U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

# GEOLOGIC MAP OF THE JASPER QUADRANGLE, NEWTON AND BOONE COUNTIES, ARKANSAS

By

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MISCELLANEOUS FIELD STUDIES MAP MF-2356

Version 1.0

Topographic base from U.S. Geological Survey, 1967
Polyconic projection; longitude of central meridian -93.1875°;
latitude of projection origin 36°; North American Datum of 1927;
Universal Transverse Mercator zone 15 grid numbers and ticks
Contour interval 20 feet

Geology mapped by Mark Hudson in 1996-98

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## 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.

## Description of Map Units

**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

**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

**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

**Bloyd Formation (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)

**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

**Hale Formation (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

**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

**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, brachipods, 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

**Fayetteville Shale (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)

**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 360 ft (64 to 110 m)

**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)

**Boone Formation (Upper to Lower Mississippian)—**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 (Upper to Lower Mississippian, Meramecian-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 1-3-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)

**St. Joe Limestone Member (Lower Mississippian, Osagean to Kinderhookian)—** 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 shaley 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

**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)

**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

**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)

## 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 north-facing 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.

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## Figure Captions

**Figure 1.** Index map showing 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.

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

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