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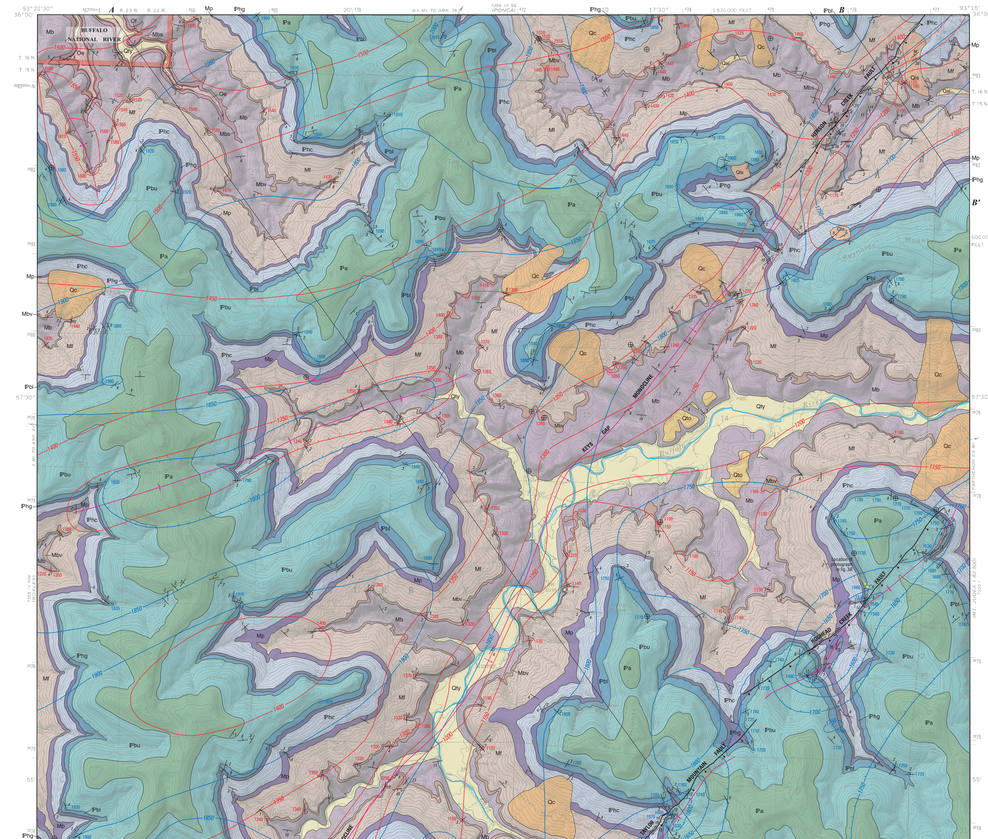
U.S. Geological Survey

Scientific Investigations Map 3360

Prepared in cooperation with the
National Park Service



Base from U.S. Geological Survey 1:24,000-scale Murray, Arkansas, 1968
Polyconic projection, North American Datum 1927 (NAD 27)
10,000-foot grid based on Arkansas coordinate system, north zone
1,000-meter Universal Transverse Mercator grid ticks, zone 15

Geologic mapping by M.R. Hudson and K.J. Turner 2010–2015
Digital database by K.J. Turner

CORRELATION OF MAP UNITS

MAP EXPLANATION

Contact—Solid line. In cross sections only, short dash where location inferred

Normal, right-lateral, strike-slip fault—Ball and bar on downthrown block, arrows show relative motion. In cross sections only, short dash where location inferred

Anticline

Syncline

Monocline—Arrow shows direction of dip

Structure contour line of equal elevation—Base of "middle Bloyd sandstone" of the upper part of the Pennsylvanian Bloyd Formation (**PIbu**). Hachures point to closed areas of lower values. Contour interval 50 ft

Structure contour line of equal elevation—Base of "middle Bloyd sandstone" of the upper part of the Pennsylvanian Bloyd Formation (**PIbu**). Contour interval 50 ft

Control point—Showing elevation (in feet) of the top of the Boone Formation (**Mb**)

Control point—Showing elevation (in feet) of the base of "middle Bloyd sandstone" of the upper part of the Pennsylvanian Bloyd Formation (**PIbu**)

Buffalo National River boundary

Shoreline of Little Buffalo River

Strike and dip of bedding

Inclined bedding—Showing strike and dip

Horizontal bedding

Fault movement—In cross sections only. Fault movement away from viewer, minus; towards viewer, plus

Location of photographs for fig. 3A and *B*

DESCRIPTION OF MAP UNITS

[Provincial series for Pennsylvanian and Mississippian units are from McFarland (1988). Due to the addition of a shaded relief base, colors on the List of Map Units and the Correlation of Map Units may not exactly match unit colors on the map.]

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 surface 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

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

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

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 (**PIbu**) and the Cane Hill Member (**PIbc**) 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

Qls **Landslide (Quaternary)**—Slide blocks of limestone, sandstone, and shale derived from the Pennsylvanian Bloyd Formation (**PIbu** and **PIbt**) through the Prairie Grove and Cane Hill Members of the Hale Formation (**PIf** and **PIhc**, respectively). Upper parts of slides are semi-coherent stratigraphic sequences back tilted into hillsides and down-dropped relative to bedrock.

Pa **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

IPbu **Bloyd Formation (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 biochemical 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 ledge 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

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 the formation is not mapped separately, and is included as being in the lower part of the Bloyd and is a 5- to 20-ft-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

IPhc **Hale Formation (Lower Pennsylvanian, Morrowan)**—Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–200 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 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

Cane Hill Member—Dominantly 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 conglomeritic 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

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 southeastern-most 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

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 contains strong 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

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 5- to 8-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 flumbosh 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

Mb **Boone Formation (Upper to Lower Mississippian)**—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 300–405 ft

Mb **Main body (Upper to Lower Mississippian, Meramecian to Osagean)**—Medium- to thick-bedded, fossiliferous, bioclastic limestone. Limestone is light to medium gray on fresh surfaces and generally coarsely crystalline with interspersed crinoid ossicles. A 1- to 3.0-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 hillslopes. Chert in uppermost part of unit contains common brachiopod molds. Thickness 310–375 ft

Mbs **St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)**—Thin-bedded, bioclastic, medium to coarse crystalline 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 shaley limestone interval, from 0.5- to 1.0-thick bed of tan sandstone containing phosphate pebbles that marks a regional erosional unconformity. Thickness approximately 30–50 ft

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 10–50 ft

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 moderate 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 Branch of quadrangle; but unit is about 300 ft thick to the northeast in the Ponca 7.5-minute quadrangle (Hudson and Turner, 2014a).

Ou **Lower Ordovician rocks, undivided**—Sedimentary rocks shown on cross sections only

INTRODUCTION

This map summarizes the geology of the Murray 7.5-minute quadrangle (fig. 1) in the Ozark Plateau region of northern Arkansas. The Ozark Plateau 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 resolve 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 (**PIbu**), 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. 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 Keys Landing fault by the Early Pennsylvanian Cane Hill Member of the Hale Formation were also recognized (Hudson and Murray, 2005) 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.

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 minor carbonate unit that Sutton (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 (**Mbs**) 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 oolitic 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 (**PIhc**) of the Hale Formation represents a significant unconformity within the map area. The thinning and local absence of the Pitkin Limestone below 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) in basal sandstone 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 conglomeratic 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 (**PIhg**) 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 (**PIbt**) of the Bloyd. It is conformable with the underlying Prairie Grove Member (**PIhg**) 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 (**PIbu**) were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka Formation (Hembree, 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 (**Pa**) is a sequence of alternating marine sandstone and shale that has generally been interpreted to represent flavio-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 Murray 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 the contact above the level of a thin coal bed approximately 200 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 (35.885°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.

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 (Boone Formation) 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 Keys Landing fault by the Early Pennsylvanian Cane Hill Member of the Hale Formation were also recognized (Hudson and Murray, 2005) 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.

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) further south in Arkansas with over 6,000 oil and gas well drilled as of 2016 (Arkansas Geological Survey, 2016).

ACKNOWLEDGMENTS

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