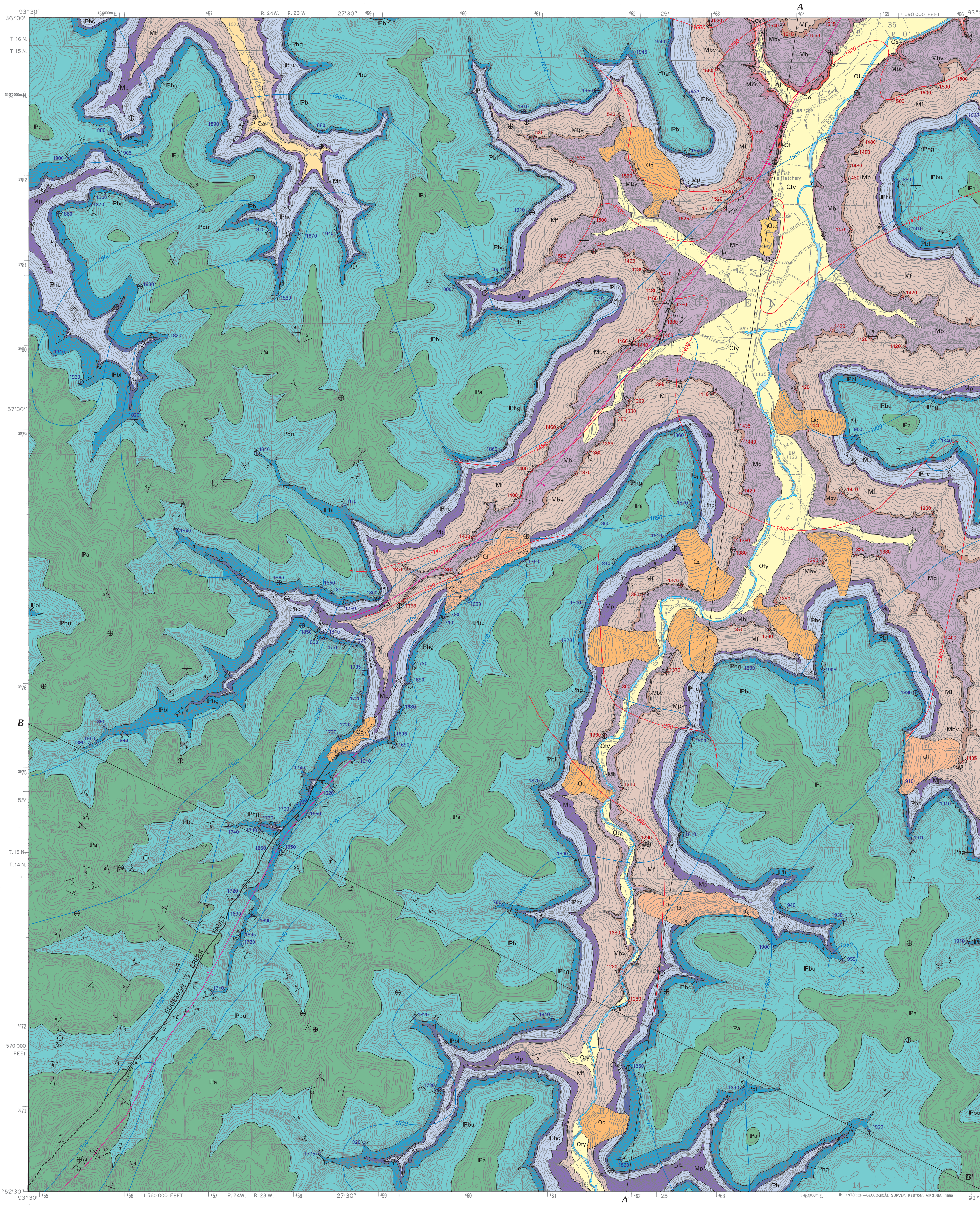
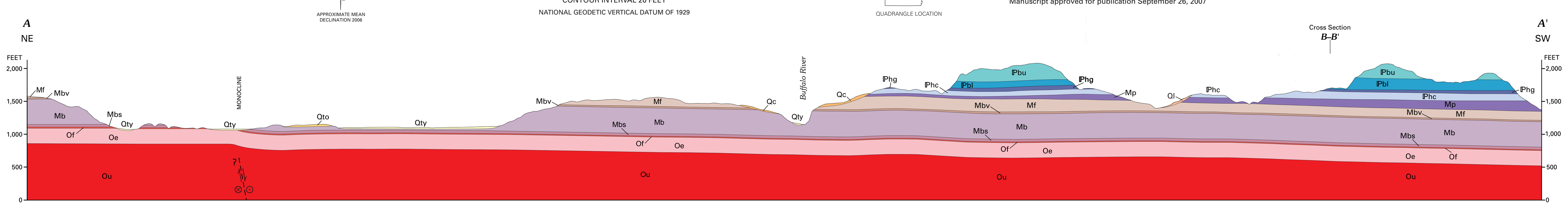
Prepared in cooperation with the
U.S. NATIONAL PARK SERVICE

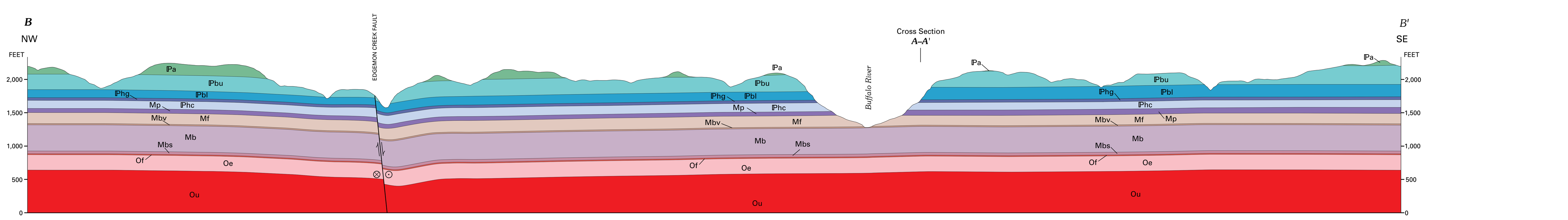


Base from U.S Geological Survey, Boxley, 1968 (photoinspected 1975)
Polyconic projection
10,000-foot grid based on Arkansas coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 15
1927 North American Datum

SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geologic mapping by M.R. Hudson and K.J. Turner, 2003–2006
Digital database prepared by K.J. Turner
Editing and digital cartography by L.J. Binder, Denver Publishing Service Center
Manuscript approved for publication September 26, 2007





GEOLOGIC MAP OF THE BOXLEY QUADRANGLE, NEWTON AND MADISON COUNTIES, ARKANSAS

By

Mark R. Hudson and Kenzie J. Turner

2007

CORRELATION OF MAP UNITS

Qty, Qal, Qc, Ql, Qto — QUATERNARY

Unconformity

ℙa — Atokan

Unconformity

ℙbu, ℙbl, ℙhg, ℙhc — Morrowan — PENNSYLVANIAN

Unconformity

Mp, Mf, Mbv — Chesterian

Unconformity

Mb — Meramecian-Osagean; Mbs — Osagean-Kinderhookian — MISSISSIPPIAN

Unconformity

Of — Upper Ordovician

Unconformity

Oe — Middle Ordovician — ORDOVICIAN

Unconformity

Ou — Lower Ordovician

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.

DESCRIPTION OF MAP UNITS

Qty **Younger terrace and active-channel alluvial 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 20 ft 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 too small to show at map scale. Low-lying parts of deposit subject to periodic flooding. As thick as 20 ft

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

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

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 (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 uncertain but probably more than 10 ft

Ql **Landslide (Quaternary)**—Large slide blocks of limestone, sandstone, and shale derived from the Pennsylvanian Bloyd Formation (ℙb) 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

ℙa **Atoka Formation (Middle Pennsylvannian, 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. 3*A*) 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

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

ℙbu **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. 3*B*). 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 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 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

ℙbl **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

Hale Formation (Lower Pennsylvanian, Morrowan)—Interbedded sequence of sandstone, siltstone, shale, and thin limestone. Thickness 100–180 ft

ℙhg **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

ℙhc **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

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, brachipods, corals, and bryzoan *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

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

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 5-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

Boone Formation (Upper to Lower Mississippian)—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

Mb **Main body (Upper 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 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 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 shaley 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

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

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 Whiteley Creek in northeast part of quadrangle, but unit is about 300 ft thick to the northeast in Ponca quadrangle (Hudson and Murray, 2003)

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

Contact

Fault—Dashed where inferred; dotted where concealed. Bar and ball on downthrown side; paired arrows indicate relative right-lateral strike-slip movement

Fault movement—In cross sections only; fault movement away from viewer (left symbol), and towards viewer (right symbol)

Monocline

Syncline

Strike and dip of bedding

30 **Inclined**

Horizontal

1400 **Line of equal elevation drawn on top of Boone Formation**—Contour interval 50 ft

1900 **Line of equal elevation drawn on base of middle Bloyd sandstone**—Contour interval 50 ft

1380 **Control point showing elevation (in feet) on upper contact of the Boone Formation**

1900 **Control point showing elevation (in feet) on base of contact of middle Bloyd sandstone**

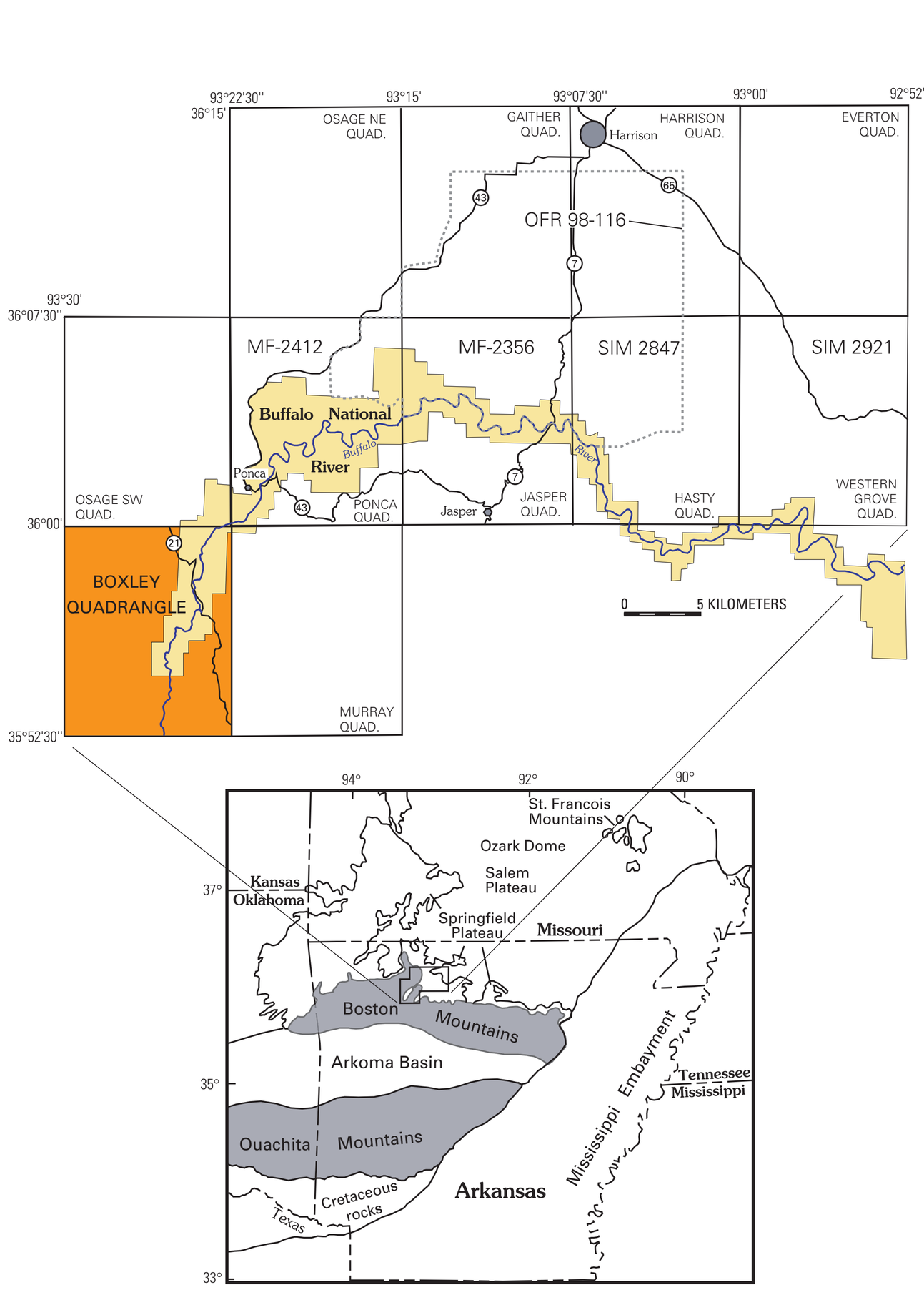


Figure 1. Location of study area within northern Arkansas, adjacent to the western part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998; Hudson and others, 2001, 2006; Hudson and Murray, 2003, 2004) are listed by publication number. Lower regional map illustrates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

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 (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 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 (Mp) 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 (ℙhg) 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. 3*A*) 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. 3*B*) 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 facies in the underlying middle Bloyd sandstone.

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, 5*A*). 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. Paleostress 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. 5*B*). 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. 5*C*). 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. 5*D*). 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.

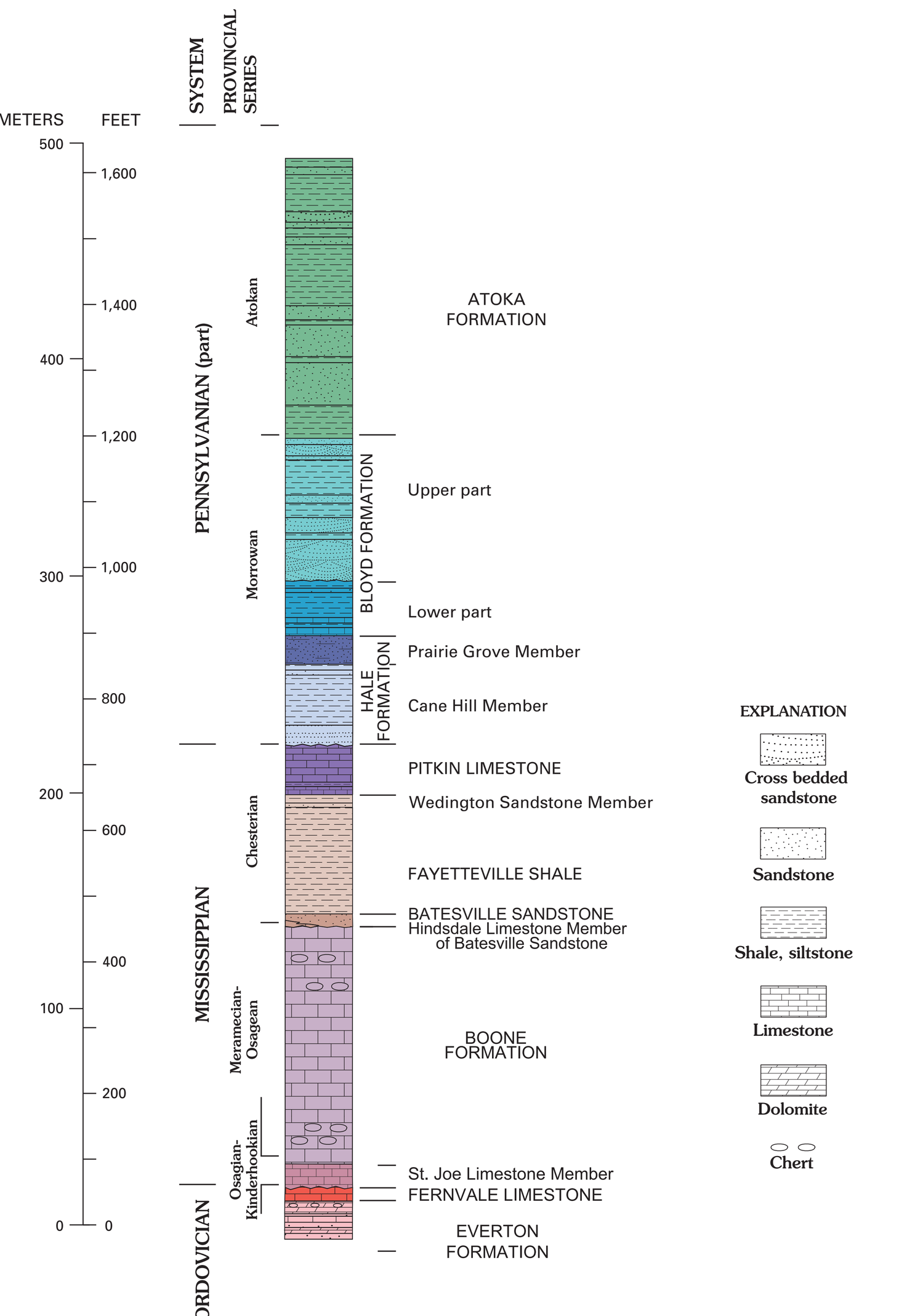


Figure 2. Stratigraphic column of Paleozoic rocks in the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

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.

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. Zachry for discussions about the Pennsylvanian stratigraphy. Helpful reviews were provided by Angela Chandler and Paul Carrara.

REFERENCES CITED

Angelier, Jacque, 1990, Inversion of field data in fault tectonics to obtain the regional stress—III, A new rapid direct inversion method by analytical means: Geophysical Journal International, v. 103, p. 363–376.

Henbest, L.G., 1953, Morrow Group and lower Atoka Formation of Arkansas: American Association of Petroleum Geologists Bulletin, v. 37, p. 1935–1953.

Horner, G.J., and Craig, W.W., 1984, The Sylamore Sandstone of north-central Arkansas, with emphasis on the origin of its phosphate, *in* McFarland, J.D., III, ed., Contributions to the geology of Arkansas, v. 2: Arkansas Geological Commission, p. 51–85.

Hudson, M.R., 1998, Geologic map of parts of the Jasper, Hasty, Ponca, Gaither, and Harrison quadrangles in and adjacent to Buffalo National River, northwestern Arkansas: U.S. Geological Survey Open-File Report 98–116, scale 1:24,000.

Hudson, M.R., 2000, Coordinated strike-slip and normal faulting in the southern Ozark dome of northern Arkansas: Deformation in a late Paleozoic foreland: Geology, v. 28, p. 511–514.

Hudson, M.R., and Cox, R.T., 2003, Late Paleozoic tectonics of the southern Ozark dome, *in* Cox, R.T., compiler, Field trip guidebook for Joint South-Central and Southeastern Sections: Geological Society of America, Tennessee Division of Geology Report of Investigations 51, p. 15–32.

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.

Hudson, M.R., and Murray, K.E., 2004, Geologic map of the Hasty quadrangle, Newton and Boone Counties, Arkansas: U.S. Geological Survey Scientific Investigations Map 2847, scale 1:24,000.

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.

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 2921, scale 1:24,000.

Manger, W.L., and Sutherland, P.K., 1992, Analysis of sections presumed to be complete across the Mississippian-Pennsylvanian boundary, southern mid-continent, *in* Sutherland, P.K., and Manger, W.L., eds., Recent advances in middle Carboniferous biostratigraphy—A symposium: Oklahoma Geological Survey Circular 94, p. 69–79.

McFarland, J.D., III, 1988, The Paleozoic rocks of the Ponca region, Buffalo National River, Arkansas, *in* Hayward, O.T., ed., Centennial Field Trip Guide, v. 4: Geological Society of America, p. 207–210.

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, Descriptions of the Eureka Springs and Harrison quadrangles: U.S. Geological Survey Atlas, Folio 202, scale 1:125,000.

Suhm, R.A., 1974, Stratigraphy of Everton Formation (early Medial Ordovician), northern Arkansas: American Association of Petroleum Geologists Bulletin, v. 58, p. 685–707.

Sutherland, P.K., 1988, Late Mississippian and Pennsylvanian depositional history in the Arkoma basin area, Oklahoma and Arkansas: Geological Society of America Bulletin, v. 100, p. 1787–1802.

Zachry, D.L., 1977, Stratigraphy of middle and upper Bloyd strata (Pennsylvanian, Morrowan), northwestern Arkansas, *in* Sutherland, P.K., and Manger, W.L., eds., Upper Chesterian-Morrowan stratigraphy and the Mississippian-Pennsylvanian boundary in northeastern Oklahoma and northwestern Arkansas: Oklahoma Geological Survey Guidebook 18, p. 61–66.

Zachry, D.L., and Sutherland, P.K., 1984, Stratigraphy and depositional framework of the Atoka Formation (Pennsylvanian), Arkoma basin of Arkansas and Oklahoma, *in* Sutherland, P.K., and Manger, W.L., eds., The Atokan series (Pennsylvanian) and its boundaries—A symposium: Oklahoma Geological Survey Bulletin 136, p. 9–17.

CONVERSION FACTORS

Multiply	By	To obtain
inches (in)	2.54	centimeters (cm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)

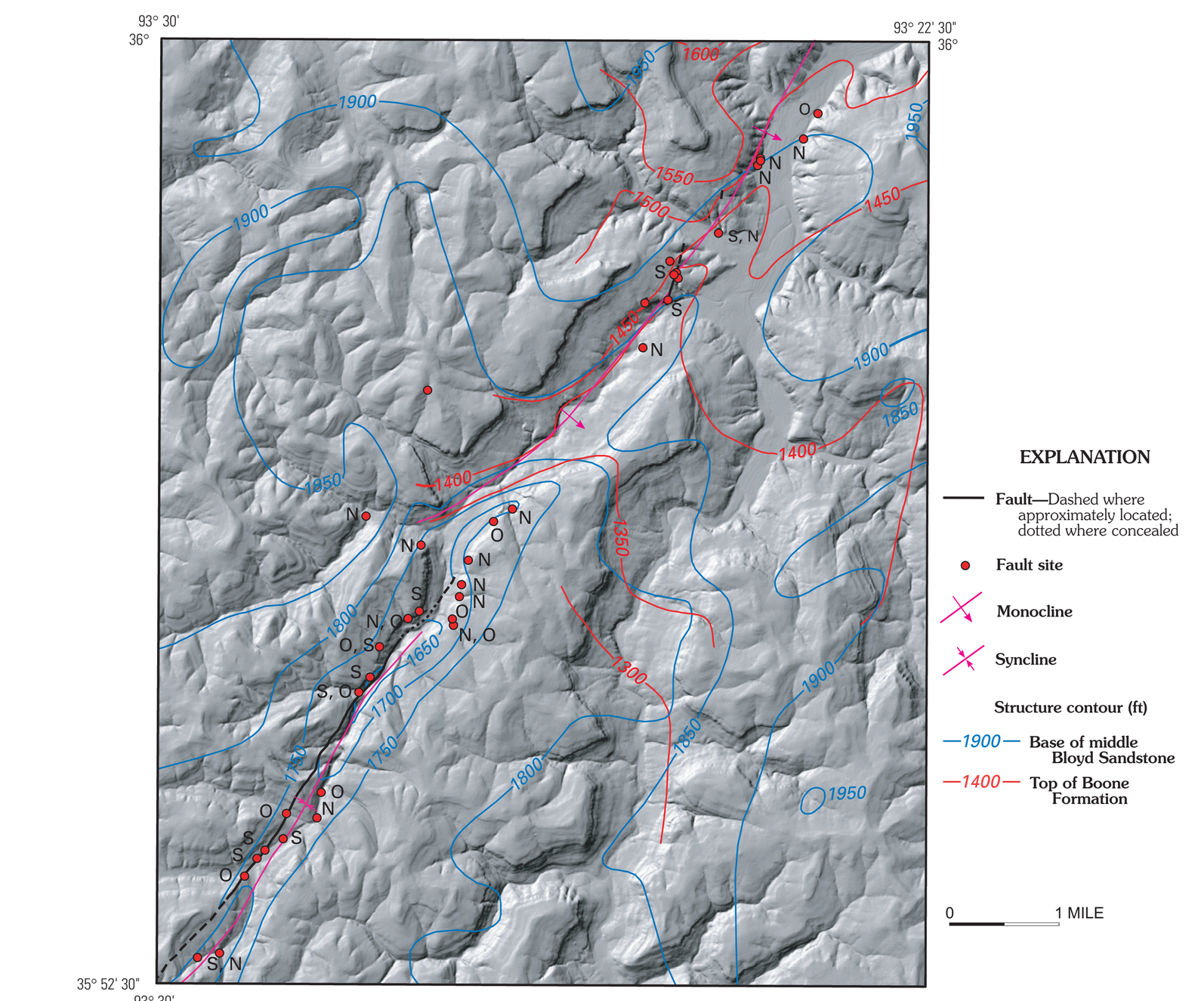


Figure 4. Shaded-relief digital elevation map of quadrangle with locations of structural features and sites where faults were observed. Slip senses for fault sites are indicated as normal, N (rake 90° to 60°), oblique, O (rake 59° to 30°), and strike-slip, S (rake 29° to 0°).

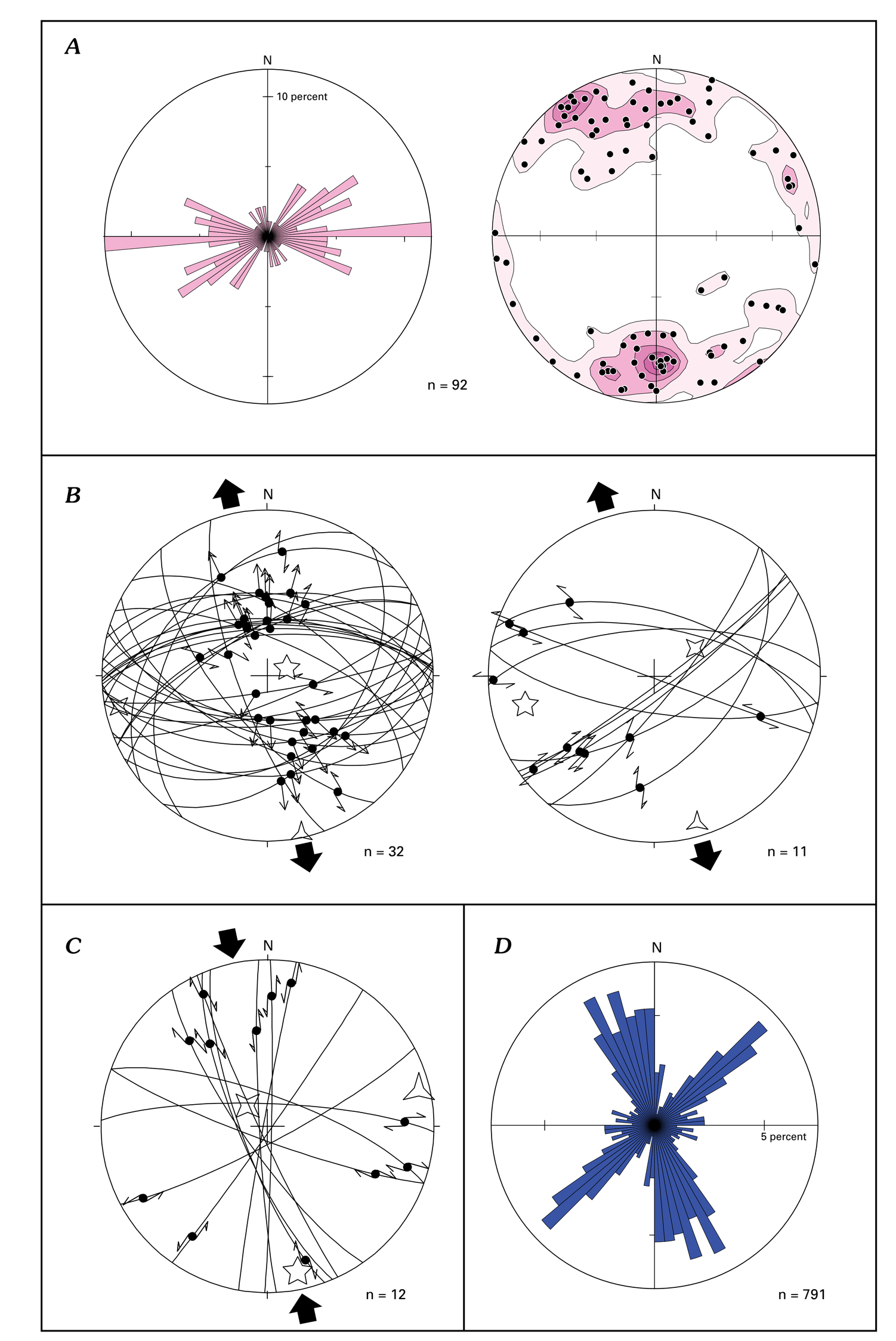


Figure 5. Structural data from the Boxley quadrangle. Number of data are "n". (*A*) Rose diagram of strike frequency (left) and stereoplot of poles and orientation-density contours (right) for faults in quadrangle. Contour levels are multiples of standard deviations; (*B*) Subset of striated faults with known slip sense that are compatible with normal (left) and 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 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.

Suggested citation:
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 2991, scale 1:24,000.