parthenon Quadrangle.

Quadrangle Location

Graphic from source map: Parthenon Quadrangle.

Map Notes

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Text from source map: Parthenon Quadrangle.

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Text from source map: Parthenon Quadrangle.

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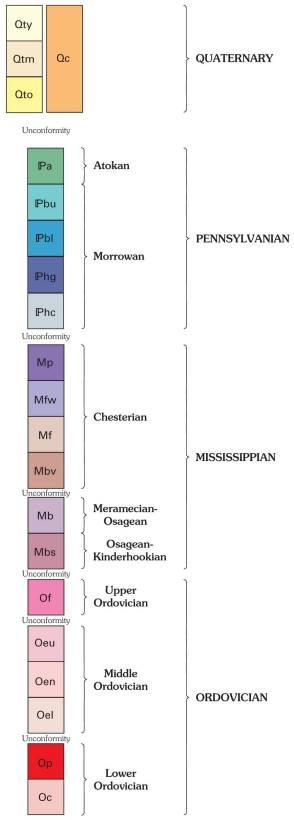
Text from source map: Parthenon Quadrangle.

Ponca Quadrangle (MF-2412)

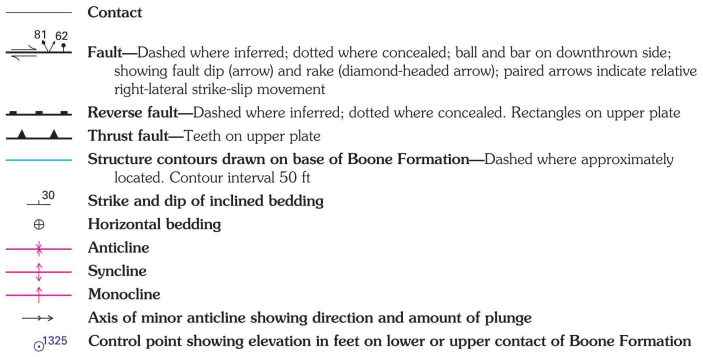
Hudson, M.R., and Murray, K.E., 2003, Geologic Map of the Ponca Quadrangle, Newton, Boone, and Carroll Counties, Arkansas: U.S. Geological Survey, Miscellaneous Field Studies Map, MF-2412, scale 1:24,000 (*GRI Source Map ID 4854*).

Correlation of Map Units



Graphic from source map: Ponca Quadrangle.

Symbols



Graphic from source map: Ponca Quadrangle.

Quadrangle Location Map

Graphic from source map: Ponca Quadrangle.

Figure 1: Location of Study Area

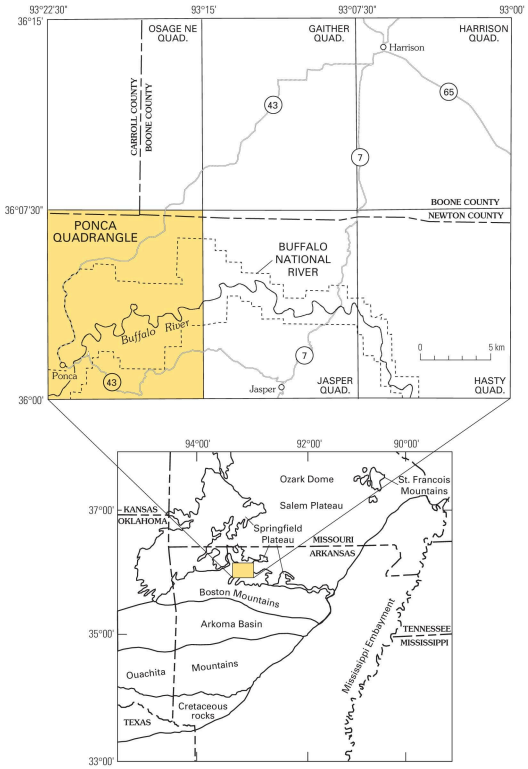


Figure 1. Location of study area within northern Arkansas, in and adjacent to the western part of Buffalo National River. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: Ponca Quadrangle.

Figure 2: Stratigraphic Column

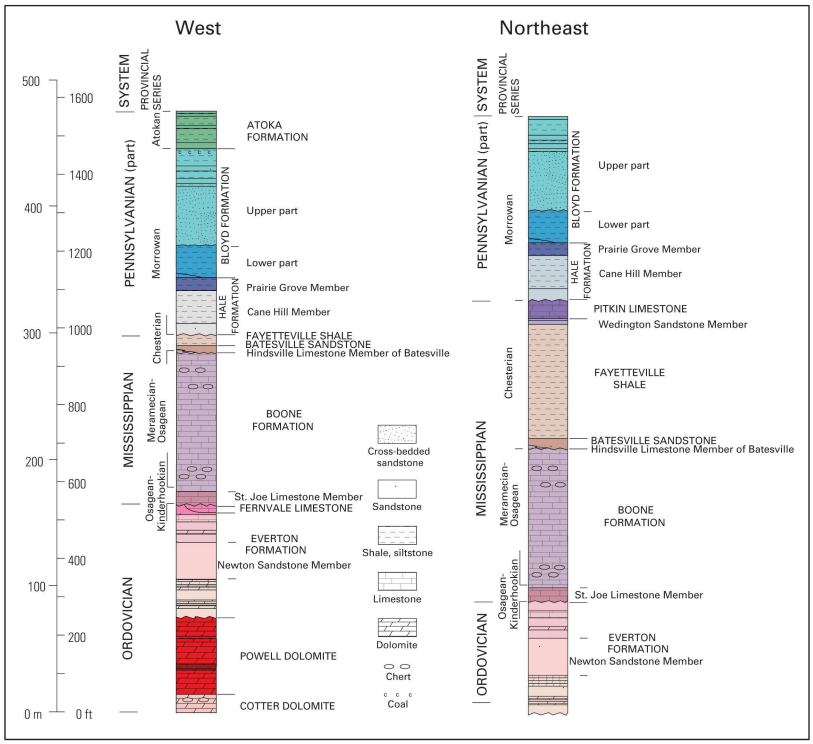


Figure 2. Stratigraphic columns for Paleozoic rocks of the map area. Column for west area generally reflects exposed stratigraphy near Hemmed-In Hollow. Column for northeast area reflects stratigraphy exposed in the Cecil Creek drainage. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

Graphic from source map: Ponca Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Ponca 7.5-minute quadrangle in the Ozark Plateaus region of northern Arkansas (fig. 1). The quadrangle is near the transition between two physiographic provinces, the Boston Mountains and the Springfield Plateau, and it contains a deep valley cut by the Buffalo River. The exposed bedrock of this region comprises an approximately 1,600-ft- (490-m-) thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds.

The geology of the Ponca quadrangle was first mapped by Purdue and Miser (1916) at 1:125,000 scale and later by Morrison (1971) at 1:24,000 scale. The current map confirms many features of these previous studies but it also identifies new structures and employs a revised stratigraphy.

Text from source map: Ponca Quadrangle.

Stratigraphy

The study area preserves a 1,600-ft- (490-m-) thick record of early and late Paleozoic deposition on what is now the southern margin of the North American continent. Stages for Pennsylvanian and Mississippian units are from McFarland (1988).

Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation and the Atoka Formation were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka (Henbest, 1953) representing the prominent cliff-forming crossbedded sandstone. Morrison (1971) followed this convention. Zachry (1977), however, concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it with the informal term “middle Bloyd sandstone.” This sandstone interval comprises the basal interval of the upper part of the Bloyd Formation as used here. The contact between the Atoka and Bloyd Formations on the map is located within alternating shale and sandstone intervals and is indistinct. Atoka Formation is interpreted to be preserved within the map area because the aggregate thickness of strata above the Hale Formation is as great as 500 ft (152 m), much greater that the typical 100-150 ft (30–46 m) thickness of the Bloyd Formation 60 km to the west in Washington County where the presence of the Kessler Limestone Member at the top of the Bloyd Formation allows separation of the Bloyd and Atoka Formations (Zachry, 1977; Zachry and Sutherland, 1984). Where it has been studied in Washington County, lower Atoka Formation is a marine sequence (Zachry and Sutherland, 1984). Within the map area, the presence of a thin coal bed approximately 250 ft (76 m) above the base of the upper part of the Bloyd Formation indicates deposition of these beds in a non-marine setting. Thus, the Bloyd-Atoka contact was placed above this horizon.

The base of the Morrowan Cane Hill Member of the Hale Formation represents a major erosional unconformity within the map area. Late Mississippian-Early Pennsylvanian erosion removed the Pitkin Limestone, the Wedington Sandstone Member, and much of the main body of the Fayetteville Shale in the western part of the map (fig. 2). This truncation is most abrupt across the Kyles Landing fault south of the Buffalo River (cross section *B*–*B*'), indicating that movement on this fault was pre-Pennsylvanian and that it caused differential erosion across the fault. North of the river, truncation of the Pitkin Limestone at the Web monocline suggests that this structure was also active before Pennsylvanian time. In addition to structural uplift, a sea-level drop at the end of the Mississippian Period (Sutherland, 1988) also was probably a key factor in development of the unconformity. Above the unconformity, the heterogeneous nature of the basal sandstone interval of the Cane Hill Member of the Hale Formation, as well as its content of conglomerate and wood fragments, suggests that this interval includes non-marine fluvial deposits that were deposited ahead of a Morrowan sea-level rise. Limestone clasts within conglomerates of the basal Cane Hill Member were probably derived from Pitkin Limestone. The main part of the Boone Formation within most of the study area does not contain as much chert as described elsewhere in northern Arkansas. As a consequence, its contact with underlying St. Joe Limestone Member, which elsewhere is based on a marked increase in chert, is indistinct. This study did not confirm major thinning of the Boone Formation in the area of the Sneeds Creek dome, as proposed by Morrison (1971). Instead, apparent thinning can be attributed to offset between the base and top of the Boone Formation across a newly recognized northeast-striking normal fault. Although thin, the phosphate nodule- bearing sandstone and overlying thin shale at the base of the St. Joe is persistent throughout much of northern Arkansas (McKnight, 1935). Based on petrography, Horner and Craig (1984) supported a correlation of the basal sandstone with the Sylamore Sandstone that was deposited as a transgressive lag during sea level rise in Late Devonian time. Strata of uppermost Ordovician through Devonian age are missing beneath the unconformity at the base of the St. Joe Limestone Member, although strata of these ages are preserved both to the east and west of the map area.

Suhm (1974) divided the Everton Formation into several formal and informal members that within the map area include, from top to bottom, the Jasper Member, B member, Newton Sandstone Member, C member, King River Sandstone Member, and Sneeds Dolomite Members. Only the Newton Sandstone Member, that forms a prominent cliff in much of the area, is mapped separately here. Suhm (1974) interpreted the mixed sandstone and carbonate interval of the Ordovician Everton

Formation as barrier islands and adjacent tidal-flat environments.

Text from source map: Ponca Quadrangle.

Structural Geology

Rocks within the map area were mildly deformed by a system of faults and folds. Structure contours on the base of the Boone Formation illustrate the location of structures and their vertical offset. The structure contours conform to elevations at 345 control points on the lower or upper contacts of the Boone Formation that were located on the topographic base map using one or a combination of a global position system receiver, a barometric altimeter, or a distinctive topographic contour pattern. A 390 ft (119 m) thickness for the Boone Formation was used to project the elevation of the basal contact from points on the upper contact, based on the average of several traverses across stratigraphic sections near the Buffalo River (Hudson, 1998).

The vertical offset across structures can be estimated from the elevation difference of formation contacts across the structures. Lateral offset is difficult to measure due to the lack of piercing points, but kinematic data suggest that strike-slip offset was important on small faults associated with the Adds Creek and Hanner Point monoclines. Fault striations that are sparsely preserved on planes of some mapped faults, or on adjacent, parallel, small-scale faults were used to infer the slip direction in some locations. Small cataclastic faults, or deformation bands (Aydin and Johnson, 1978), were commonly developed in porous Everton Formation sandstone in and adjacent to structures. Slip sense for mapped faults was inferred either from offset of bedding, from asymmetric minor fault-plane features, or from the geometry of conjugate sets of deformation bands in adjacent rock. Faults of normal, reverse, and strike-slip sense are all present within the map area.

The Kyles Landing fault is a reverse fault that dies out in the Bee Bluff monocline north of the Buffalo River. Beds of Everton and Boone Formations and Batesville Sandstone dip moderately to steeply adjacent to the fault, defining a nearly horizontal model fold axis that trends south-southeast (fig. 3*A*). The orientation of this fold axis and the geometry of sparse small-scale reverse faults (fig. 3*B*) and conjugate deformation bands (fig. 3*C*) in hanging wall Everton Formation indicate that the fault has reverse motion. The plane of the Kyles Landing fault is not exposed but, assuming a south-southeast strike, its trace over topography suggests that it dips steeply west-southwest (cross section *B*–*B*'). Traced southward, the Kyles Landing fault and adjacent folded strata are unconformably overlain by Cane Hill Member, indicating that this structure formed in Late Mississippian-Early Pennsylvanian time. To the north, the Bee Bluff monocline is interpreted to abut against a west-northwest continuation of the coeval Web monocline, although this interpretation is conjectural because the inferred connection is concealed beneath Pennsylvanian rock. Small strike-slip and normal faults were observed locally within the north-facing Web monocline in the adjacent Jasper quadrangle (Hudson and others, 2001), suggesting that it probably formed over a transtensional fault.

Normal faults are the predominant structures within the map area. In surface exposures the normal faults dip from 50° to 85°, aver ging 71° dip for 15 measurements. Seven west-northwest-striking, en echelon normal faults form a 2-km-wide, N. 60° W.-trending zone that crosses the center of the area and intersects the east-northeast-striking Compton fault and the northeast-trending Hanner Point monocline. This en echelon pattern of normal faults is like that produced in analog models of low-angle oblique rifts (Withjack and Jamison, 1986), suggesting that the zone may have developed over a basement weakness. Striations on the individual mapped faults within this zone have high rakes (fig. 3*D*), indicating extension was essentially normal to their strike. Likewise, conjugate sets of eformation bands measured in Everton Formation sandstone at a footwall site (36° 3.99'N, 93° 18.77'W) adjacent to the California Point fault (fig. 3*E*) also indicate south-southwest extension. Within the zone, maximum down drop lies within the Jim Bluff graben, whose strata are about 600 and 450 ft lower than correlative strata on adjacent northern and southern zone flanks, respectively. The Compton fault dips steeply southeast and has normal throw of over 300 feet in its central part (cross-section *A*–*A*'), but this offset decreases abruptly at its eastern end. Conjugate sets of deformation bands (fig. 3F)

observed at a hanging wall site (36° 4.57'N, 93° 19.89'W) adjacent to the eastern part of the Compton fault are consistent with north-northwest extension on this fault, but the deformation bands at this site are crosscut by small-scale strike-slip faults (fig. 3*G*) that suggest that the fault was probably reactivated under north-northwest shortening. Mapped normal faults within the quadrangle affect all Paleozoic strata and thus they were active after Middle Pennsylvanian time. The normal faults accommodated north-directed extension that was probably caused by flexure of the foreland of the developing Ouachita orogeny to the south (Hudson, 2001).

The northeast-trending Adds Creek and Hanner Point monoclines in the western part of the map area are associated with a zone of short mapped faults and small-scale faults having strike-slip as well as dip-slip offset. Together with a northeast alignment of lead-zinc mines near Ponca (McKnight, 1935) and topographic features on and beyond the quadrangle, these structures lie within a N. 30° E.-trending zone that has been called the Ponca lineament (McFarland, 1988). It is likely that this lineament formed over a preexisting fault zone in Precambrian basement that was partly reactivated with strike-slip and down-to-the southeast motion to form the overlying monoclines and associated small faults. The left step between the Adds Creek and Hanner Point monoclines is similar to what might form above en echelon Riedel faults within a buried northeast-trending dextral fault zone (Tchalenko, 1970). The Adds Creek and Hanner Point monoclines and associated faults affect all Paleozoic strata and thus they were active after Middle Pennsylvanian time.

The Sneeds Creek dome (Purdue and Miser, 1916) is an east-northeast-elongated, doubly plunging anticline in the footwall of the Compton fault within which rocks of the quadrangle achieve their highest elevation. Although this fold probably initiated as an extensional forced fold (Withjack and others, 1990) above the Compton normal fault, the presence of a small, south-southeast-vergent thrust fault in the fold core (Sec. 6, T. 16 N., R. 22 W.) suggests that this fold also accommodated some north-northwest shortening. We interpret that the Sneeds Creek dome probably was tightened during later reactivation of the Compton fault in response to north-northwest-directed compression at the end of the Ouachita orogeny.

Dips of bedding within folds in the map area are generally greater than 5° and have consistent directions. Away from structures, where structure contours indicate little dip of the base of the Boone Formation, dips of bedding at the surface are mostly low and variable in direction. These dispersed attitudes can be attributed to local subsidence caused by karst dissolution within the abundant limestone and dolomite rock units and to unrecognized rock creep.

Joints within the map area (406 joints measured) are distributed in two dominant strike sets (fig. 3*H*), northeast and north. A less prominent joint set strikes east. Joint planes within limestone and dolomite formations, such as the Boone Formation, are commonly enlarged due to dissolution.

Text from source map: Ponca Quadrangle.

Economic Geology

Lead and zinc were mined intermittently within the Ponca-Boxley district from the 1860's through the 1950's (McKnight, 1935; McFarland, 1988). Within the map area, the mines are located near Ponca and align in a northeast trend that is collinear with the Adds Creek monocline. McKnight (1935) reported that about 4,000 tons of concentrates of galena, zinc carbonate, and zinc silicate were produced from the Ponca-Boxley district. All ore zones precipitated at or near the contact between upper Boone Formation and Batesville Sandstone, and most are associated with zones of fracturing and small strike-slip faults (McKnight, 1935).

Text from source map: Ponca Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. Special thanks go to the private owners who allowed access onto their land during this study. We thank J.D. McFarland, III, D.N. Mott, and D.L. Zachry for helpful discussions during the course of the study. Helpful reviews were provided by W.R. Page, K. Kellogg, and J.D. McFarland, III.

Text from source map: Ponca Quadrangle.

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Text from source map: Ponca Quadrangle.

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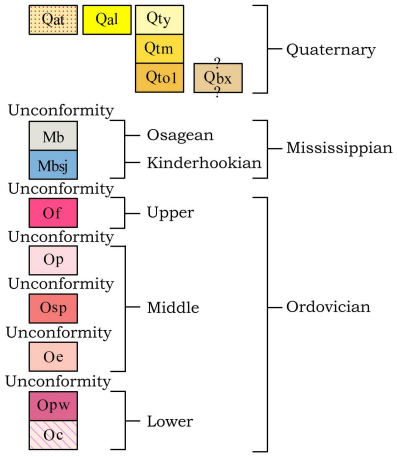
Text from source map: Ponca Quadrangle.

Rea Valley Quadrangle (DGM-AR-00730)

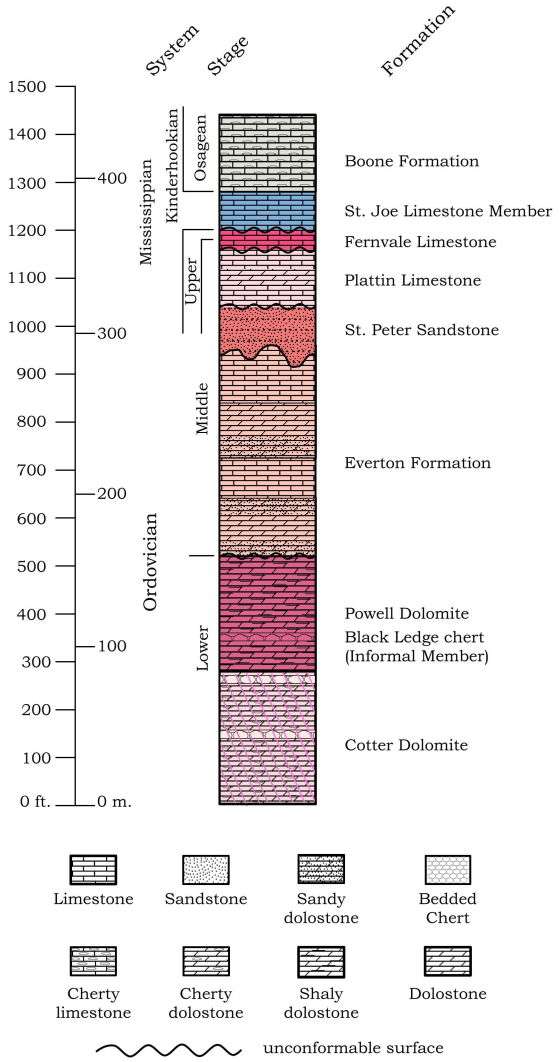
Ausbrooks, S.A., Johnson, T.C., Nondorf, L.M., and Traywick, C.L., 2011, Geologic Map of the Rea Valley Quadrangle, Marion County, Arkansas: Arkansas Geological Survey, Digital Geologic Quadrangle Map, DGM-AR-00730, scale 1:24,000 (*GRI Source Map ID 74687*).

Correlation of Map Units



Graphic from source map: Rea Valley Quadrangle.

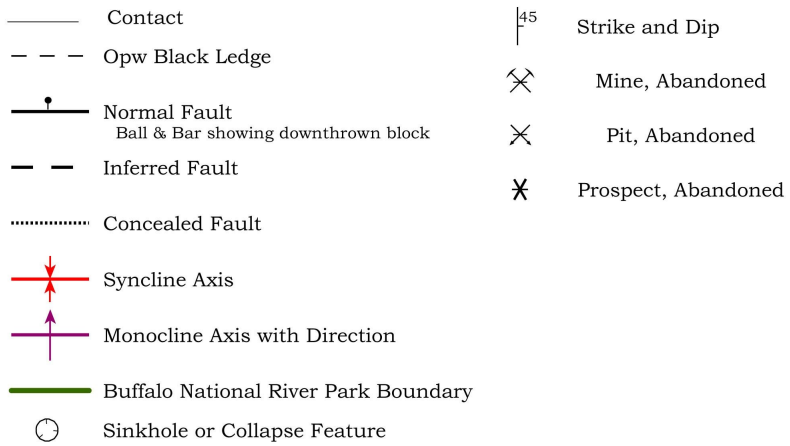
Stratigraphic Column



Paleozoic Rocks within the quadrangle. (Maximum thickness of each unit shown).

Graphic from source map: Rea Valley Quadrangle.

Symbols

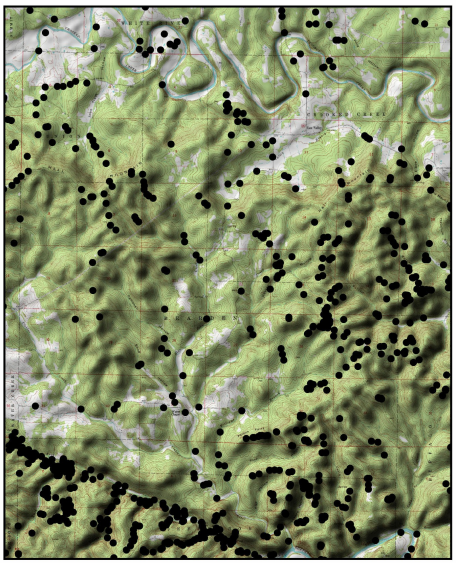


Graphic from source map: Rea Valley Quadrangle.

Quadrangle Location Map

Graphic from source map: Rea Valley Quadrangle.

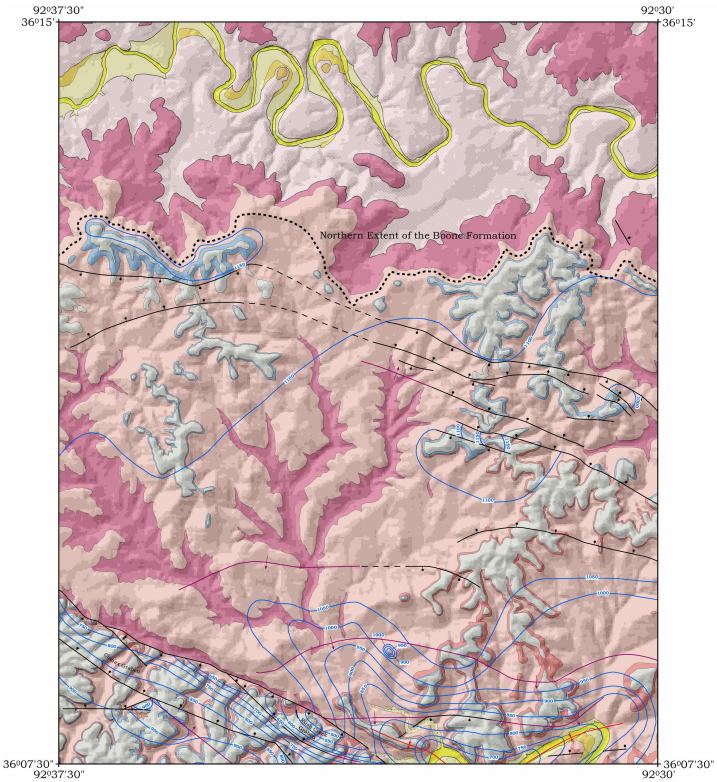
Topographic Map with Data Collection Points



Map of the Rea Valley Quadrangle showing location of data collection points.

Graphic from source map: Rea Valley Quadrangle.

Major Structures and Generalized Structure Contours Map



Map of the Rea Valley quadrangle showing location of major structures and generalized structural contours on the base of the Boone Formation. Contour interval: 50 Feet (Adapted from McKnight, 1935)

Graphic from source map: Rea Valley Quadrangle.

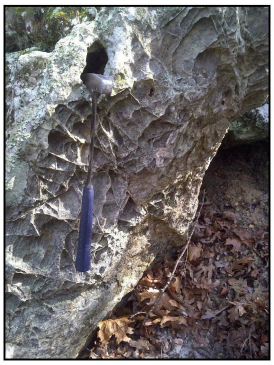
Photographs

Photo 1

Stromatolites in the lower limestone of the Everton Formation (Oe) on Hall Mountain.

Photograph from source map: Rea Valley Quadrangle.

Photo 2



Deformation bands in the St. Peter Sandstone (Osp) near Rush Creek Fault.

Photograph from source map: Rea Valley Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Rea Valley 7.5-minute quadrangle. This quadrangle was previously mapped by E.E. Glick in 1970 for the Geologic Map of Arkansas (1976). E.T. McKnight (1935) mapped the Rea Valley as part of a larger (1:125,000-scale) map focused on the understanding of the lead and zinc deposits of the area. Structural contours on the base of the Boone Formation were adapted from McKnight (1935). This map incorporates previously collected data with new detailed geologic mapping. The geologic contacts and structural features are based on field observations. Data collection points were obtained by using a Global Positioning System (GPS) receiver in conjunction with a U.S. Geological Survey 7.5-minute topographic map. Bedrock dipping less than 3° is considered horizontal. Bedrock units of less than 20 feet thick were considered “not mappable” at a 1:24,000-scale and were incorporated into adjacent stratigraphic units. Approximately 2 miles (3 kilometers) of the Buffalo National River are located on this quadrangle and are managed by the National Park Service. Almost 17 miles (27 kilometers) of Crooked Creek meanders across the northern portion of the quadrangle.

Text from source map: Rea Valley Quadrangle.

Summary

Stratigraphically, over 1400 feet (427 meters) of Lower Ordovician to Mississippian age strata are exposed in this formations comprise the surface rock over the majority of the map (north of the Rush Creek Fault) and form the gently undulating surface of the gently undulating Salem Plateau. The Mississippian Boone Formation forms ridges on the dissected Springfield Plateau. Quaternary terrace and alluvium deposits are present in the valleys of Crooked Creek, the Buffalo River and its tributaries. Two terrace levels are well-developed along the west half of Crooked Creek and the

Buffalo River - a younger and medial. Several poorly exposed and isolated deposits of an older terrace were located higher above Crooked Creek.

Regional structure is controlled in large part by an uplifted area (known as the Ozark Dome) centered in southeastern Missouri. From this structural high, the progressively younger rock formations dip southward and form increasingly elevated plateau surfaces (Ozark Plateaus Region) in Arkansas. A prominent escarpment south of Crooked Creek separates the Salem and Springfield Plateaus. Locally, certain areas of bedrock have been deformed by both large and small faults and folds. Structural highlights of the Rea Valley include a pair of normal faults that form the Hall Mountain Graben spanning across the northern portion of the map and the faults and monoclines of the Rush Lead and Zinc Mining District in the southern portion of the quadrangle. These include the Rush Creek, Climax, Cold Spring and Monte Cristo Fault Systems and the Cabin Creek Monocline.

The Hall Mountain Graben spans across the northern portion of the map and has approximately 20 to 80 feet (6 to 24 meters) of vertical displacement along its length. The Rush Creek Fault is downthrown to the southwest. According to McKnight (1935) the Rush Creek Fault has a maximum vertical displacement of approximately 450 feet (137 meters). The Climax and Cold Spring Faults are downthrown to the northeast and have maximum vertical displacements of approximately 150 feet (45 meters) each. The north-dipping Climax and Cold Spring Faults in conjunction with the south-dipping Rush Creek Fault form the Climax and Rush Creek Grabens, respectively. The Cabin Creek Monocline dips to the south with a structural drop of approximately 450 feet (McKnight, 1935). This area was heavily prospected for zinc in the late 1800's and
early 1900's. Zinc mines and prospect pits are present throughout the quadrangle; however locations are not shown within the National Park since they are considered sensitive park resources.

Text from source map: Rea Valley Quadrangle.

Acknowledgments

This map was produced for the National Park Service through the Geologic Resource Inventory Program through contract C2360086145. Special thanks to the National Parks Service, U.S. Forest Service and to private landowners who graciously allowed access to their property. Helpful discussions with M.R. Hudson of the U.S. Geological Survey, Denver, CO. provided guidance and insight into the Quaternary age remnant block deposits associated with faulting. Upper Ordovician formation and lithologic unit determination based on conodont fauna analysis by Dr. Stephen A. Leslie of James Madison University, Harrisonburg, VA. The Buffalo National River Park boundary came from the National Park Service, Harrison, Arkansas.

Text from source map: Rea Valley Quadrangle.

Disclaimer and Contact Information

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Text from source map: Rea Valley Quadrangle.

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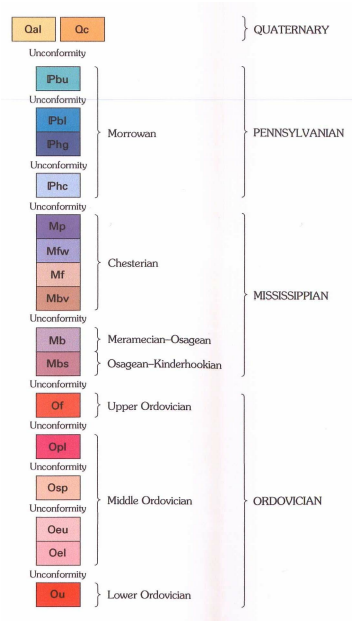
Text from source map: Rea Valley Quadrangle.

St. Joe Quadrangle (SIM-3074)

Hudson, M.R., and Turner, K.J., 2009, Geologic Map of the St. Joe Quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-3074, scale 1:24,000 (*GRI Source Map ID 75172*).

Correlation of Map Units

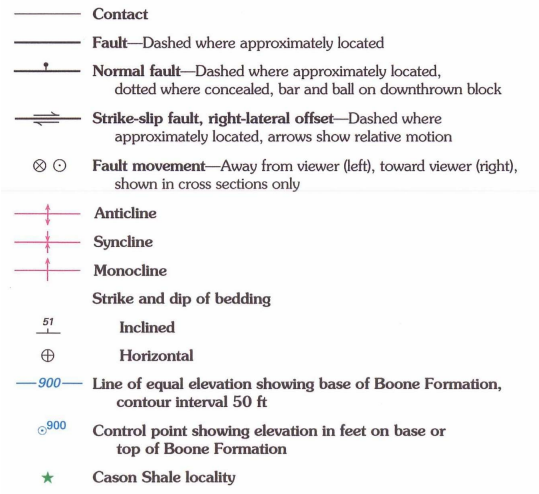


Graphic from source map: St. Joe Quadrangle.

Quadrangle Location Map

Graphic from source map: St. Joe Quadrangle.

Map Explanation



Graphic from source map: St. Joe Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Figure 1: Location of Study Area

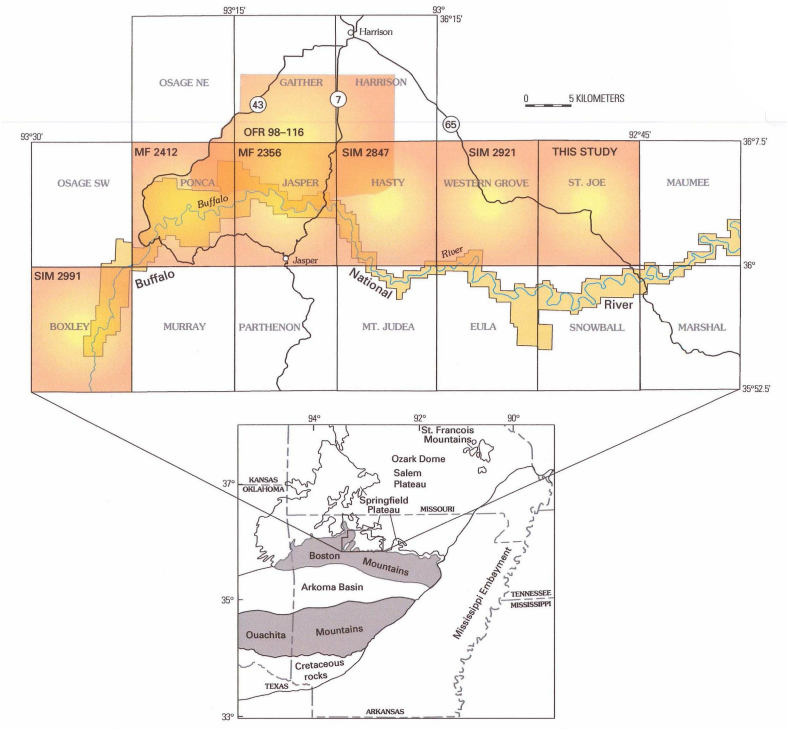


Figure 1. Location of study area within northern Arkansas, adjacent to the western part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998; Hudson and others, 2001, 2006; Hudson and Murray, 2003, 2004; Hudson and Turner, 2007) are listed by publication number. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

Graphic from source map: St. Joe Quadrangle.

Figure 2: Stratigraphic Column

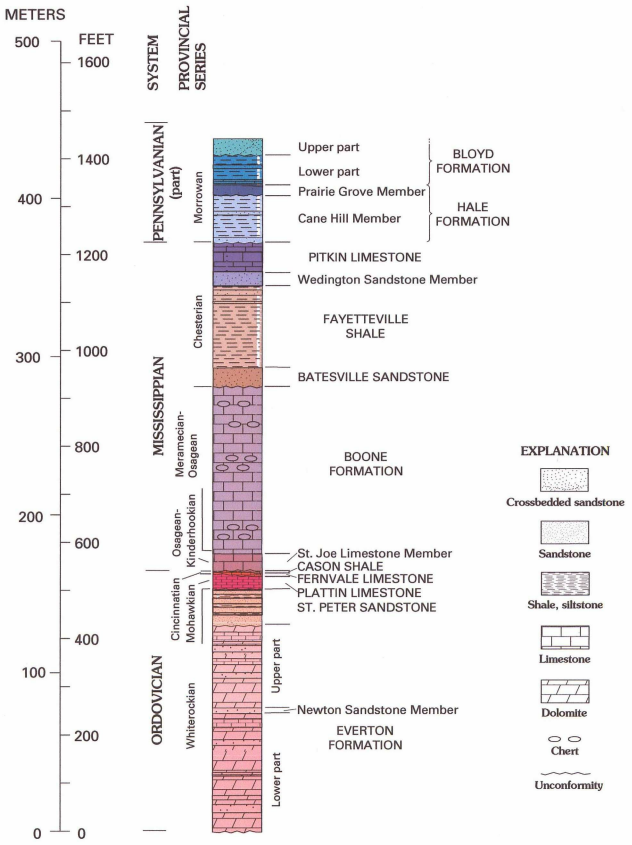


Figure 2. Stratigraphic column for Paleozoic rocks representative of the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1998).

Graphic from source map: St. Joe Quadrangle.

Figure 3: Mining and Structural Map

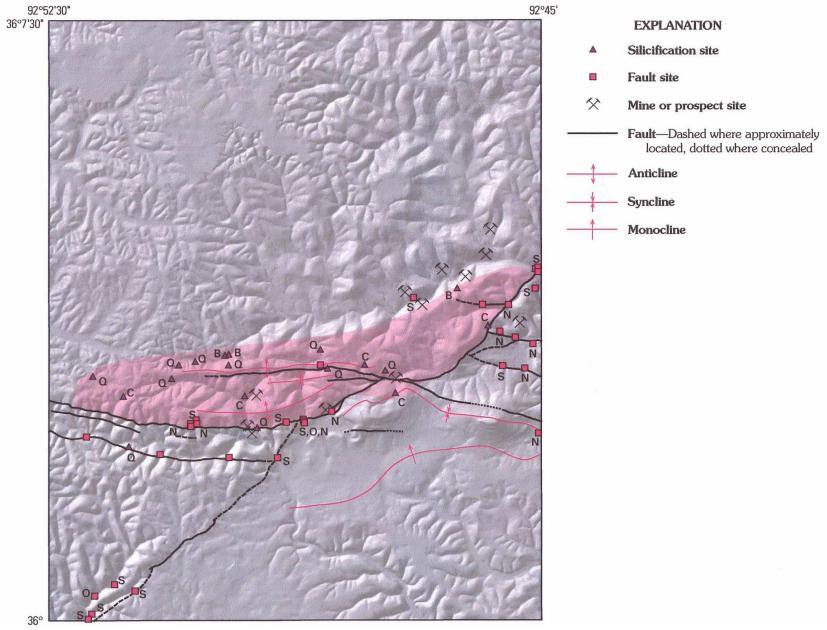


Figure 3. Shaded-relief digital elevation map of quadrangle with locations of Pb-Zn mines and prospects, structural features, and sites where faults (squares) and silicification (triangles) were observed. Where determined, slip senses for faults at sites are indicated as normal, N (rake 90° to 60°); obliques, O (rake 59° to 30°); and strike-slip, S (rake 29° to 0°). Sites with silicification define an elongate area (pink) centered mostly north of the St. Joe and Davy Crockett faults. Silicification was classified as Q, coarse and microcrystalline quartz crystals; B, silica-cemented chert breccia; or C, enhanced silica cementation in sandstone. Mine and prospect location are estimated from descriptions in McKnight (1935).

Graphic from source map: St. Joe Quadrangle.

Figure 5: Photographs

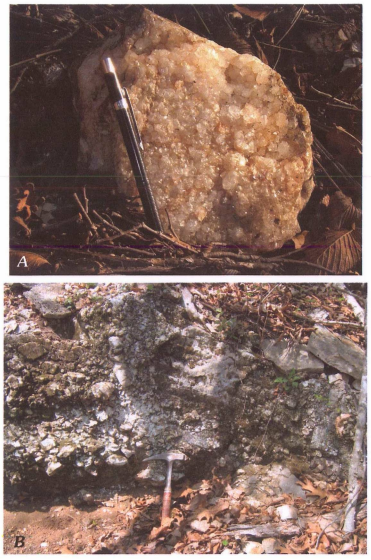


Figure 5. Photograph of (A) quartz crystals on chert block from Boon Formation (pencil is about 5 in. long), and (B) chert breccia mass (hammer handle is about 12 in. long). Photographs by M.R. Hudson and K.J. Turner, 2008.

Photographs from source map: St. Joe Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the St. Joe 7.5-minute quadrangle (fig. 1) in the Ozark Plateaus region of northern Arkansas. Geologically, the area lies on the southern flank of the Ozark dome, an uplift that exposes oldest rocks at its center in Missouri. Physiographically, the St. Joe quadrangle lies within the Springfield Plateau, a topographic surface generally held up by Mississippian cherty limestone (Purdue and Miser, 1916). The quadrangle also contains isolated mountains (for example, Pilot Mountain) capped by Pennsylvanian rocks that are erosional outliers of the higher Boston Mountains plateau to the south. Tomahawk Creek, a tributary of the Buffalo River, flows through the eastern part of the map area, enhancing bedrock erosion. Exposed bedrock of this region comprises an approximately 1,300-ft-thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly deformed by a series of faults and folds.

The geology of the St. Joe quadrangle was mapped by McKnight (1935) as part of a larger area at 1:125,000 scale. The current map confirms many features of this previous study, but it also identifies new structures and uses a revised stratigraphy. Mapping for this study was conducted by field inspection of numerous sites and was compiled as a 1:24,000- scale geographic information system (GIS) database. Locations and elevations of sites were determined with the aid of a global positioning satellite receiver and a hand-held barometric altimeter that was frequently recalibrated at points of known elevation. Hill-shade-relief and slope maps derived from a U.S. Geological Survey 10-m digital elevation model as well as U.S. Geological Survey orthophotographs from 2000 were used to help trace ledge-forming units between field traverses within the Upper Mississippian and Pennsylvanian part of the stratigraphic sequence. Strikes and dips of beds were typically measured along stream drainages or at well-exposed ledges. Beds dipping less than 2° are shown as horizontal. Structure contours constructed on the base of the Boone Formation were hand drawn based on elevations of control points on both lower and upper contacts of the Boone Formation as well as other limiting

information on their maximum or minimum elevations.

Text from source map: St. Joe Quadrangle.

Stratigraphy

The quadrangle preserves a 1,300-ft-thick record of early and late Paleozoic deposition on what is now the southern margin of the North American continent. Provincial series terms for Pennsylvanian and Mississippian units are from McFarland (1988).

The Middle Ordovician Everton Formation (Oe) is a heterogeneous sandstone and carbonate unit that Suhm (1974) interpreted to have been deposited in barrier island and tidal flat depositional environments. The Everton Formation is discontinuously overlain by the Middle Ordovician St. Peter Sandstone (Osp) and Plattin Limestone (Opl) and, in the eastern part of the Mill Creek graben, by the Upper Ordovician Fernvale Limestone (Of) and Cason Shale (McKnight, 1935). Due to its limited thickness and distribution, Cason Shale was mapped undivided with Fernvale Limestone where it was observed west of the town of St. Joe. Whereas Cason Shale includes Silurian facies in its type area to the east near Batesville, Arkansas, Craig (1975) demonstrated that only its basal Upper Ordovician part is present in its isolated western outcrops.

The base of the Mississippian section is a major unconformity that progressively cuts deeper into the underlying Ordovician section towards the northwestern part of the quadrangle. The Mississippian Boone Formation (Mb) is the most widespread unit at the surface within the quadrangle. The phosphate-nodule-bearing sandstone at the base of theSt. Joe Limestone Member (Mbs) is persistent throughout much of northern Arkansas (McKnight, 1935). This sandstone was probably deposited as a transgressive lag during sea-level rise in Late Devonian time (Homer and Craig, 1984). The contact of the main body of the Boone Formation with the St. Joe Limestone Member is gradational and is based on the change to thin bedding and the generally chert-free lithology of the St. Joe Limestone Member. Near the top of the formation an oolite interval as thick as 3 ft is common. Braden and Ausbrooks (2003a) also recognized this facies in areas to the south and correlated this interval with the Short Creek Oolite Member of the Boone Formation, which is present in Missouri and Kansas (McKnight and Fischer, 1970). Black shales of the Fayetteville Shale (Mf) represent deposition within a southward-deepening muddy shelf that shoaled upward during deposition of the Pitkin Limestone (Mp) (Handford, 1985).

Initial Morrowan deposition reflects sea-level rise following a sea-level drop at the end of the Mississippian (Sutherland, 1988). Typical thin-bedded, rippled, fine- to very fine grained sandstones and siltstones of Cane Hill Member (Phc) of the Hale Formation were probably deposited in tidal flat environments (Manger and Sutherland, 1992). The quadrangle lies at the northeastern margin of the distribution of thick Prairie Grove Member (PNhg) of the Hale Formation (Sutherland, 1988). The Prairie Grove Member in the study area is represented by indistinct planar- or cross-bedded, calcite-cemented sandstone deposited in a shoreface environment. The lower part of the Bloyd Formation (PNbl) conformably overlies the Prairie Grove Member and represents deposition in an open-marine platform setting as sea level continued to rise. Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation (PNbu) were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka Formation (Henbest, 1953) representing the prominent cliff-forming crossbedded sandstone. Zachry (1977), however, concluded that the cliff-forming sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it with the informal term "middle Bloyd sandstone." The unconformable contact between the upper and lower parts of the Bloyd Formation represents a period of erosion prior to deposition of the middle Bloyd sandstone by terrestrial braided streams.

Text from source map: St. Joe Quadrangle.

Structural Geology

Rocks within the map area were deformed by a system of faults and folds. Structure contours on the base of the Boone Formation illustrate the location of structures and their vertical offset. The structure contours conform to elevations at 328 control points located at both lower and upper contacts of the Boone Formation, as well as other information limiting maximum or minimum elevations of these contacts. A 390-ft thickness for the Boone Formation (Mb) (including the St. Joe Limestone Member (Mbs)) was used to project the elevation of the basal contact from points on the upper contact. This average thickness was based on thicknesses from five stratigraphic sections farther west near the Buffalo River (Hudson, 1998).

Several regionally extensive fault systems intersect within the St. Joe quadrangle. We map faults that correspond to those previously named by McKnight (1935) as the St. Joe, Mill Creek, Pilot Mountain, Tomahawk, and South Tomahawk faults, although our fault traces differ in detail, and we also map several additional faults. The Mill Creek graben in the southwestern part of the quadrangle is part of a graben system that extends about 15 miles farther to the west (Purdue and Miser, 1916; Hudson and Murray, 2003; Hudson and others, 2006). Bounding the south side of the graben, the Mill Creek fault dies out eastward at its intersection with the northeast-striking Confederate fault, which we project into the quadrangle from areas farther southwest (Braden and Ausbrooks, 2003a, 2003b). Structure contours highlight a gentle southeast dip of strata in a broad flank northwest of the Confederate fault. This dipping block was part of the St. Joe monocline as named by McKnight (1935), but we abandon this as a separate structural feature and instead link it to growth of the Confederate fault. Cross section *A-A'* demonstrates that about 200 feet down-to-the southeast throw on the Confederate fault is required in addition to the southeast dip of strata to provide sufficient structural relief for the typical thickness of Boone Formation (Mb) between outcrops of its base and top. Bounding the north side of the Mill Creek graben, the St. Joe fault continues northeastward from its intersection with the Confederate fault until it overlaps the Davy Crockett fault at the southeastern border of Sec. 8, T. 16 N., R. 17 W. The Davy Crockett fault includes the northeast-striking segment of the Tomahawk fault of McKnight (1935), but we rename this fault segment because our mapping demonstrates that it continues to the northeast past McKnight's west-northwest striking segment of the Tomahawk fault, which we retain as a name. Similar to the Tomahawk fault, the west-northwest- striking South Tomahawk and Pilot Mountain faults extend from beyond the east edge of the quadrangle to intersect the Davy Crockett fault at their west ends. The West Mountain fault aligns with, and may be a westward continuation of, the Pilot Mountain fault across the Davy Crockett fault.

Whereas the vertical offset of structures can be estimated from the elevation difference of formation contacts across the structures, their lateral offset is difficult to measure due to the lack of appropriate markers. Fault data collected from mostly small-scale faults at numerous sites within the quadrangle (fig. 3) indicate the typical orientations and slip senses for faults (fig. 4A) and give insight into the causative stresses responsible for deformation. Most of these faults are small displacement cataclastic faults, deformation bands (Aydin and Johnson, 1978), preferentially developed in sandstones of the St. Peter Sandstone (Osp) and Everton Formation (Oe). Those faults whose slip senses could be determined are predominantly normal or strike slip (fig. 4B). Normal faults strike from east-northeast to east-southeast and dip moderately to the north or south. Among strike-slip faults, those with right-lateral sense mostly strike northeast and those with left-lateral sense have strikes ranging from east-southeast to south-southeast. Paleostress inversions for these normal and strike-slip faults, using the method of Angelier (1990), demonstrate that they formed in a stress regime with a least principal stress axis oriented south to south-southeast and near horizontal and with intermediate and maximum principal stress axes flipping between near vertical and east-northeast and near horizontal (fig. 4B). Similar coordinated movements among normal and strike-slip faults have been documented elsewhere in the southern Ozark dome, and their north-south extension accommodated late Paleozoic flexure of the southern continental margin as it was loading by the adjacent Ouachita orogenic belt (Hudson, 2001). From these data we interpret that (1) northeast-striking Confederate and Davy Crockett faults have components of right-lateral slip as well as down-to-the-southeast throw, and (2) east- to southeast-striking faults like those bounding the Mill Creek graben have normal slip.

The structure contours illustrate several folds and broad domes. The Baker Spring monocline on the eastern edge of the quadrangle has about 150 ft of relief and is expressed by consistent 5-10° north to north-northeast dips. Just to the north, a synclinal axis underlies St. Joe and Pilot Mountains with a northern limb upturned adjacent to the Davy Crockett (cross section *B-B')* and Pilot Mountain faults. Two east-west-trending open anticlines and a syncline lie directly north of the St. Joe fault. A broad, east-southwest trending dome is present in the northeastern part of the quadrangle. Away from folds, dips of bedding are low and variable in direction. These dispersed attitudes are attributed in part to local subsidence caused by karst dissolution within the abundant limestone and dolostone rock units.

Joints measured within the map area (695 total) are near vertical and distributed in several sets (fig. 4). The dominant set strikes north. Less prominent joint sets strike northeast and west-northwest. Joint planes within limestone and dolostone formations, such as the Boone (Mb) and Everton Formations (Oe), are commonly enlarged due to dissolution.

Text from source map: St. Joe Quadrangle.

Economic Geology

McKnight (1935) described lead and zinc ores from several mines in the St. Joe and Tomahawk Creek mining districts located on the northern, upthrown side of the St. Joe and Davy Crockett faults within the St. Joe quadrangle (fig. 3). The dominant ore mined from local prospects consists of sphalerite (ZnS) and zinc carbonate and minor copper in the form of malachite. Dolomitic and limestone layers of the Everton Formation (Oe) host most prospects. Silicification was commonly associated with Pb-Zn mineralization (McKnight, 1935) and was noted at several sites during this field investigation (fig. 3) defining an elongate area mostly north of the St. Joe and Davy Crockett faults. Within the Boone Formation (Mb), silica was precipitated as fracture coatings of drusy quartz having euhedral crystals tips as wide as 1/2 in. (fig. 5A). Additionally, within the Boone Formation and its basal St. Joe Limestone Member, several elongate bodies of brecciated chert cemented by microcrystalline quartz (fig. 5B) were noted, standing 3 to 20 ft high as erosion-resistant ridges. These masses probably formed by dissolution of limestone and collapse of chert within the Boone Formation followed by silicification during flow of mineralizing fluids. Enhanced silicic cementation of sandstone beds was also noted within the Ordovician St. Peter Sandstone (Osp) and Everton Formation (Oe) and at one location within the Pennsylvanian Cane Hill Member (Phc) of the Hale Formation.

Text from source map: St. Joe Quadrangle.

Acknowledgments

This work was conducted in a cooperative project between the U.S. Geological Survey and the U.S. National Park Service. Special thanks go to the many private owners who allowed access onto their land during this study.

Text from source map: St. Joe Quadrangle.

Disclaimer & Contact Information

Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This map was produced on request, directly from digital files, on an electronic plotter. For sale by U.S. Geological Survey Information Services Box 25286, Federal Center, Denver, CO 80225 1-888-ASK-USGS. ArcInfo coverages and a PDF for this map are available at http://pubs.usgs.gov/sim/2009/3074/

Text from source map: St. Joe Quadrangle.

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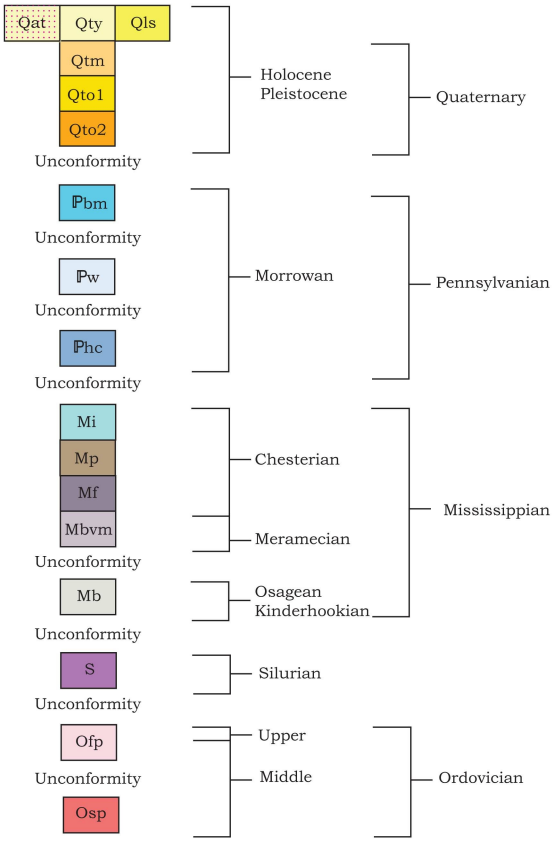
Text from source map: St. Joe Quadrangle.

Snowball Quadrangle (DGM-AR-00800)

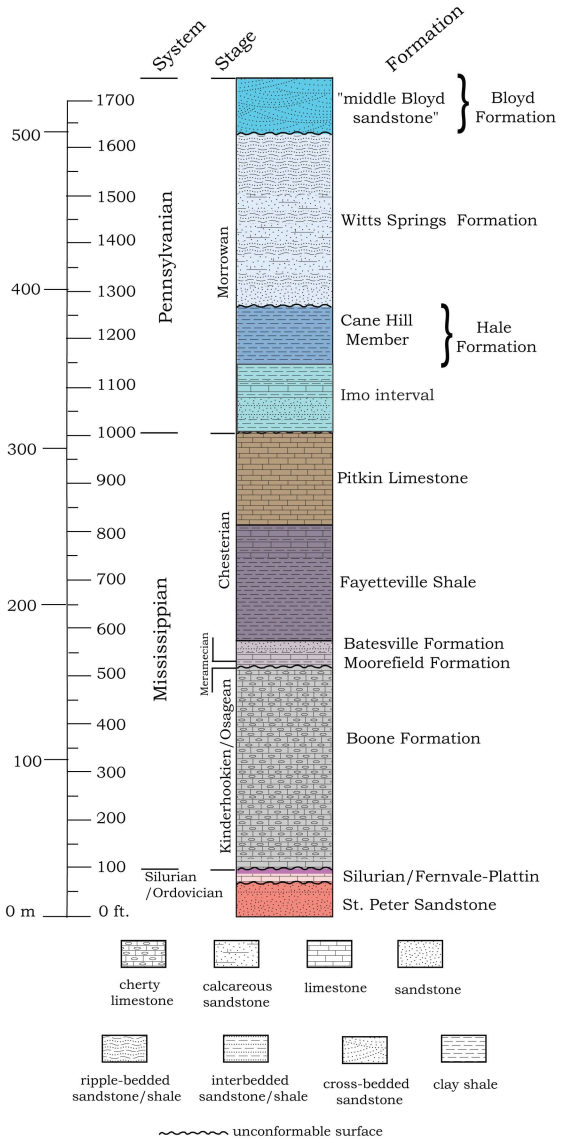
Braden, A.K., and Ausbrooks, S.M., 2003, Geologic Map of the Snowball Quadrangle, Searcy County, Arkansas: Arkansas Geological Commission, Digital Geologic Quadrangle Map, DGM-AR-00800, scale 1:24,000 (*GRI Source Map ID 62287*).

Correlation of Map Units



Graphic from source map: Snowball Quadrangle.

Stratigraphic Column



Graphic from source map: Snowball Quadrangle.

Symbols

Contact

Normal fault - ball and bar on downthrown side. Dashed where inferred. Dotted where concealed.

40 Inclined bedded showing strike and dip

Gravel pit

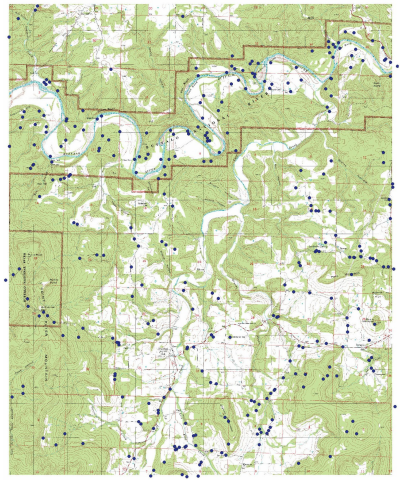
Quarry

Graphic from source map: Snowball Quadrangle.

Quadrangle Location Map

Graphic from source map: Snowball Quadrangle.

Topographic Map with Data Collection Points



Topographic map of the Snowball quadrangle showing location of data collection points.

Graphic from source map: Snowball Quadrangle.

Map Notes

Introduction

This map illustrates the surface geology of the Snowball quadrangle. This quadrangle was previously mapped at a 1:62,500 scale by Glick and Frezon in 1965 and Haley in 1976 for the Geologic Map of Arkansas. From 2002-2003, this quadrangle was mapped for the National Cooperative Geologic Mapping Program through STATEMAP. During 2014-2015, the terrace deposits along the Buffalo National River were mapped with funding provided by the National Park Service. Approximately 17.5 miles of the Buffalo National River are located in this quadrangle and are managed by the National Park Service.

Approximately 1700 feet (518 meters) of Middle Ordovician to Morrowan-age strata crop out in this area. The Middle Ordovician St. Peter Sandstone is present only in the northwestern corner of the

map where it is upthrown by a fault. Middle and Upper Ordovician and Silurian limestones are present locally along the Buffalo National River. The Lower Mississippian Boone Formation forms the Springfield Plateau surface on the majority of the quadrangle. Upper Mississippian to Morrowan sandstone, shale, and limestone form steep knobs and slopes on the edge of the Boston Mountains escarpment in the southern half of the quadrangle.

Quaternary terrace and alluvium deposits are present in the valley of the Buffalo National River and its tributaries. Two terrace levels are well developed along the river: a younger and a medial. Older terraces are located 80-160 (24-49 meters) feet above the river in most meander bends. Very old terrace deposits are preserved locally approximately 200 feet (61 meters) above the river.

Text from source map: Snowball Quadrangle.

Acknowledgments

This map was produced for STATEMAP, Cooperative Agreement Award 02HQAG0017, a matching-funds grants program with the US Geological Survey under The National Cooperative Geologic Mapping Program in 2003. In 2014-2015 the AGS mapped terrace deposits along the middle section of the Buffalo National River through a National Park Service contract. Thanks for Corbin Cannon and Daniel Rains for their assistance with mapping the terrace deposits. Special thanks to the National Park Service, U.S. Forest Service, Game and Fish Commission, and to private landowners who graciously allowed access to their property.

Text from source map: Snowball Quadrangle.

Limitations & Contact Information

This map, like all geologic maps, is based on interpretations which were made from the data available at the time it was created. As work continues and new data is collected, the contacts and structures depicted on this map may be changed.

For the latest edition of this and other AGS maps and publications, please call Publication Sales at 501-296-1877, or visit the Vardelle Parham Geology Center, 3815 West Roosevelt Road, Little Rock, Arkansas 72204. This map is also available on our website at: http://www.geology.ar.gov/geologicmaps/dgm_24k.htm.

Text from source map: Snowball Quadrangle.

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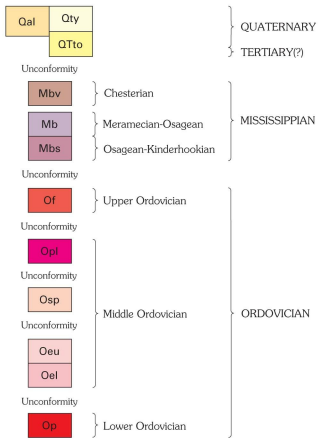
Text from source map: Snowball Quadrangle.

Western Grove Quadrangle (SIM-2921)

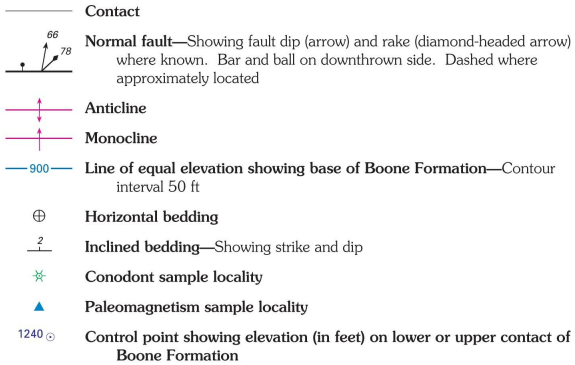
Hudson, M.R., Turner, K.J., and Repetski, J.E., 2006, Geologic Map of the Western Grove Quadrangle, Northwestern Arkansas: U.S. Geological Survey, Scientific Investigations Map, SIM-2921, scale 1:24,000 (*GRI Source Map ID 74478*).

Correlation of Map Units



Graphic from source map: Western Grove Quadrangle.

Symbols



Graphic from source map: Western Grove Quadrangle. Control points were not included in the GRI digital geologic-GIS data.

Quadrangle Location Map

Graphic from source map: Western Grove Quadrangle.

Figure 1: Location of Study Area

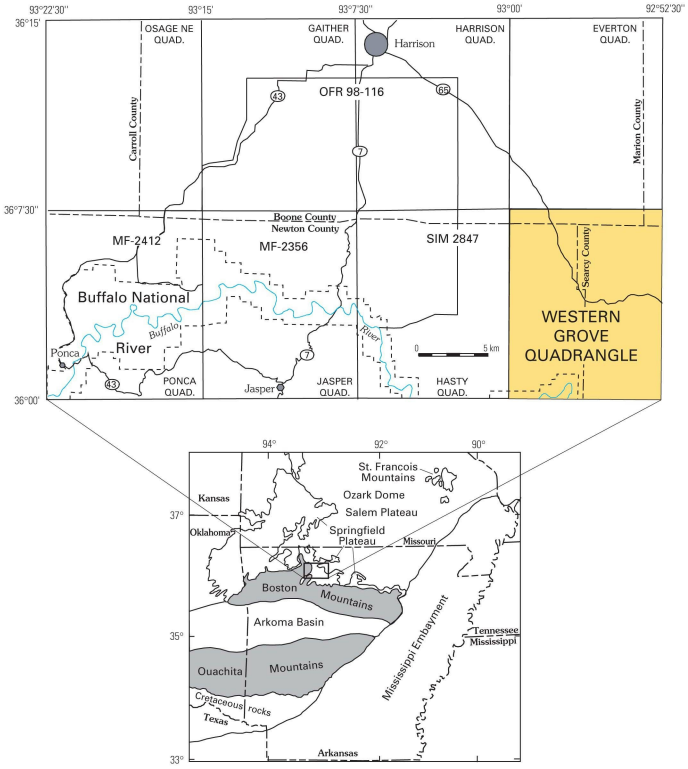


Figure 1. Location map of Western Grove quadrangle within northern Arkansas, including part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998: Hudson and others 2001; Hudson and Murray, 2003, 2004) are listed by publication number. Regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas. Ozark Plateaus region is composed of Salem and Springfield Plateaus and Boston Mountains.

Graphic from source map: Western Grove Quadrangle.

Figure 2: Stratigraphic Column

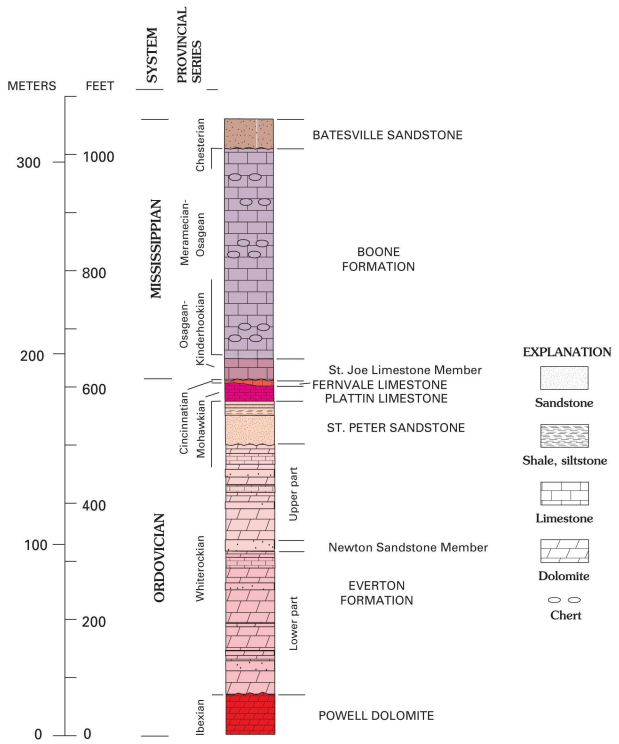


Figure 2. Stratigraphic column for Paleozoic rocks of the map area. Provincial series are from McFarland (1988) and Ethington and others (1989).

Graphic from source map: Western Grove Quadrangle.

Table 1: Conodont Data

Table 1. Conodont data from Ordovician units in the Western Grove quadrangle, Arkansas.

Field number USGS collection number[1] Latitude north/ Longitude west	Stratigraphic unit	Conodont fauna[2]	Age range of conodonts	CAI[3]	Remarks
02WG241 USGS 11951-CO 36° 1.660′/ 92° 56.461′	Plattin Limestone	*Curtognathus* sp., including elements variously referred to as "*Cardiodella*," "*Polycaulodus*," and "*Trucherognathus*" – 8 elements *Drepanoistodus suberectus* (Branson and Mehl) – 3 elements *Erismodus* cf. *E. typus* (Branson and Mehl) – 4-P; 3-S; 1-M elements *Panderodus gracilis* (Branson and Mehl) – 21 elements *Plectodina* aff. *P. aculeata* (Stauffer) – 3-P; 6-Sa; 11-Sb; 18-Sc; 9-M elements *Tropodus*? sp. – 3-Sa; 1-Sb/Sd; 4-Sc; 2-M(?) elements 3 unassigned oistodontiform elements 14 indeterminate elements (fragments)	Very late Middle Ordovician to early Late Ordovician; most likely Mohawkian[4]	1.5	Shallow, warm biofacies 4.14-kg sample processed (1.25 kg +20-mesh, and 190 g of 20- to 170-mesh insoluble residue remained) CAI values of 1.5 indicate that these conodonts and their host-rocks underwent post-depositional heating approximately in the range of 50º–90º C (Epstein and others, 1977)
02WG397 USGS 11952-CO 36° 0.339′/ 92° 55.438′	Plattin Limestone	*Erismodus asymmetricus* (Branson and Mehl)? – 1-Sc element	Late Middle to medial Late Ordovician	1.5	Shallow, warm biofacies 2.25-kg sample processed (5 g +20-mesh, and 25 g of 20- to 170-mesh insoluble residue remained)
02WG425 USGS 11953-CO 36° 0.043′/ 92° 55.960′	Plattin Limestone	"*Cardiodella*" sp. – 3 elements *Erismodus* cf. *E. asymmetricus* (Branson and Mehl) – 1-Pb; 2-M; 1-Sa; 2-Sb; 3-Sc elements *Panderodus gracilis* (Branson and Mehl) – 34 elements *Plectodina* aff. *P. aculeata* (Stauffer) – 1-Pb; 2-M; 2-Sa; 10-Sb; 3-Sc elements *Tropodus*? sp. – 1 Sb/Pb; 1-Sc elements 1 unassigned oistodontiform element 9 unassigned ramiform elements 19 indeterminate elements (fragments)	Very late Middle Ordovician to early Late Ordovician; most likely Mohawkian	1.5	Shallow, warm biofacies 3.2-kg sample processed (900 g +20-mesh, and 16 g of 20- to 170-mesh insoluble residue remained)
02WG481 USGS 11954-CO 36° 0.512′/ 92° 56.961′	Powell Dolomite	*Diaphorodus delicatus* (Branson and Mehl) – 1-M; 2-Sb/Sd; 3-Sc elements	Late to latest Early Ordovician (late Ibexian), based on morphology of these conodont elements	high 1.5	Shallow, warm biofacies 3.95-kg sample processed (5 g +20-mesh, and 145 g of 20- to 200-mesh insoluble residue remained)

[1]The Cambrian-Ordovician fossil collection locality register is maintained at the USGS, Eastern Earth Surface Processes Team, Reston, VA 20192.
[2]Conodont element notations P, S, M, and so on, refer to presumed location of the respective elements in the conodont apparatus, and follows Sweet (1981).
[3]Conodont color alteration index (CAI) is a measure of organic maturation (Epstein and others, 1977).
[4]The International Commission on Stratigraphy of the International Union of Geological Sciences recently standardized the base of the Upper Ordovician at the base of the graptolite *Nemagraptus gracilis* zone, meaning that all Mohawkian and younger strata in North America are now considered Upper Ordovician (see Bergstrom and others, 2000). However, due to long-standing practice in stratigraphic usage in the central U.S.A., in this report we retain this traditional usage of considering the Mohawkian as Middle Ordovician.

Graphic from source map: Western Grove Quadrangle.

Map Notes

Introduction

This map summarizes the geology of the Western Grove 7.5-minute quadrangle (fig. 1) in northern Arkansas on the southern flank of the Ozark dome, a regional uplift centered in southeastern Missouri. Physiographically, the map area is part of the Ozark Plateaus region and is within the Springfield Plateau, a land surface underlain by gently dipping Mississippian cherty limestone (Purdue and Miser, 1916). A segment of the Buffalo River loops through the southern part of the quadrangle, and the river and adjacent lands form part of Buffalo National River, a park administered by the U.S. National Park Service. The U.S. National Park Service supported preparation of this map in collaboration with their dye-tracer studies to better understand natural resources of the Buffalo River watershed, particularly the hydrogeologic framework of springs.

The exposed bedrock of this map area comprises approximately 1,000 ft of Ordovician and Mississippian carbonate and clastic sedimentary rocks (fig. 2) that have been mildly folded and broken by faults. The geology of the Western Grove quadrangle was first mapped by McKnight (1935) at 1:125,000 scale. This study confirms much of his mapping but also identifies additional structures and revises the distribution of stratigraphic units.

The area was mapped by field inspection of stratigraphic and structural features at numerous sites that were located with the aid of a global-positioning satellite receiver and a barometric altimeter that was frequently calibrated at points of known elevation. Contacts and structural features were compiled on a 1:24,000 scale-stable topographic base. Beds dipping less than 2° were considered to be horizontal. Structure contours showing the base of the St. Joe Limestone Member of the Boone Formation were hand drawn by visual inspection of control-point elevations that were either directly

measured in the field or calculated from field measurements of upper-contact elevations of the Boone Formation. Samples of Ordovician carbonate rocks were collected for conodont analysis and were analyzed by J.E. Repetski at U.S. Geological Survey facilities in Reston, Va. Samples of unconsolidated terrace deposits for paleomagnetic analysis were collected in oriented plastic cubes and were analyzed by M.R. Hudson at the U.S. Geological Survey Rock Magnetism Laboratory in Denver, Colo.

Text from source map: Western Grove Quadrangle.

Stratigraphy

The study area exposes a 1,000-ft-thick record of discontinuous middle Paleozoic deposition of shallow-water sediments that became limestone, dolostone, and sandstone on the southern margin of the North American continent. Stages for Mississippian units are from McFarland (1988).

Powell Dolomite was originally identified by McKnight (1935) in the area adjacent to the Buffalo River near Mt. Hersey. A sample processed for conodonts from site 11954-CO (table 1) near the Buffalo River yielded a single species, *Diaphorodus delicatus*. This species, together with abundant insoluble residue from this sample (expected for an argillaceous dolostone), are consistent with an identification of Powell Dolomite of latest Early Ordovician (late Ibexian) age (table 1).

The Middle Ordovician Everton Formation is a heterogeneous unit of intermixed sandstone and carbonate that Suhm (1974) interpreted as having been deposited in barrier island and tidal flat depositional environments. Glick and Frezon (1953) and Suhm (1974) measured a series of stratigraphic sections in the Everton Formation along the 130-mi length of the Buffalo River, and they documented a change from an eastern, carbonate-rich facies to a western, more sand-rich facies. The sand-rich nature of the western facies is demonstrated by the presence of the Newton Sandstone Member as thick as 100 ft which can be mapped as a separate unit in the Ponca quadrangle (fig. 1, Hudson and Murray, 2003). In the Western Grove quadrangle, the carbonate-rich facies of the Everton is predominant and the Newton Sandstone Member is only 10–15 ft thick and not easily distinguished from other sandstone intervals within the Everton. During mapping, recognition of the Newton Sandstone Member was based on its position above limestone containing distinctive stromatolite hemispheres near the top of the lower part of the Everton Formation.

The massive basal sandstone of the St. Peter Sandstone unconformably overlies sandy dolostone of the upper part of the Everton Formation in the south-central part of the quadrangle. To the north and northwest, the basal sandstone pinches out and, in the absence of shale outcrops in thicker sections, thin sandstone beds of the St. Peter are difficult to distinguish from sandstone in the upper part of the Everton Formation.

Plattin Limestone overlies the St. Peter Sandstone throughout much of the southern part of the quadrangle, and its thickness ranges from zero to 70 ft. The Plattin Limestone is typically gray, dense, fine micritic limestone, but its upper part also locally contains fine grained calcarenite that is laminated and crossbedded. One conodont sample (11952-CO) from dense limestone near the base of a 70-ft-thick section in a tributary to Cane Branch Creek yielded a single specimen of the conodont species *Erismodus*, a morphotype that indicates a late Middle Ordovician to medial Late Ordovician age, younger than typical limestone of the upper part of the Everton Formation (table 1). Two samples (11951-CO, 11953-CO) from calcarenite near the top of the Plattin interval yielded conodonts that indicate a very late Middle Ordovician to early Late Ordovician age (table 1). McKnight (1935) described an isolated locality in a tributary to Mill Branch (SW 1/4, NE 1/4, sec. 19, T. 16 N., R. 18 W.), containing loose blocks of light-gray sandstone that he correlated to Middle Ordovician Kimmswick Limestone on the basis of echinoderm fauna. No other Kimmswick Limestone outcrops have been identified nearby. We think McKnight (1935) probably miscorrelated a sandstone interbed within the upper calcarenite interval of the Plattin Limestone with the Kimmswick Limestone. Conodont assemblages in the Plattin calcarenite samples (table 1) from the quadrangle are distinct

from what have been reported for Kimmswick Limestone where it is well developed about 60 mi farther east in the Batesville district of Arkansas (Craig, 1975).

Fernvale Limestone is preserved only as small, discontinuous lenses beneath the unconformity at the base of the Mississippian Boone Formation. Fernvale lenses were mapped where they were directly observed to be at least 5 ft thick in the quadrangle, but it is likely that other unobserved lenses exist. Fernvale lenses are restricted to the central parts of the quadrangle including (1) beneath a knob east of the southeastern part of Clear Creek, (2) at two locations on the southeast limb of the Shaddock Branch anticline, (3) where Shaddock Branch cuts through the western part of the Mill Creek graben, (4) south of Hurricane Branch in the footwall of the Mill Creek fault, and (5) on a ridge northeast of Davis Creek about 1.5 mi upstream from its confluence with the Buffalo River.

The Mississippian Boone Formation is the most widespread unit exposed within thequadrangle and consists of a thin basal St. Joe Limestone Member and a thicker bedded overlying main body. Throughout much of the quadrangle the lower part of the St. Joe Limestone Member is greenish-gray, fossiliferous shale containing thin limestone beds; the shale interval is 15 ft thick where well exposed in the wall of the commercial parking lot for Hurricane Cave near the center of the quadrangle (sec. 7, T. 16 N., R. 18 W.). The contact of the main body of the Boone Formation with the St. Joe Limestone Member is gradational and picked where thin beds of St. Joe Limestone Member give way upward to thicker, chert-bearing beds. Thin oolitic limestone locally present near the top of the Boone Formation was also recognized by Braden and Ausbrooks (2003a) to the south, and they correlated it with the Short Creek Oolite Member of the Boone Formation in Missouri and Kansas (McKnight and Fischer, 1970).

The relative age of unconsolidated terrace deposits adjacent to the Buffalo River (units Qty and QTto) can be determined from their height above the river; there are no constraints on their absolute age. The deposits of unit Qty are likely Quaternary in age but deposits of unit QTto, which are 80–120 ft above the river, may be as old as Tertiary (> 1.8 Ma). Three samples were collected for paleomagnetic analysis from reddish clay overlying high level cobbles of unit QTto northwest of the river (lat 35° 0.325' N., long 92° 57.573' W.). The samples yielded a normal polarity magnetization and thus could be as young as the Brunhes chron (< 780 ka), but could also possibly record one of several older normal polarity subchrons within the Matuyama chron (Berggren and others, 1995).

Text from source map: Western Grove Quadrangle.

Structural Geology

Rocks within the map area were mildly folded and faulted. Structure contours showing the base of the Boone Formation highlight the structures and their vertical displacement. The structure contours conform to elevations at 215 control points located at both lower and upper contacts of the Boone Formation. A 390-ft thickness for the Boone Formation (including the St. Joe Limestone Member) was used to project elevations from points on the upper contact to the basal contact. This thickness is based on the average of five stratigraphic sections farther west near the Buffalo River (Hudson, 1998), where thickness ranges from 380 to 405 ft. Structure contour elevations were also limited to be lower than Boone Formation outcrops in valley bottoms, such as where the Hurricane Branch crosses the Mill Creek graben. Upper contacts of the Boone Formation were limited to be higher than Boone outcrops on hilltops.

The predominant structural feature of the Western Grove quadrangle is the Mill Creek graben (McKnight, 1935), which is mapped east-west across the center of the quadrangle. The St. Joe and Mill Creek faults bound the north and south sides of the graben, respectively. The main plane of the St. Joe fault dips 66° S. in the abandoned pit of the Hurricane Mine (lat 36° 3.169' N., long 92° 59.479' W.), and associated fault striations rake 78° E., indicating a predominant normal sense of slip. Whereas McKnight (1935) showed the Mill Creek fault to continue across the quadrangle, we map this fault as dying out in the western part of the quadrangle (sec. 10, T. 16 N., R. 19 W.). A separate north-

dipping normal fault begins just to the north and continues to the west beyond the quadrangle. Fault displacements are greatest in the eastern part of the Mill Creek graben, where the Batesville Sandstone is preserved; throw is as much 400 ft on the St. Joe fault and 250 ft on the Mill Creek fault. Throw on the St. Joe fault decreases westward to less than 200 ft northeast of where the Mill Creek fault ends, but farther west throw on the St. Joe fault increases. The graben system continues more than 6 mi beyond the west edge of the quadrangle where it becomes the Braden Mountain graben (Hudson and Murray, 2004).

Several folds and broad domes are evident in the structure contour map. The greatest structural relief in the quadrangle, about 300 ft, reflects folding across the northwest trending Cane Branch monocline, named by Braden and Ausbrooks (2003b) in the adjacent Eula quadrangle. The base of the Boone Formation reaches its highest elevation on the upthrown side of the Cane Branch monocline southeast of Mt. Hersey. In this area, erosion by the Buffalo River has exposed the oldest stratigraphic unit, the Powell Dolomite. Whereas most folds in the quadrangle are monoclines, both limbs of the northeast-trending Shaddock Branch anticline have significant dip. The northwestern limb of the anticline dips most steeply and merges southwestward with the Yardelle monocline. The north-dipping Yardelle monocline extends about a mile west of the quadrangle (Hudson and Murray, 2004). The Yardelle monocline and Shaddock Branch anticline collectively bring the lower part of the Everton Formation to the surface along Davis Creek north of the St. Joe fault. In the eastern and central part of the quadrangle, strata in the immediate footwall of the St. Joe fault consistently dip north 5°–16°; structural relief on this footwall flank is as much as 150 ft. A broad dome in the northeastern part of the quadrangle raises the base of the Boone Formation above the 1,100-ft elevation, and erosion by Clear Creek on its western flank has exposed the lower part of the Everton Formation.

Away from fold limbs, bedding dips are typically low and variable in direction. These dispersed attitudes can be attributed in part to local subsidence caused by karst dissolution within the abundant limestone and dolostone units.

Joints measured within the map area (441 total) are nearly vertical and distributed in several sets (fig. 3). The predominant sets strike north, northeast, and west-northwest to west. Joint planes within limestone and dolostone formations, such as the Boone and Everton Formations, are commonly enlarged by dissolution.

Text from source map: Western Grove Quadrangle.

Acknowledgments

This work was conducted in a cooperative project of the U.S. Geological Survey and the U.S. National Park Service. Special thanks go to the private owners who allowed access to their land during this study, particularly J. Henthorn, who helped facilitate access to several areas. We thank D.N. Mott and C.J. Bitting of the U.S. National Park Service, and A.K. Braden and S.M. Ausbrooks of the Arkansas Geological Commission for helpful
discussions on the geology, karst features, and hydrology of the area during the course of the study. Helpful reviews were provided by W.D. Johnson and J.C. Cole.

Text from source map: Western Grove Quadrangle.

Disclaimer & Contact Information

Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This map was produced on request, directly from digital files, on an electronic plotter. For sale by U.S. Geological Survey Information Services Box 25286, Federal Center, Denver, CO 80225 1-888-ASK-USGS. ArcInfo coverages and a PDF for this map are available at http://pubs.usgs.gov/sim/2006/2921/

Text from source map: Western Grove Quadrangle.

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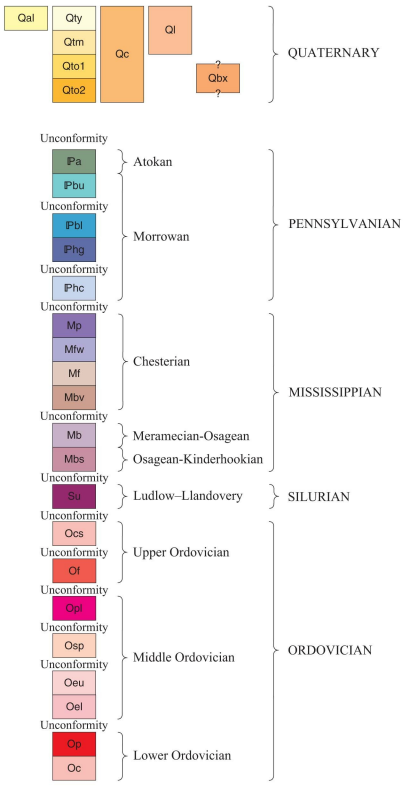
Text from source map: Western Grove Quadrangle.

West-Central Buffalo National River Region (SIM-3314)

Hudson, M.R., and Turner, K.J., 2014, Geologic Map of the West-Central Buffalo National River Region, Northern Arkansas: U.S. Geological Survey, Scientific Investigations Map SIM-3314, scale 1:24,000 (*GRI Source Map ID 75962*).

This source was used along with source map data specific to each 7.5' quadrangle for the following 7.5' quadrangles: Hasty, Jasper, Maumee, Ponca, St. Joe and Western Grove.

Correlation of Map Units



Graphic from source map: West-Central Buffalo National River Region.

Map Location (Western Sheet)

Graphic from source map: West-Central Buffalo National River Region.

Map Location (East Sheet)

MAP LOCATION

Graphic from source map: West-Central Buffalo National River Region.

Figure 1: Location of Study Area

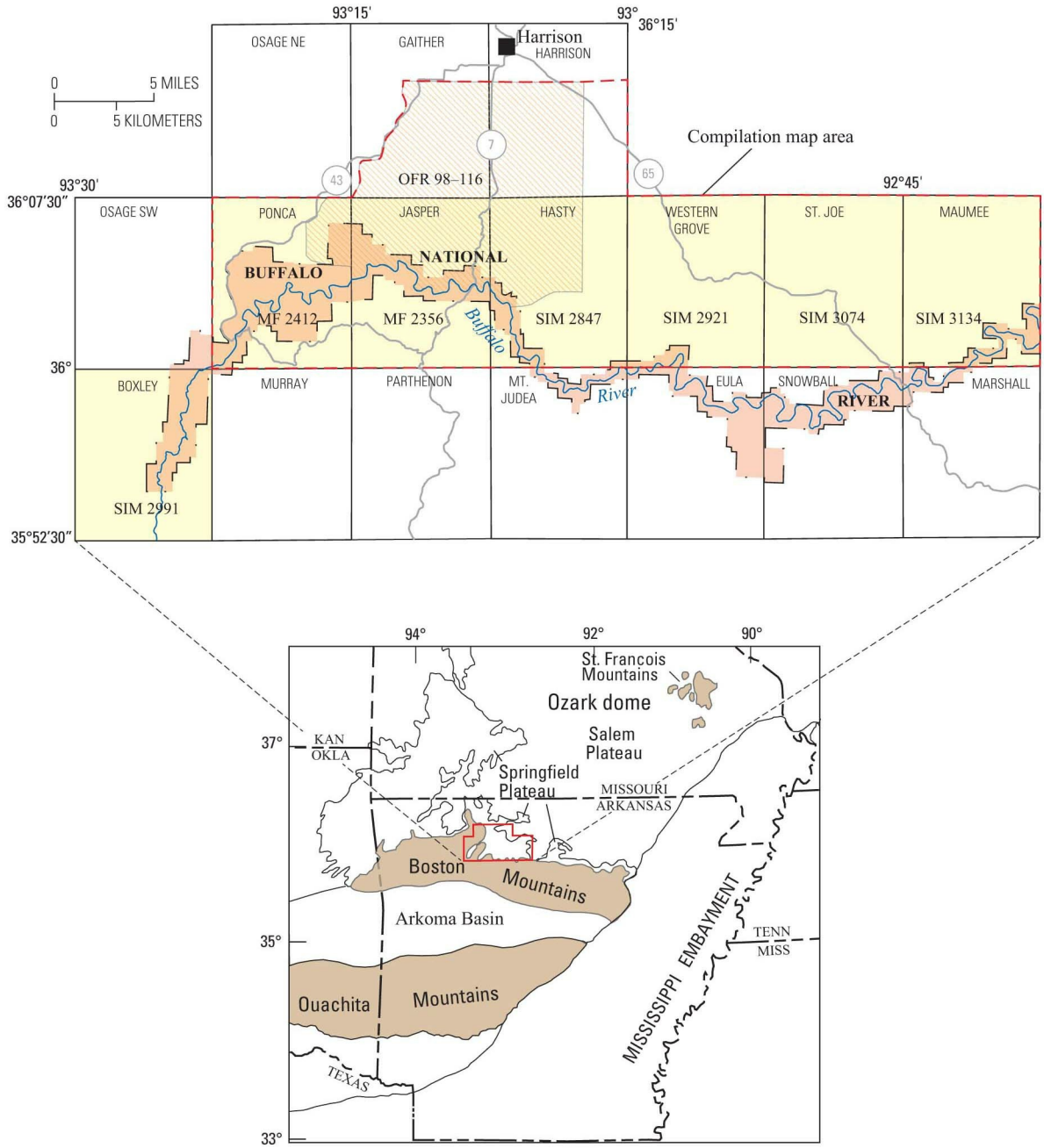
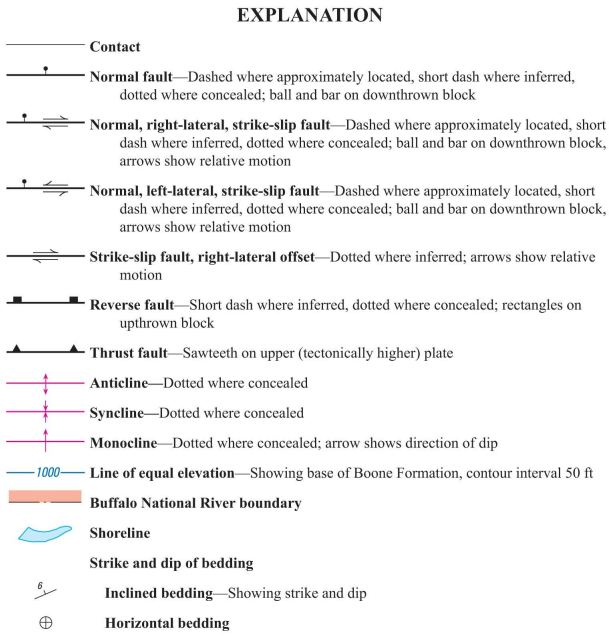


Figure 1. Location of study area within northern Arkansas, overlapping the west-central part of Buffalo National River. Previously published U.S. Geologic Survey geologic maps in the area (Hudson, 1998; Hudson and others, 2001, 2006; Hudson and Murray, 2003, 2004; Hudson and Turner, 2007, 2009; Turner and Hudson, 2010) are highlighted in yellow and their publication numbers are show,. Lower regional map shows geologic and selected physiographic provinces of Arkansas and adjacent areas. The Ozarks Plateaus region includes Salem and Springfield Plateaus, and Boston Mountain physiographic provinces.

Graphic from source map: West-Central Buffalo National River Region.

Explanation



Graphic from source map: West-Central Buffalo National River Region.

Photographs

Photo 1

Photo 1. View to the northwest of the Steel Creek area (Ponca quadrangle). Buffalo River is flanked on the left by grassy, youngest terrace deposit (Qty). Roark Bluff, along the right side of the river, is held up by the Newton Sandstone Member of the Everton Formation (Oeu). Photograph by M.R. Hudson, 1998.

Photograph from source map: West-Central Buffalo National River Region.

Photo 2

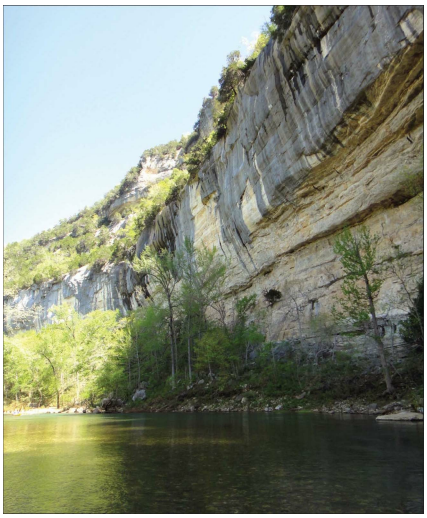


Photo 2. View looking north of the base of Big Bluff (Ponca quadrangle) with exposures of Powell Dolomite (Op) overlain by Everton Formation, including Newton Sandstone Member (Oeu) holding up prominent bluff. Buffalo River is in the foreground. Photograph by M.R. Hudson, 2012.

Photograph from source map: West-Central Buffalo National River Region.

Photo 3

Photo 3. The 209-foot-high waterfall at Hemmed-In Hollow (Ponca quadrangle). Powell Dolomite (Op) forms lower part of the slope and is overlain by Everton Formation (Oel, Oeu). Photograph by M.R. Hudson, 2012.

Photograph from source map: West-Central Buffalo National River Region.

Photo 4

Photo 4. View to the east of the Buffalo River with teh St. Joe Limestone Member of the Boon Formation (Mbs) overlying upper part of Everton Formation (Oeu). Strata have a shallow southeastern dip within the eastern part of a graben structure between the St. Joe and the South Braden Mountain faults (Jasper quadrangle). Photograph by M.R. Hudson, 2011.

Photograph from source map: West-Central Buffalo National River Region.

Photo 5

Photo 5. View to the south of the confluence of the Little Buffalo River (right) with the Buffalo River (Hasty quadrangle). Photograph by M.R. Hudson, 2010.

Photograph from source map: West-Central Buffalo National River Region.

Map Notes

Introduction

This report summarizes the geology of the west-central Buffalo National River region (fig. 1) in the Ozark Plateaus region of northern Arkansas. Geologically, the region lies on the southern flank of the Ozark dome, an uplift that exposes oldest rocks at its center in Missouri. Physiographically, the map area spans the Springfield Plateau, a topographic surface generally held up by Mississippian cherty

limestone (Purdue and Miser, 1916) and the higher Boston Mountains plateau to the south, held up by Pennsylvanian rocks. The Buffalo River flows eastward through the map area, enhancing bedrock erosion of an approximately 1,600-ft- (490-m-) thick sequence of Ordovician, Mississippian, and Pennsylvanian carbonate and clastic sedimentary rocks that have been mildly deformed by a series of faults and folds. Quaternary surficial units are present as alluvial deposits along major streams, including a series of terrace deposits from the Buffalo River, as well as colluvium and landslide deposits mantling bedrock on hillslopes.

This report presents a compilation and update of previously published geologic mapping for all or parts of eight U.S. Geological Survey 1:24,000-scale quadrangles in the west-central Buffalo National River area (fig. 1). For ease of plotting, the physical map is divided into two parts: a western part (sheet 1) that consists of the Ponca, Jasper, Gaither, Harrison, and Hasty quadrangles. The eastern part (sheet 2) is composed of the Western Grove, St. Joe, and Maumee quadrangles. The report makes available a continuous Geographic Information System (GIS) database (not divided into western and an eastern parts) for the geology, including the southern Gaither and southwestern Harrison quadrangles that were previously only available in printed form (Hudson, 1998), and it also includes an area of new mapping for the southeastern part of the Harrison quadrangle. The map updates some areas of the previously published maps. Most of these updates are in the earliest published maps, the Jasper (Hudson and others, 2001), Ponca (Hudson and Murray, 2003), and Hasty (Hudson and Murray, 2004) quadrangles. Changes to previous maps were based on both additional field observations and interpretation of 2009 and 2011 lidar (Light Detection and Ranging) surveys yielding high-resolution topographic data for the western parts of the map area (available at *http://earthexplorer.usgs.gov*). Additional rock units shown in the Jasper, Hasty, and Ponca quadrangles reflect (1) subdivision of the Middle Ordovician Everton Formation into upper and lower parts that have hydrogeologic significance (Hudson and others, 2011), (2) addition of Middle Pennsylvanian Atoka Formation on highest ridge crests of the Jasper quadrangle to match its distribution on the Ponca (Hudson and Murray, 2003) and the nearby Boxley (Hudson and Turner, 2007) quadrangles, and (3) recognition of a series of Quaternary terrace deposits associated with older, higher positions of the Buffalo River. Additional elevation control points on upper and lower contacts of the Boone Formation allowed modification of structure contours for the base of the Boone Formation; locally, Boone Formation contacts were modified to match changes to this structure contour model. Unit contacts in southern and southwestern edges of the Ponca quadrangle were modified to match field constraints available within adjacent Boxley (Hudson and Turner, 2007) and Murray quadrangles (Hudson and Turner, unpub. mapping). In the context of available high-resolution lidar topographic data, contacts for ledge-forming Upper Mississippian and Pennsylvanian units were inspected in areas between field traverses and modified, where needed, to match their typical topographic expression. Likewise, fault lines within the Ponca and Jasper quadrangles were examined between field-site locations and modified to align with truncations of topographically expressed rock units, where obvious.

More detailed descriptions of geologic features and processes for the area are included in the text materials that accompany the original maps (fig. 1) incorporated into this compilation.

Text from source map: West-Central Buffalo National River Region.

Credits & Contact Information

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Text from source map: West-Central Buffalo National River Region.

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Text from source map: West-Central Buffalo National River Region.

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