Prepared in cooperation with the U.S. Geological Survey National Park Service CORRELATION OF MAP UNITS QUATERNARY Middle Pennsylvanain Unconformity PENNSYLVANIAN Lower Pennsylvanian Unconformity Unconformity Upper Mississippian Chesterian Unconformit Middle Mississippian Lower Mississippian Unconformity Upper Ordovician Unconformity Middle Ordovician > ORDOVICIAN **Jnconformity**  Lower Ordovician **DESCRIPTION OF MAP UNITS** [Provincial stages for Pennsylvanian and Mississippian units are from McFarland (1988, 2004). Division of the Pennsylvanian and Mississippian subsystems follows Heckel and Clayton (2006)] Oty 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 feet (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 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 (Pbu) and the Cane Hill Member (Phc) 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 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 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 (Pbu). 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 Bloyd Formation (Lower Pennsylvanian, Morrowan)—Interbedded sequence of sandstone, siltstone, shale, and limestone beds separated into upper and lower parts. Thickness as much as 360 ft Upper part—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 **ower part**—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 Hale Formation (Lower Pennsylvanian, Morrowan)—Interbedded 130-260 ft **Prairie Grove Member**—Brown to reddish-brown, fine- to nedium-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 Base from U.S. Geological Survey 1:24,000-scale Osage SW, Ark., 1968 Geologic mapping by K. Turner and M. Hudson 2014 through 2018 cross-beds may have bidirectional dips. Sandstone weathers to form Universal Transverse Mercator projection, North American Datum 1927 (NAD 27) GIS database and digital cartography by K. Turner rounded surfaces with elliptical cavities as long as 1 ft. Unit contains 10,000-foot grid based on Arkansas coordinate system, north zone some interbeds of reddish-brown, coarse bioclastic limestone. Shale T. Brandt scanned and registered the topographic base map 1,000-meter Universal Transverse Mercator grid ticks, zone 15 layers separating sandstone beds are reported regionally (Southerland, Publishing support provided by the Science Publishing Network, 1988), but were not observed in the map area. Unit forms steep slopes APPROXIMATE MEAN DECLINATION, 2018 MAP LOCATION and is often covered by thin colluvium derived from overlying units. Edit and digital layout by L. Binder CONTOUR INTERVAL IS 20 FEET Manuscript approved for publication August 27, 2018 Basal contact with Cane Hill Member (Phc) is unconformable. DATUM IS MEAN SEA LEVE Thickness 30–80 ft VERTICAL EXAGGERATION x2

U.S. Department of the Interior

Elevation, as used in this report, refers to distance above sea level.

## Geologic Map of the Osage SW 7.5' Quadrangle, Newton, Madison, and Carroll Counties, Arkansas

VERTICAL EXAGGERATION x2

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 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. 3*B*). 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 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 **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 **Boone Formation (Middle to Lower Mississippian)**—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 (Middle to Lower Mississippian, Meramecian to Osagean)— 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

St. Joe Limestone Member (Lower Mississippian, Osagean to **Kinderhookian**)—Thin-bedded, bioclastic limestone with ubiquitous 3- to 6-millimeter (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 **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 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 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) Lower Ordovician rocks, undivided—Sedimentary rocks shown on cross

**MAP EXPLANATION** ————Contact—Solid where location is accurate; long dash where location is approximate, short dash where inferred. In cross sections only, short dash where location projected above current surface Normal fault—Ball and bar on downthrown block. Solid line where location accurate; long dash where location approximate, and dotted where concealed. In cross sections only, short dash where projected above

current surface Folds—Dashed where location is approximate

**—— —— Monocline**—Arrow shows direction of dip

sandstone" that marks the base of the upper part of the Pennsylvanian Bloyd Formation (Pbu). Hachures point to closed areas of lower values. Contour interval 50 ft ——1150——Structure contour line of equal elevation—Top of the Mississippian Boone Formation (Mb). Hachures point to closed areas of lower values. Contour

PLANAR AND POINT FEATURES • 1930 **Control point**— Showing elevation (in feet) of the base of "middle Bloyd sandstone" of the upper part of the Pennsylvanian Bloyd Formation (Pbu) ⊙ 1460 **Control point**—Showing elevation (in feet) of the top of the Mississippian Boone Formation (Mb)

Strike and dip of bedding Inclined bedding—Showing strike and dip Horizontal bedding

Shoreline of Buffalo Rive

Buffalo National River boundary

Figure 1. Location of study area in northern Arkansas, adjacent to the western part of Buffalo National River. Previously published U.S. Geological Survey (USGS) geologic maps are highlighted in yellow . This report in dashed blue outline. USGS Investigations Map 3314 in dashed green outline. Lower regional map (modified from Hudson, 2000) shows geologic and selected physiographic provinces of Arkansas and adjacent areas with the Osage SW 7.5' quadrangle highlighted as a yellow box. The Ozark Plateaus region includes Salem and

Springfield Plateaus and Boston Mountains physiographic provinces.

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. 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

EXPLANATION

Cross-bedded sandstone

Ripple-bedded sandstone

Calcareous sandstone

Dolomitic sandstone

Unconformity

Figure 2. Representative stratigraphic column for Paleozoic rocks in the map area based on maximum

McFarland (1988, 2004). Division of the Pennsylvanian and Mississippian subsystems follows Heckel and

thickness of units. North American stage names for Pennsylvanian and Mississippian units are from

**Figure 3**. *A*, Photograph of bottom of sandstone bed in Cane Hill Member of the Hale Formation (IPhc)

are 0.5 inch (in) long. Photograph by M. Hudson, 2017. B, Photograph of bryozoan Archimedes in Pitkin

is 6.5 in. long. Photograph by M. Hudson, 2016.

Limestone (Mp) where observed in the northwesternmost drainage of the quadrangle, west of Dinsmore.

showing rip-up clasts of shale and siltstone as well as casts of wood fragments in a sand matrix. Fingernails

Fayetteville Shale (Mf) that underlies Pitkin Limestone in this area is only about 60 feet thick. Green pen cap is

(Mbv) showing angular to subrounded clast of weathered chert in fossiliferous limestone matrix. Hammer head

INTRODUCTION

Geologically, the area is on the southern flank of the Ozark dome, an uplift with the oldest

This map summarizes the geology of the U.S. Geological Survey (USGS) Osage SW

2.5 in. long. Photograph. by K. Turner, 2016. *C*, Photograph of Hindsville Member of the Batesville Sandstone

7.5-minute quadrangle (fig. 1) in the Ozark Plateaus region of northern Arkansas.

the Osage SW quadrangle is located within a transitional area between the Boston

the quadrangle is an approximately 1,460-foot (ft)-thick sequence of Ordovician,

majority of the quadrangle is privately owned land.

points and projection of bedding attitudes.

to the Kings River.

others, 1984).

karstification.

(Glick, 1979).

rocks exposed at its center in the St. Francois Mountains in Missouri. Physiographically,

Mountains to the south and the Springfield Plateau to the north (fig. 1). Exposed within

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

Geologic mapping for this study was compiled at 1:24,000-scale in a geographic

(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

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.

Formation (Mb) and the base of a prominent Pennsylvanian sandstone unit that marks the

base of the upper part of the Bloyd Formation (Pbu) to conform to elevations of control

**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

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 within a shallow shelf environment where recurrent intervals of marine to subaerial transitions occurred throughout the Middle and Late Ordovician 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); the St. Peter

Sandstone and Plattin Limestone, deposits preserved between the Everton and Fernvale

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

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 into massive, chert-rich beds of the main body of the Boone Formation (Mb).

sandstone and minor limestone. The basal Hindsville Limestone Member (not mapped

depositional hiatus and period of erosion, which resulted from sea level fall following

Sandstone are interpreted as having been deposited in delta front and shoreface environ-

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;

ments that prograded into the area from the northeast during Chesterian sea level rise

deposition of the Boone Formation (Handford, 1995). Sandstones of the Batesville

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

The Boone Formation is a widespread unit throughout the region and is prone to

Limestone Member grades upward from generally chert-free, red to pink, and thin bedded

The Batesville Sandstone (Mbv) overlies the Boone Formation and is composed of

Structure contours were manually constructed at the top of the Mississippian Boone

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

frequently recalibrated at points of known elevation. Contacts were traced between

traverses using shaded relief and slope maps derived from U.S. Geological Survey

Clayton (2006). Ss, sandstone; Ls, limestone; K, Kinderhookian.

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 (Phc), which were deposited above the unconformity (for example, Purdue and Miser, 1916; Hudson and Turner, 2016).

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 (Phg) 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 (Pbl), 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 highenergy 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 (Pbu) 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).

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 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 from 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

sandstone that holds up a prominent topographic ledge. This sandstone sequence is fine-grained sandstone with ripple laminations.

## STRUCTURAL GEOLOGY

The dominant structural feature of the Osage SW 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

decreasing the throw across the Compton fault to the west. Along the south side of Middendorf and others (1997) to extend an additional 18 mi west of the Osage SW quadrangle boundary.

lies about 1.2 mi south of the Compton fault. The Logan Mountain fault is the longest to the west past the quadrangle boundary. Cumulative displacement across the Logan 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 drop 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 within the Boxley quadrangle (Hudson and Turner, 2007) that together compose the

southwestern part of the Ponca lineament (McFarland, 1988).

Structural data gathered from faults and deformation bands 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.

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

Sandstone and siltstone channels of the Cane Hill Member (Phc) vary laterally and

The Atoka Formation (Pa) is composed of alternating beds of marine sandstone and shale that, in the southern Ozarks region, is interpreted as fluvio-deltaic deposits (Zachry exposed approximately 30 miles (mi) west of the map area in Washington County where

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 typical of Atoka facies in the region as it contains thin- to medium-bedded, very fine to

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 northeasttrending down-to-northwest fault branches from the Compton fault into its footwall, 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 A parallel zone of down-to-north monoclinal folds and small-offset normal faults

fault along this structural zone and starts in the upper reaches of Dry Creek and extends 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

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

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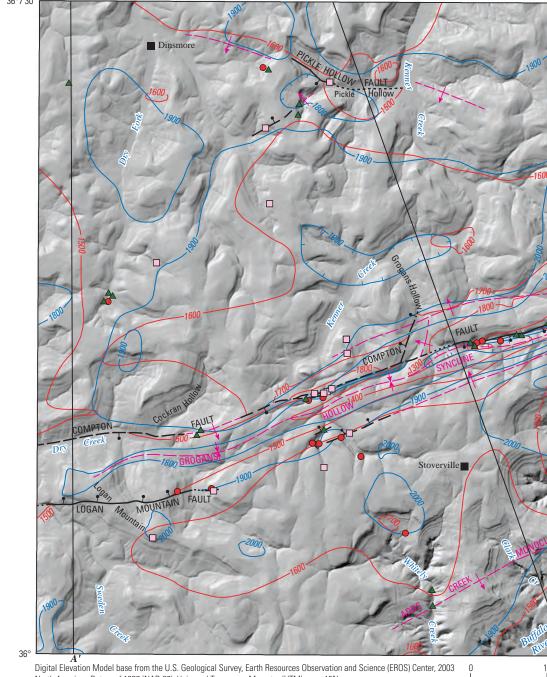
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North American Datum of 1927 (NAD 27), Universal Transverse Mercator (UTM), zone 15N Normal fault—Bar and ball on downthrown Syncline block. Long dash, location approximate,

 $A \longrightarrow A$ ' Line of section

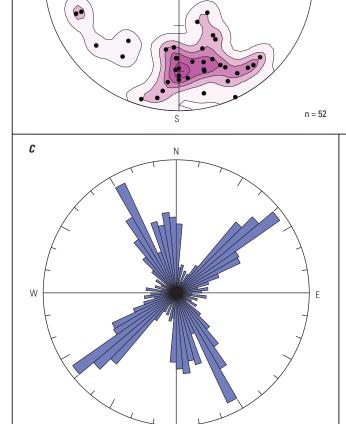
Figure 4. Shaded-relief digital elevation map of the U.S. Geological Survey Osage SW 7.5' quadrangle with locations of structural features, structure contours (100-foot interval), and sites where faults were observed. Where determined, slip senses for faults at sites are indicated as normal (rake 90° to 60°) and strike-slip (rake 29° to 0°). Also shown are locations where deformation bands were observed

short dash, location concealed Structure contour elevation—Hachures point

to closed areas of lower values. Contour

Base of upper part of Bloyd Formation (Pbu)
Top of the Boone Formation (Mb)

interval 100 feet



**Figure 5.** Structural data for the Osage SW quadrangle. Number of data are "n". A, Stereoplot of poles and orientation density contours for faults in the quadrangle. Contour levels are multiples of standard deviations. B, Subset of striated faults with known slip sense. Arcs and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Black, gray, and white symbols indicate normal, strike-slip, and reverse slip sense, respectively. Small arrows show movement sense of hanging wall block. Red-filled large, medium, and small circles represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, from paleostress analysis of Angelier (1990), excluding three faults with large misfits (indicated by two grayed symbols and one white symbol). Large arrows show azimuth of least horizontal compression.  $C_i$ , Rose diagram of strike frequency of joints recorded within the map area. Database of fault, joint, and deformation band measurements are available for download from Turner and Hudson

(2018) as a ScienceBase data release at

https://doi.org/10.5066/P98DH5SP.

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