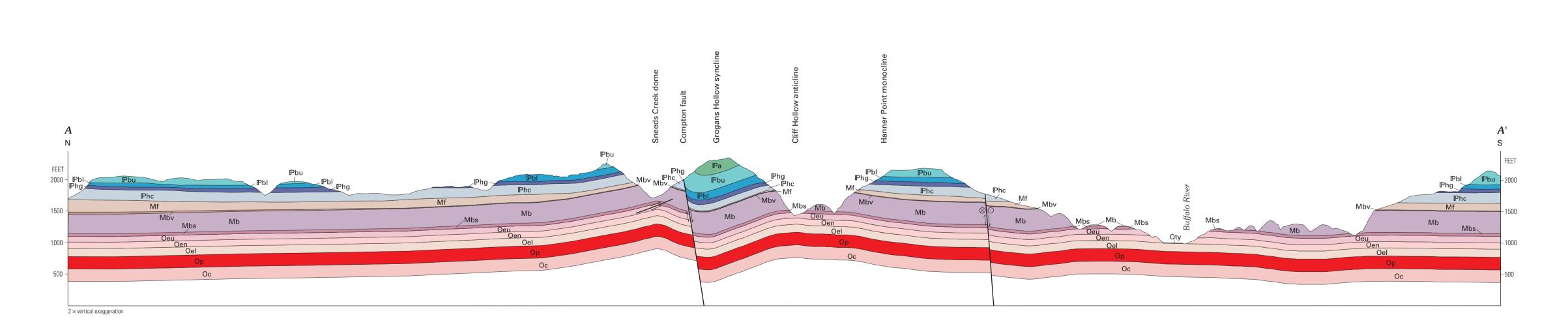
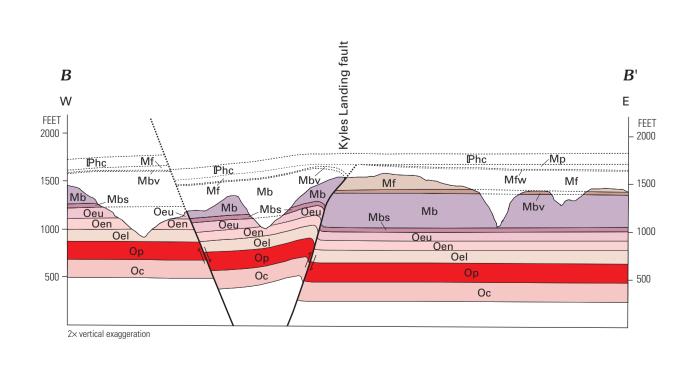
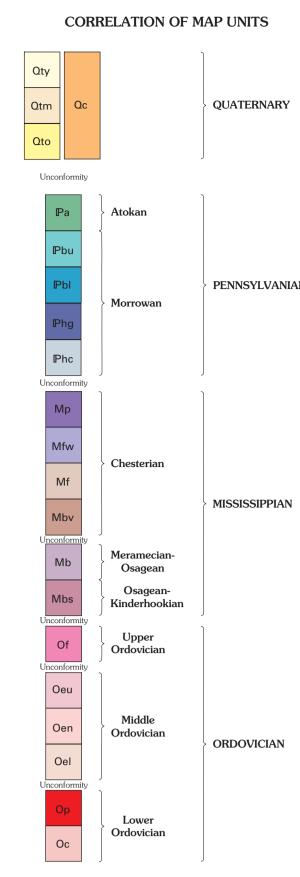
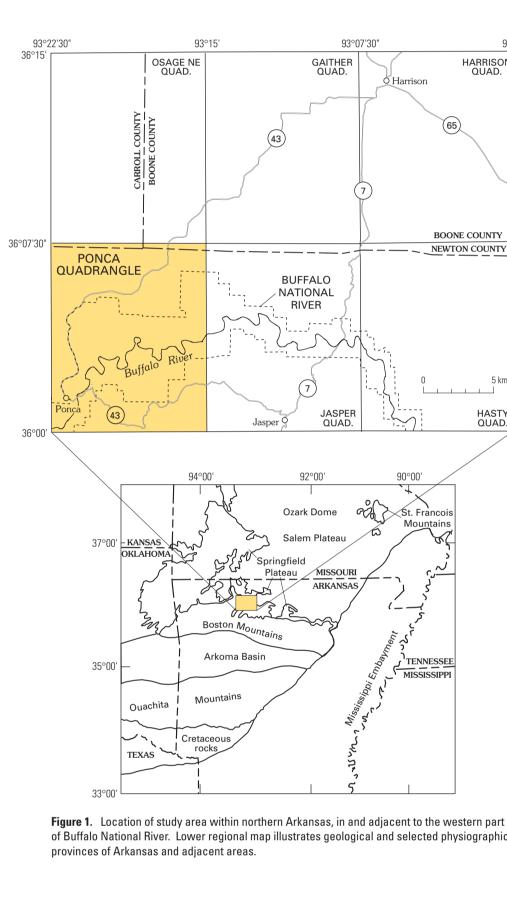


NATIONAL GEODETIC VERTICAL DATUM OF 1929





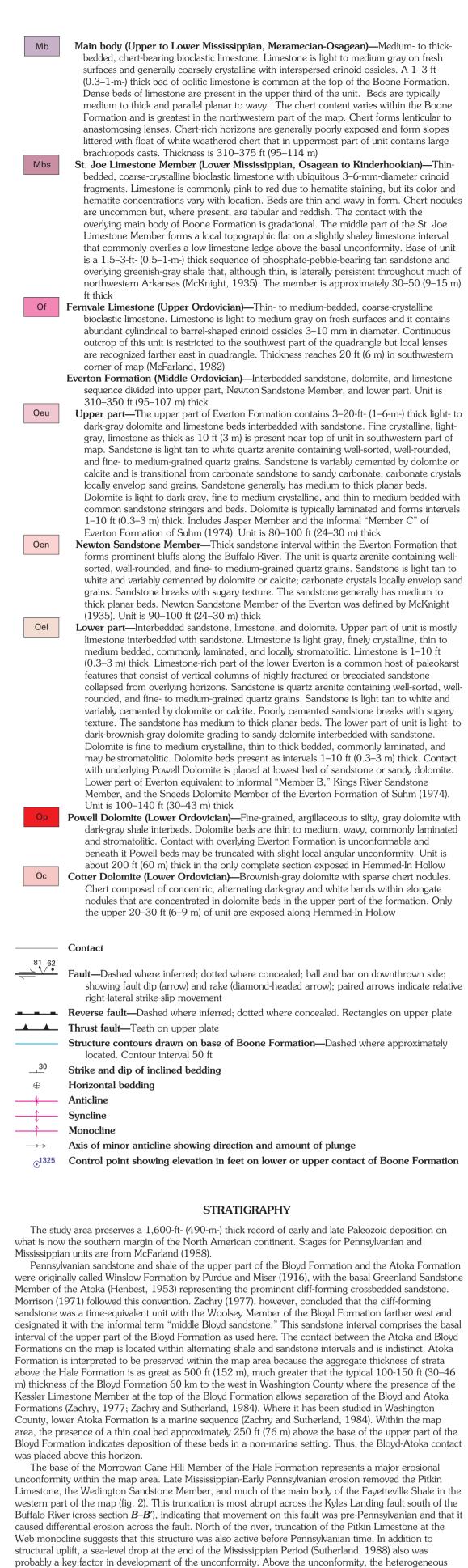


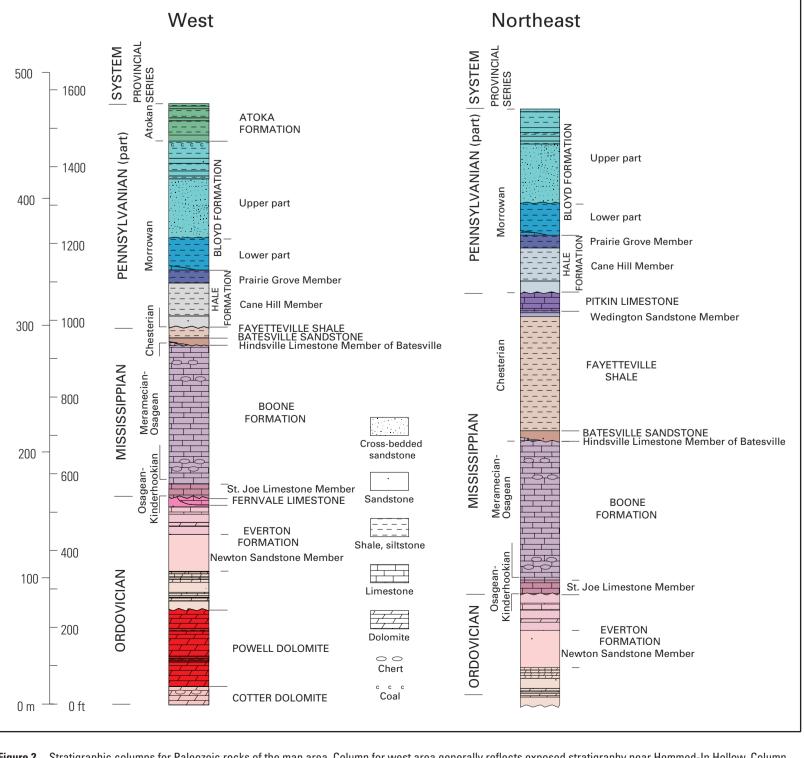




BOONE COUNTY







m). Large variation in thickness of unit partly results from Late Mississippian-Early

Mbv Batesville Sandstone (Upper Mississippian, Chesterian)—Fine- to very fine grained, light-

Hale Formation

the northeastern part of the area

tormation is 380–405 ft (116–122 m)

Pennsylvanian erosion beneath unconformity at base of the Cane Hill Member of the

to medium-brown, calcite-cemented sandstone with interbedded limestone. Thin to

part of unit. Sandstone commonly contains burrows on bedding plane surfaces and

to dark-gray, fetid, fossiliferous limestone beds are locally interbedded with sandstone. The Hindsville Limestone Member (Purdue and Miser, 1916) is present in the northeast

map area at the base of the formation and is as much as 5 ft (1.5 m) thick in the Cecil

subangular clasts of white chert that range in size to as much as 2 in. (5 cm). Limestone

along streams. Where stripped of overlying Fayetteville Shale, the top of the Batesville is

beds of the Batesville contain crinoids and brachiopods. Sandstone and limestone beds

contain 2-10-mm-diameter oxidized pyrite framboids that weather to reddish-brown spheres. The Batesville commonly forms a topographic ledge that forms small waterfalls

typically a topographic flat that hosts sinkholes formed by collapse into dissolution cavities in underlying Boone Formation. Thickness is 3-30 ft (1-9 m) and is greatest in

Boone Formation (Upper to Lower Mississippian)—Formation consists of 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. The total thickness of the

Creek drainage. Hindsville Limestone Member is distinguished by the presence of

medium beds are typically parallel laminated with low-angle crossbeds common in upper

breaks into tabular blocks. One or more discontinuous, 1–3-ft- (0.3–1-m-) thick, medium-

Figure 2. Stratigraphic columns for Paleozoic rocks of the map area. Column for west area generally reflects exposed stratigraphy near Hemmed-In Hollow. Column for northeast area reflects stratigraphy exposed in the Cecil Creek drainage. Provincial series are from Purdue and Miser (1916) and McFarland (1988).



gray, limestone as thick as 10 ft (3 m) is present near top of unit in southwestern part of map. Sandstone is light tan to white quartz arenite containing well-sorted, well-rounded, and fine- to medium-grained quartz grains. Sandstone is variably cemented by dolomite or calcite and is transitional from carbonate sandstone to sandy carbonate; carbonate crystals locally envelop sand grains. Sandstone generally has medium to thick planar beds. Dolomite is light to dark gray, fine to medium crystalline, and thin to medium bedded with common sandstone stringers and beds. Dolomite is typically laminated and forms intervals 1-10 ft (0.3–3 m) thick. Includes Jasper Member and the informal "Member C" of Everton Formation of Suhm (1974). Unit is 80–100 ft (24–30 m) thick Newton Sandstone Member—Thick sandstone interval within the Everton Formation that forms prominent bluffs along the Buffalo River. The unit is quartz arenite containing wellsorted, well-rounded, and fine- to medium-grained quartz grains. Sandstone is light tan to white and variably cemented by dolomite or calcite; carbonate crystals locally envelop sand grains. Sandstone breaks with sugary texture. The sandstone generally has medium to thick planar beds. Newton Sandstone Member of the Everton was defined by McKnight Lower part—Interbedded sandstone, limestone, and dolomite. Upper part of unit is mostly limestone interbedded with sandstone. Limestone is light gray, finely crystalline, thin to medium bedded, commonly laminated, and locally stromatolitic. Limestone is 1-10 ft (0.3-3 m) thick. Limestone-rich part of the lower Everton is a common host of paleokarst features that consist of vertical columns of highly fractured or brecciated sandstone collapsed from overlying horizons. Sandstone is quartz arenite containing well-sorted, wellrounded, and fine- to medium-grained quartz grains. Sandstone is light tan to white and variably cemented by dolomite or calcite. Poorly cemented sandstone breaks with sugary texture. The sandstone has medium to thick planar beds. The lower part of unit is light- to dark-brownish-gray dolomite grading to sandy dolomite interbedded with sandstone. Dolomite is fine to medium crystalline, thin to thick bedded, commonly laminated, and may be stromatolitic. Dolomite beds present as intervals 1-10 ft (0.3–3 m) thick. Contact with underlying Powell Dolomite is placed at lowest bed of sandstone or sandy dolomite. Lower part of Everton equivalent to informal "Member B," Kings River Sandstone Member, and the Sneeds Dolomite Member of the Everton Formation of Suhm (1974). Powell Dolomite (Lower Ordovician)—Fine-grained, argillaceous to silty, gray dolomite with dark-gray shale interbeds. Dolomite beds are thin to medium, wavy, commonly laminated and stromatolitic. Contact with overlying Everton Formation is unconformable and beneath it Powell beds may be truncated with slight local angular unconformity. Unit i about 200 ft (60 m) thick in the only complete section exposed in Hemmed-In Hollow **Cotter Dolomite (Lower Ordovician)**—Brownish-gray dolomite with sparse chert nodules. Chert composed of concentric, alternating dark-gray and white bands within elongate

Fault—Dashed where inferred; dotted where concealed; ball and bar on downthrown side; showing fault dip (arrow) and rake (diamond-headed arrow); paired arrows indicate relative **Reverse fault**—Dashed where inferred; dotted where concealed. Rectangles on upper plate Structure contours drawn on base of Boone Formation—Dashed where approximately

# STRATIGRAPHY

Pennsylvanian sandstone and shale of the upper part of the Bloyd Formation and the Atoka Formation were originally called Winslow Formation by Purdue and Miser (1916), with the basal Greenland Sandstone Member of the Atoka (Henbest, 1953) representing the prominent cliff-forming crossbedded sandstone. Morrison (1971) followed this convention. 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." This sandstone interval comprises the basal interval of the upper part of the Bloyd Formation as used here. The contact between the Atoka and Bloyd Formations on the map is located within alternating shale and sandstone intervals and is indistinct. Atoka Formation is interpreted to be preserved within the map area because the aggregate thickness of strata above the Hale Formation is as great as 500 ft (152 m), much greater that the typical 100-150 ft (30–46 m) thickness of the Bloyd Formation 60 km to the west in Washington County where the presence of the Kessler Limestone Member at the top of the Bloyd Formation allows separation of the Bloyd and Atoka Formations (Zachry, 1977; Zachry and Sutherland, 1984). Where it has been studied in Washington County, lower Atoka Formation is a marine sequence (Zachry and Sutherland, 1984). Within the map area, the presence of a thin coal bed approximately 250 ft (76 m) above the base of the upper part of the Bloyd Formation indicates deposition of these beds in a non-marine setting. Thus, the Bloyd-Atoka contact

Limestone, the Wedington Sandstone Member, and much of the main body of the Fayetteville Shale in the western part of the map (fig. 2). This truncation is most abrupt across the Kyles Landing fault south of the Buffalo River (cross section B-B'), indicating that movement on this fault was pre-Pennsylvanian and that it caused differential erosion across the fault. North of the river, truncation of the Pitkin Limestone at the Web monocline suggests that this structure was also active before Pennsylvanian time. In addition to probably a key factor in development of the unconformity. Above the unconformity, the heterogeneous nature of the basal sandstone interval of the Cane Hill Member of the Hale Formation, as well as its content of conglomerate and wood fragments, suggests that this interval includes non-marine fluvial deposits that were deposited ahead of a Morrowan sea-level rise. Limestone clasts within conglomerates of the basal Cane Hill Member were probably derived from Pitkin Limestone. The main part of the Boone Formation within most of the study area does not contain as much chert

as described elsewhere in northern Arkansas. As a consequence, its contact with underlying St. Joe Limestone Member, which elsewhere is based on a marked increase in chert, is indistinct. This study did not confirm major thinning of the Boone Formation in the area of the Sneeds Creek dome, as proposed by Morrison (1971). Instead, apparent thinning can be attributed to offset between the base and top of the Boone Formation across a newly recognized northeast-striking normal fault. Although thin, the phosphatenodule-bearing sandstone and overlying thin shale at the base of the St. Joe is persistent throughout much of northern Arkansas (McKnight, 1935). Based on petrography, Horner and Craig (1984) supported a correlation of the basal sandstone with the Sylamore Sandstone that was deposited as a transgressive lag during sea level rise in Late Devonian time. Strata of uppermost Ordovician through Devonian age are missing beneath the unconformity at the base of the St. Joe Limestone Member, although strata of these ages are preserved both to the east and west of the map area.

map area include, from top to bottom, the Jasper Member, B member, Newton Sandstone Member, C member, King River Sandstone Member, and Sneeds Dolomite Members. Only the Newton Sandstone Member, that forms a prominent cliff in much of the area, is mapped separately here. Suhm (1974) interpreted the mixed sandstone and carbonate interval of the Ordovician Everton Formation as barrier

Suhm (1974) divided the Everton Formation into several formal and informal members that within the

islands and adjacent tidal-flat environments.



## 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 contours conform to elevations at 345 control points on the lower or upper contacts of the Boone Formation that were located on the topographic base map using one or a combination of a global position system receiver, a barometric altimeter, or a distinctive topographic contour pattern. A 390 ft (119 m) thickness for the Boone Formation 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). The vertical offset across structures can be estimated from the elevation difference of formation contacts across the structures. Lateral offset is difficult to measure due to the lack of piercing points, but kinematic data suggest that strike-slip offset was important on small faults associated with the Adds Creek and Hanner Point monoclines. Fault striations that are sparsely preserved on planes of some mapped faults, or on adjacent, parallel, small-scale faults were used to infer the slip direction in some locations. Small cataclastic faults, or deformation bands (Aydin and Johnson, 1978), were commonly developed in porous Everton Formation sandstone in and adjacent to structures. Slip sense for mapped faults was inferred either from offset of bedding, from asymmetric minor fault-plane features, or from the geometry of conjugate sets of deformation bands in adjacent rock. Faults of normal, reverse, and strike-slip sense are all present within the map area. The Kyles Landing fault is a reverse fault that dies out in the Bee Bluff monocline north of the Buffalo River. Beds of Everton and Boone Formations and Batesville Sandstone dip moderately to steeply adjacent to the fault, defining a nearly horizontal model fold axis that trends south-southeast (fig. 3A). The orientation of this fold axis and the geometry of sparse small-scale reverse faults (fig. 3B) and conjugate deformation bands (fig. 3C) in hanging wall Everton Formation indicate that the fault has reverse motion. The plane of the Kyles Landing fault is not exposed but, assuming a south-southeast strike, its trace over topography suggests that it dips steeply west-southwest (cross section B-B'). Traced southward, the Kyles

Landing fault and adjacent folded strata are unconformably overlain by Cane Hill Member, indicating that this structure formed in Late Mississippian-Early Pennsylvanian time. To the north, the Bee Bluff monocline is interpreted to abut against a west-northwest continuation of the coeval Web monocline, although this interpretation is conjectural because the inferred connection is concealed beneath Pennsylvanian rock. Small strike-slip and normal faults were observed locally within the north-facing Web monocline in the adjacent Jasper quadrangle (Hudson and others, 2001), suggesting that it probably formed over a transtensional fault. Normal faults are the predominant structures within the map area. In surface exposures the normal faults dip from 50° to 85°, averaging 71° dip for 15 measurements. Seven west-northwest-striking, en echelon normal faults form a 2-km-wide, N. 60° W.-trending zone that crosses the center of the area and intersects the east-northeast-striking Compton fault and the northeast-trending Hanner Point monocline. This en echelon pattern of normal faults is like that produced in analog models of low-angle oblique rifts (Withjack and Jamison, 1986), suggesting that the zone may have developed over a basement weakness. Striations on the individual mapped faults within this zone have high rakes (fig. 3D), indicating extension was essentially normal to their strike. Likewise, conjugate sets of deformation bands measured in Everton Formation sandstone at a footwall site (36° 3.99' N, 93° 18.77' W) adjacent to the California Point fault (fig. 3E) also indicate south-southwest extension. Within the zone, maximum down drop lies within the Jim Bluff graben, whose strata are about 600 and 450 ft lower than correlative strata on adjacent northern and southern zone flanks, respectively. The Compton fault dips steeply southeast and has normal throw of over 300 feet in its central part (cross-section A-A'), but this offset decreases abruptly at its eastern end. Conjugate sets of deformation bands (fig. 3F) observed at a hanging wall site (36° 4.57' N, 93° 19.89' W) adjacent to the eastern part of the Compton fault are consistent with north-northwest extension on this fault, but the deformation bands at this site are crosscut by small-scale strike-slip faults (fig. 3G) that suggest that the fault was probably reactivated under north-northwest shortening. Mapped normal faults within the quadrangle affect all Paleozoic strata and thus they were active after Middle Pennsylvanian time. The normal faults accommodated north-directed extension that was probably caused by flexure of the foreland of the developing Ouachita orogeny to the south (Hudson, 2001). The northeast-trending Adds Creek and Hanner Point monoclines in the western part of the map area

are associated with a zone of short mapped faults and small-scale faults having strike-slip as well as dip-slip offset. Together with a northeast alignment of lead-zinc mines near Ponca (McKnight, 1935) and topographic features on and beyond the quadrangle, these structures lie within a N. 30° E.-trending zone that has been called the Ponca lineament (McFarland, 1988). It is likely that this lineament formed over a preexisting fault zone in Precambrian basement that was partly reactivated with strike-slip and down-to-thesoutheast motion to form the overlying monoclines and associated small faults. The left step between the Adds Creek and Hanner Point monoclines is similar to what might form above en echelon Riedel faults within a buried northeast-trending dextral fault zone (Tchalenko, 1970). The Adds Creek and Hanner Point monoclines and associated faults affect all Paleozoic strata and thus they were active after Middle Pennsylvanian time. The Sneeds Creek dome (Purdue and Miser, 1916) is an east-northeast-elongated, doubly plunging anticline in the footwall of the Compton fault within which rocks of the quadrangle achieve their highest elevation. Although this fold probably initiated as an extensional forced fold (Withjack and others, 1990) above the Compton normal fault, the presence of a small, south-southeast-vergent thrust fault in the fold core (Sec. 6, T. 16 N., R. 22 W.) suggests that this fold also accommodated some north-northwest shortening. We interpret that the Sneeds Creek dome probably was tightened during later reactivation of

the Compton fault in response to north-northwest-directed compression at the end of the Ouachita Dips of bedding within folds in the map area are generally greater than 5° and have consistent directions. Away from structures, where structure contours indicate little dip of the base of the Boone Formation, dips of bedding at the surface are mostly low and variable in direction. These dispersed attitudes can be attributed to local subsidence caused by karst dissolution within the abundant limestone and dolomite rock units and to unrecognized rock creep. Joints within the map area (406 joints measured) are distributed in two dominant strike sets (fig. 3H), northeast and north. A less prominent joint set strikes east. Joint planes within limestone and dolomite formations, such as the Boone Formation, are commonly enlarged due to dissolution. ECONOMIC GEOLOGY

Lead and zinc were mined intermittently within the Ponca-Boxley district from the 1860's through the 1950's (McKnight, 1935; McFarland, 1988). Within the map area, the mines are located near Ponca and align in a northeast trend that is collinear with the Adds Creek monocline. McKnight (1935) reported that about 4,000 tons of concentrates of galena, zinc carbonate, and zinc silicate were produced from the Ponca-Boxley district. All ore zones precipitated at or near the contact between upper Boone Formation and Batesville Sandstone, and most are associated with zones of fracturing and small strike-slip faults (McKnight, 1935).

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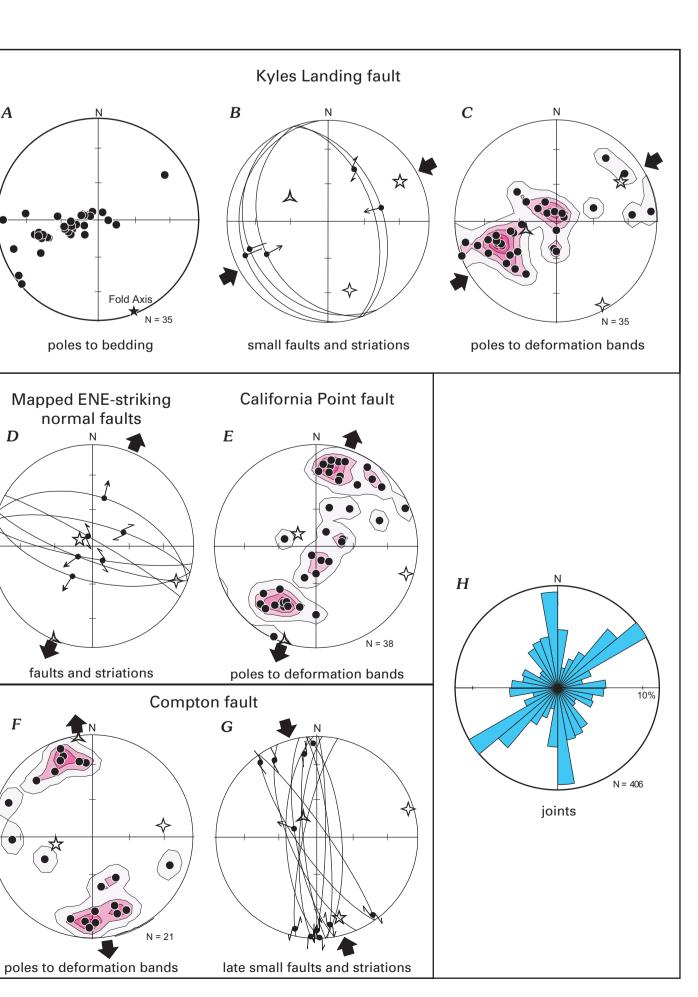
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**Figure 3.** Structural data for the map area. (A) Equal-area projection of poles to bedding adjacent to the Kyles Landing fault, with model fold axis. (**B**) Striated faults within the hanging wall of the Kyles Landing fault. Great circles and dots are lower hemisphere projections of fault planes and their slip lines, respectively. Small arrows show movement sense, with greater head ornamentation indicating higher confidence on slip determination. Open five-, four-, and three-pointed stars represent orientation of maximum, intermediate, and least principal paleostress axes, respectively, estimated from analysis of Angelier (1990). Large black arrows show azimuth of maximum horizontal compression. (C) Poles and orientation density contours for deformation bands in hanging wall of Kyles Landing fault. Contour levels are multiples of standard deviations. Two density highs define conjugate sets from which orientation of principal stress axes were constructed by bisecting obtuse and acute angles to find maximum and least principal paleostress axes. (D) Striated map-scale faults from en echelon zone trending west-northwest across map area Large black arrows show azimuth of least horizontal compression Other conventions as in B. (E) Poles and orientation density contours for deformation bands at a site in footwall of California Point fault. Large black arrows show azimuth of least horizontal compression. Other conventions as in C. (F) Poles and orientation density contours for deformation bands at a site in hanging wall of the Compton fault. Large black arrows show azimuth of least horizontal compression. Other conventions as in C. (G) Striated small-scale secondary faults from site in hanging wall of the Compton fault. Large black arrows show azimuth of maximum horizontal compression. Other conventions as in **B**. (**H**) Rose diagram of strike frequency of joints recorded within

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