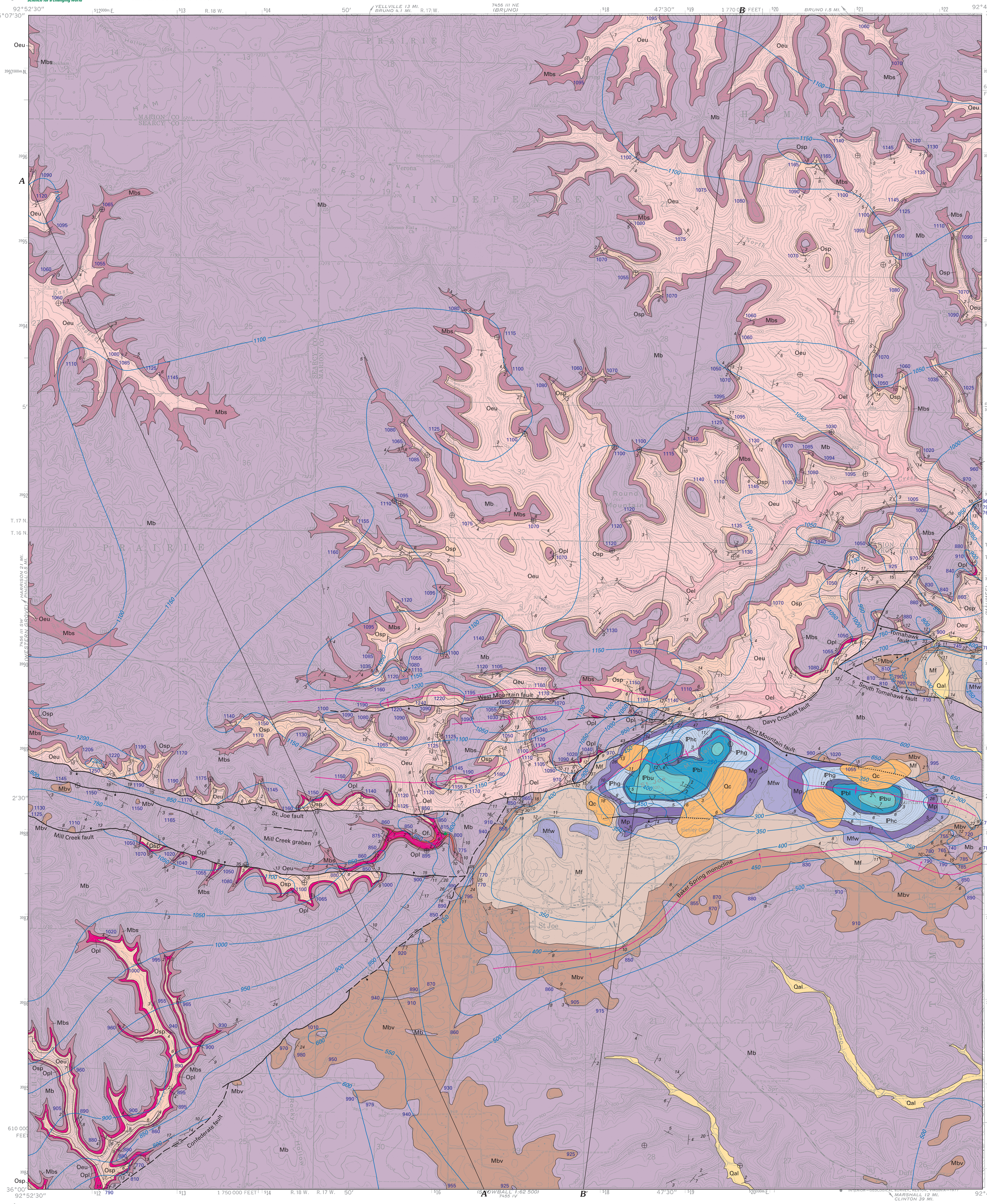
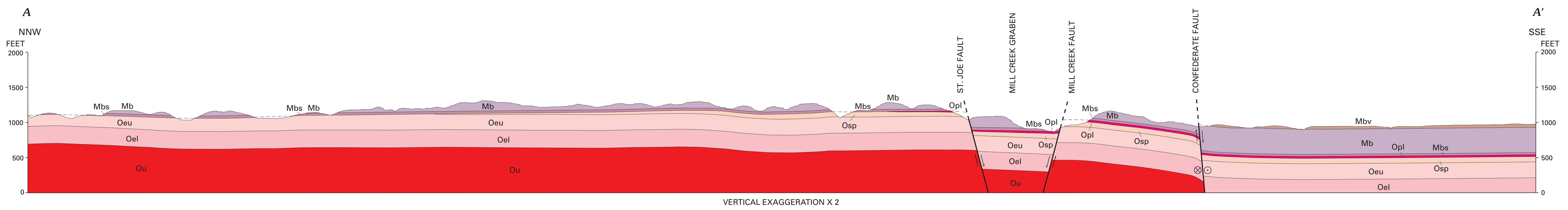
Prepared in cooperation with the
U.S. NATIONAL PARK SERVICE

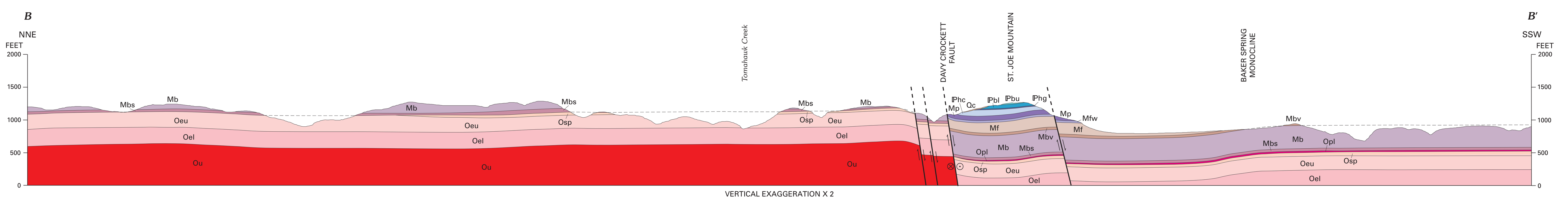


Base from U.S. Geological Survey, 1967
Projection and 10,000-foot grid ticks: Arkansas coordinate system, north zone
1000-meter Universal Transverse Mercator grid, zone 15
1927 North American Datum

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

Geology mapped by M.R. Hudson and K.J. Turner, 2005–2008
Digital map database prepared by Kenzie J. Turner
Editing and digital cartography by Gayle M. Dumonceaux
Denver Publishing Service Center
Manuscript approved for publication March 20, 2009

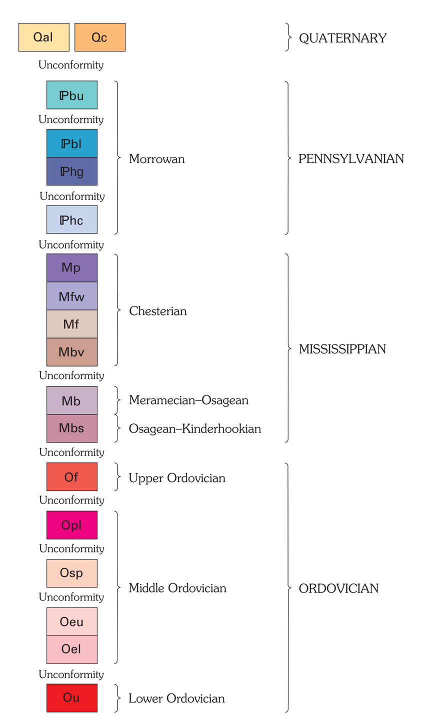




GEOLOGIC MAP OF THE ST. JOE QUADRANGLE, SEARCY AND MARION COUNTIES, ARKANSAS

By
Mark R. Hudson and Kenzie J. Turner
2009

CORRELATION OF MAP UNITS



INTRODUCTION

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

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

DESCRIPTION OF MAP UNITS

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

Qc **Colluvial deposits (Quaternary)**—Unconsolidated deposits of subrounded to angular blocks as large as 20 ft in diameter, commonly in an orange-brown silty clay matrix. Blocks are mostly derived from basal sandstone of upper part of Bloyd Formation (Pbu) and 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

Bloyd Formation (Lower Pennsylvanian, Morrowan)—Interbedded sequence of sandstone, siltstone, shale, and thin limestone beds separated into lower and upper intervals. As much as 180 ft thick

Pbu **Upper part**—Crossbedded sandstone capping Pilot and St. Joe Mountains. Sandstone forms prominent cliffs as tall as 60 ft on Pilot Mountain and more subdued ledges on St. Joe Mountain. Sandstone is white to light-brown, fine- to medium-grained quartz arenite and is a composite of 1- to 3-ft-thick tabular and trough crossbed sets. Sandstone has a sharp erosional base and contains concentrations of white quartz pebbles and, locally, casts and molds of wood fragments. Rocks of the upper Bloyd Formation were originally assigned to the Winslow Formation by Purdue and Miser (1916). Zachry (1977) concluded that the basal sandstone was a time-equivalent unit with the Woolsey Member of the Bloyd Formation farther west and designated it the "middle Bloyd sandstone." Maximum preserved thickness is 110 ft

Pbl **Lower part**—Sequence of predominantly dark-gray to black shale and siltstone with thin beds of sandstone and limestone; poorly exposed under moderate to steep hillslopes. Siltstone is medium to dark gray, fissile, and moderately bioturbated. Medium beds of rippled, very fine grained sandstone are locally exposed as ledges. Coarse bioclastic limestone is reddish gray and weathers dark brown but is poorly exposed and mostly observed in loose blocks in lower part of sequence. Thickness 50–70 ft

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 in its base and thin interbeds of fossiliferous limestone. Beds are planar or crossbedded, and crossbeds may have bi-directional dips. Weathered sandstone forms rounded surfaces. Sandstone forms steep hillslopes or ledges that are commonly covered by slope debris from overlying units. Thickness 10–25 ft

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

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

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 160–200 ft

Mfw **Wedington Sandstone Member**—Brown to light-gray, well-indurated, calcite-cemented sandstone and siltstone. Wedington caps a steep slope and is separated from overlying Pitkin Limestone by a common topographic bench. Sandstone is very fine grained and is present in thick to thin planar beds with internal parallel laminations and locally developed low-angle crossbeds. Sandstone grades downward into siltstone beds that are ripple cross-laminated and bioturbated. Wedington grades downward into main body. Thickness 25–40 ft

Mf **Main body**—Below the Wedington Sandstone Member, middle part of Fayetteville Shale is poorly exposed black shale that locally contains thin, rippled beds of olive-brown siltstone near its top. Lower part of Fayetteville crops out along stream gullies where it consists of black fissile shale that may contain medium- to light-gray, fetid septarian concretions as large as 2 ft in diameter. The Fayetteville Shale is susceptible to landslides. Thickness 130–160 ft

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

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 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 common in upper part of unit. Beds of dense, fine-grained limestone are present in upper one-third of unit. Beds are typically parallel planar to wavy, but channel fills are locally present in lower part of unit. Chert content varies vertically and laterally within Boone and forms lenticular to anastomosing lenses. Chert-rich horizons are generally poorly exposed but produce abundant float of white-weathered chert on hillslopes. Chert in uppermost part of unit contains prominent brachiopod molds. Thickness 310–375 ft

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

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

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

Osp **St. Peter Sandstone (Middle Ordovician)**—Very fine grained, grayish-yellow sandstone interbedded with blue-green siltstone, shale, and sparse dolostone. Sandstone is calcite-cemented arenite containing well-rounded quartz grains. Upper part of unit, as thick as 25 ft, is sandstone interbedded with blue-green fissile shale, thin-bedded siltstone, and sparse 0.5- to 3-ft-thick beds of brown-gray, fine crystalline dolostone; shale, siltstone, and dolostone interval poorly exposed, but is locally marked by zone of slumped sandstone blocks on hill slopes. Main part of unit contains a sequence of 1- to 2-ft-thick sandstone beds overlying a massive basal sandstone ledge as thick as 20 ft. Bioturbation is common in most sandstone beds and includes cylindrical burrows (*Skolithos*) perpendicular to bedding that weather to distinctive straw-like forms. Basal sandstone is crossbedded, contains inclined fractures, and discordantly overlies laminated sandy dolomite in upper part of Everton Formation at local recesses. Unit thins to nothing to northwest due to pre-Mississippian erosion beneath unconformity at base of St. Joe Limestone Member of Boone Formation. Thickness ranges from 0 to 70 ft

Everton Formation (Middle Ordovician)—Interbedded dolostone, limestone, and sandstone sequence, divided into upper and lower parts. Unit is 300–400 ft thick

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

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

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

STRATIGRAPHY

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

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

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

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

MAP EXPLANATION

- **Contact**
- **Fault**—Dashed where approximately located
- **Normal fault**—Dashed where approximately located, dotted where concealed, bar and ball on downthrown block
- **Strike-slip fault, right-lateral offset**—Dashed where approximately located, arrows show relative motion
- ⊗ ⊙ **Fault movement**—Away from viewer (left), toward viewer (right), shown in cross sections only
- **Anticline**
- **Syncline**
- **Monocline**
- **Strike and dip of bedding**
  - 51 **Inclined**
  - ⊕ **Horizontal**
- 900 **Line of equal elevation showing base of Boone Formation, contour interval 50 ft**
- ⊙900 **Control point showing elevation in feet on base or top of Boone Formation**
- ★ **Cason Shale locality**

STRUCTURAL GEOLOGY

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

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

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

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

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

ECONOMIC GEOLOGY

McKnight (1935) described lead and zinc ores from several mines in the St. Joe and Tomahawk Creek mining districts located on the northern, upthrown side of the St. Joe and Davy Crockett faults within the St. Joe quadrangle (fig. 3). The dominant ore mined from local prospects consists of sphalerite (ZnS) and zinc carbonate and minor copper in the form of malachite. Dolomitic and limestone layers of the Everton Formation (Oe) host most prospects. Silicification was commonly associated with Pb-Zn mineralization (McKnight, 1935) and was noted at several sites during this field investigation (fig. 3) defining an elongate area mostly north of the St. Joe and Davy Crockett faults. Within the Boone Formation (Mb), silica was precipitated as fracture coatings of drusy quartz having euhedral crystals tips as wide as ½ in. (fig. 5*A*). Additionally, within the Boone Formation and its basal St. Joe Limestone Member, several elongate bodies of brecciated chert cemented by microcrystalline quartz (fig. 5*B*) were noted, standing 3 to 20 ft high as erosion-resistant ridges. These masses probably formed by dissolution of limestone and collapse of chert within the Boone Formation followed by silicification during flow of mineralizing fluids. Enhanced silicic cementation of sandstone beds was also noted within the Ordovician St. Peter Sandstone (Osp) and Everton Formation (Oe) and at one location within the Pennsylvanian Cane Hill Member (Phc) of the Hale Formation.

ACKNOWLEDGMENTS

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

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.
Aydin, A., and Johnson, A.M., 1978, Development of faults as zone of deformation bands and as slip surfaces in sandstone: Pure and Applied Geophysics, v. 116, p. 931–942.
Braden, A.K., and Ausbrooks, S.M., 2003a, Geologic map of the Eula quadrangle, Newton and Searcy Counties, Arkansas: Arkansas Geological Commission Digital Geologic Quadrangle Map DGM-AR-00269, scale 1:24,000.
Braden, A.K., and Ausbrooks, S.M., 2003b, Geologic map of the Snowball quadrangle, Searcy County, Arkansas: Arkansas Geological Commission Digital Geologic Quadrangle Map DGM-AR-00800, scale 1:24,000.
Craig, W.W., 1975, Stratigraphy and conodont faunas of the Cason Shale and the Kimmswick and Fernvale Limestones of northern Arkansas, *in* Headrick, K.N., and Wise, O.A., eds., Contributions of the geology of the Arkansas Ozarks, Arkansas Geological Commission, p. 61–95.
Glick, E.E., and Frezon, S.E., 1953, Lithologic character of the St. Peter Sandstone and Everton Formation in the Buffalo River Valley, Newton County, Arkansas: U.S. Geological Survey Circular 249, 39 p.
Handford, C.R., 1985, Facies and bedding sequences in shelf-storm-deposited carbonates—Fayetteville Shale and Pitkin Limestone (Mississippian), Arkansas: Journal of Sedimentary Petrology, v. 56, p. 123–137.
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., 2001, 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., Murray, K.E., and Pezzutti, D., 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., 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, http://pubs.usgs.gov/sim/2004/2847/.
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, 1:24,000 scale, http://pubs.usgs.gov/sim/2006/2921/.
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, 1:24,000 scale, http://pubs.usgs.gov/sim/2991/.
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.
McKnight, E.T., and Fischer, R.P., 1970, Geology and ore deposits of the Picher field, Oklahoma and Kansas: U.S. Geological Survey Professional Paper 588, 165 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.

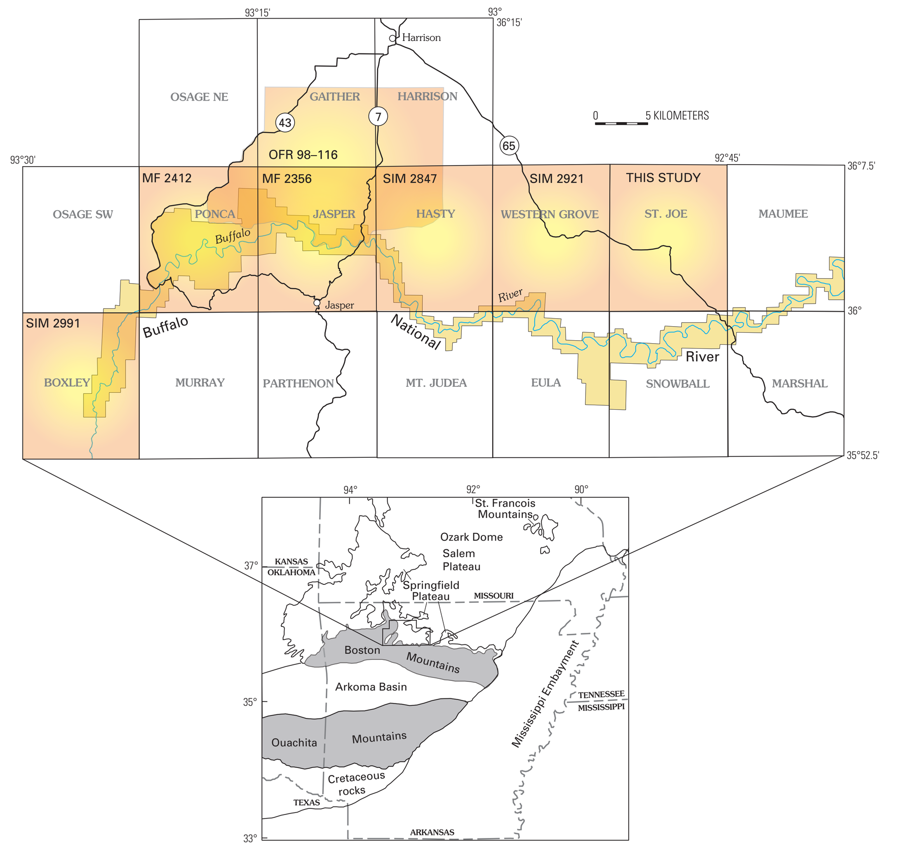


Figure 1. Location of study area within northern Arkansas, adjacent to the eastern part of Buffalo National River. Other U.S. Geological Survey geologic maps in area (Hudson, 1998; Hudson and others, 2001, 2006; Hudson and Murray, 2003, 2004; Hudson and Turner, 2007) are listed by publication number.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

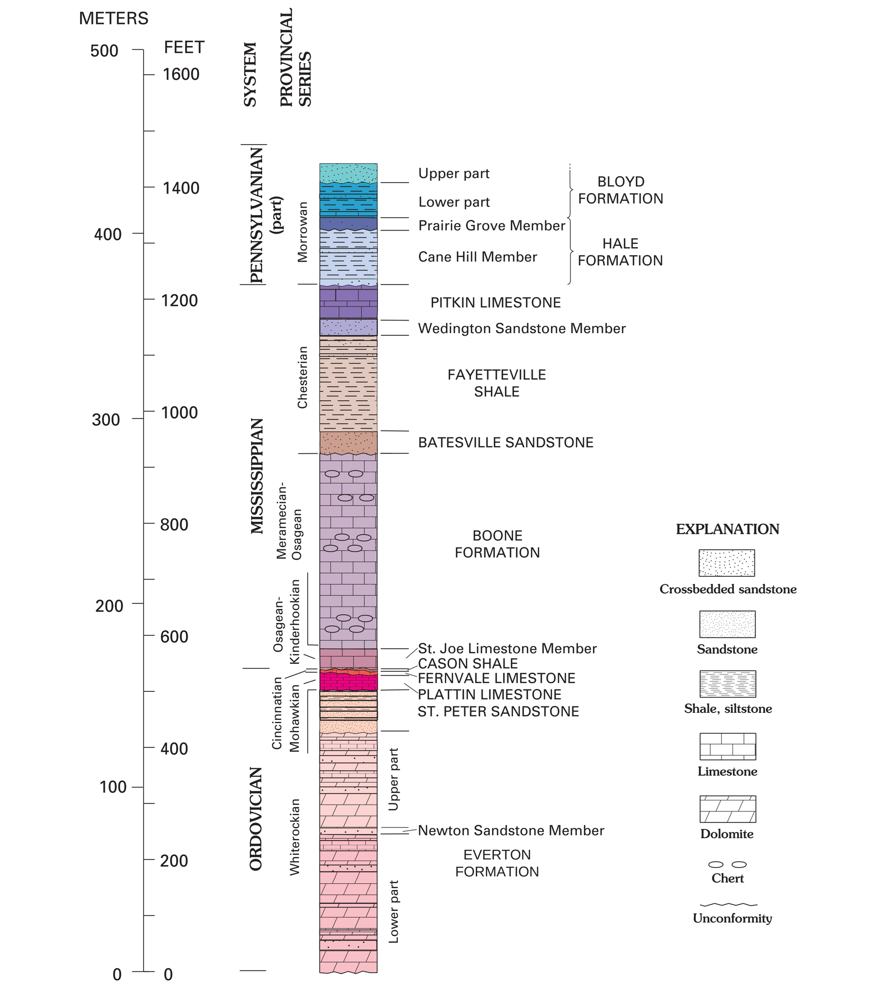


Figure 2. Stratigraphic column for Paleozoic rocks representative of the map area. Provincial series are from Purdue and Miser (1916) and McFarland (1988).

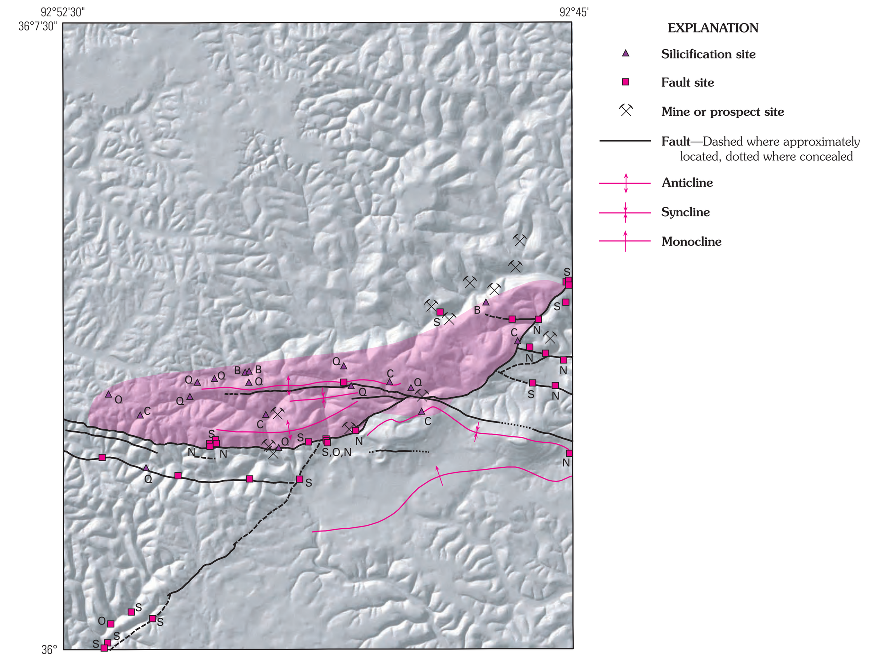


Figure 3. Shaded-relief elevation map of quadrangle with locations of Pb-Zn mines and prospects, structural features, and sites where faults (squares) and silicification (triangles) were observed. Where determined, slip senses for faults at sites are indicated as normal, N (rake 90° to 60°); oblique,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

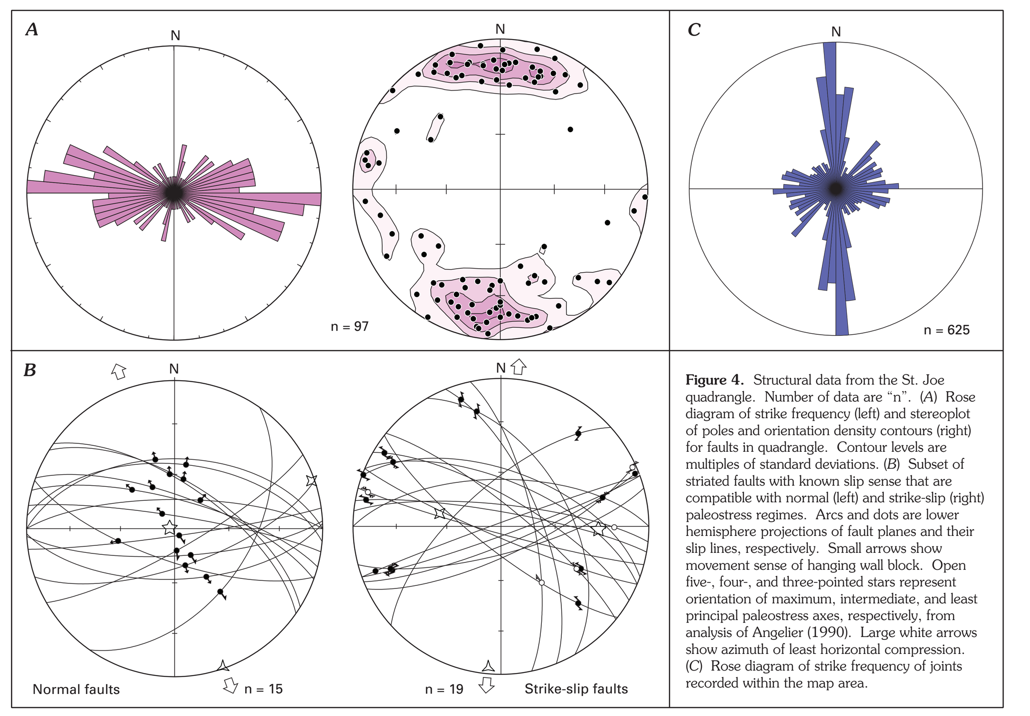


Figure 4. Structural data from the St. Joe quadrangle. Number of data are "n". (*A*) Rose diagram of strike frequency (left) and stereoplot of poles and orientation density contours (right) for faults in quadrangle. Contour levels are multiples of standard deviations. (*B*) Subset of striated faults 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 white arrows show azimuth of least horizontal compression. (*C*) Rose diagram of strike frequency of joints recorded within the map area.

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

CONVERSION FACTORS

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

Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Government
This map was produced on request, directly from digital files, on an electronic plotter
For sale by U.S. Geological Survey Information Services
Box 25286, Federal Center, Denver, CO 80225
1-888-ASK-USGS
ArcInfo coverages and a PDF for this map are available at http://pubs.usgs.gov/sim/3074/
Suggested citation:
Hudson, M.R., and Turner, K.J., 2009, Geologic map of the St. Joe quadrangle, Searcy and Marion Counties, Arkansas: U.S. Geological Survey Scientific Investigations Map 3074, scale 1:24,000.