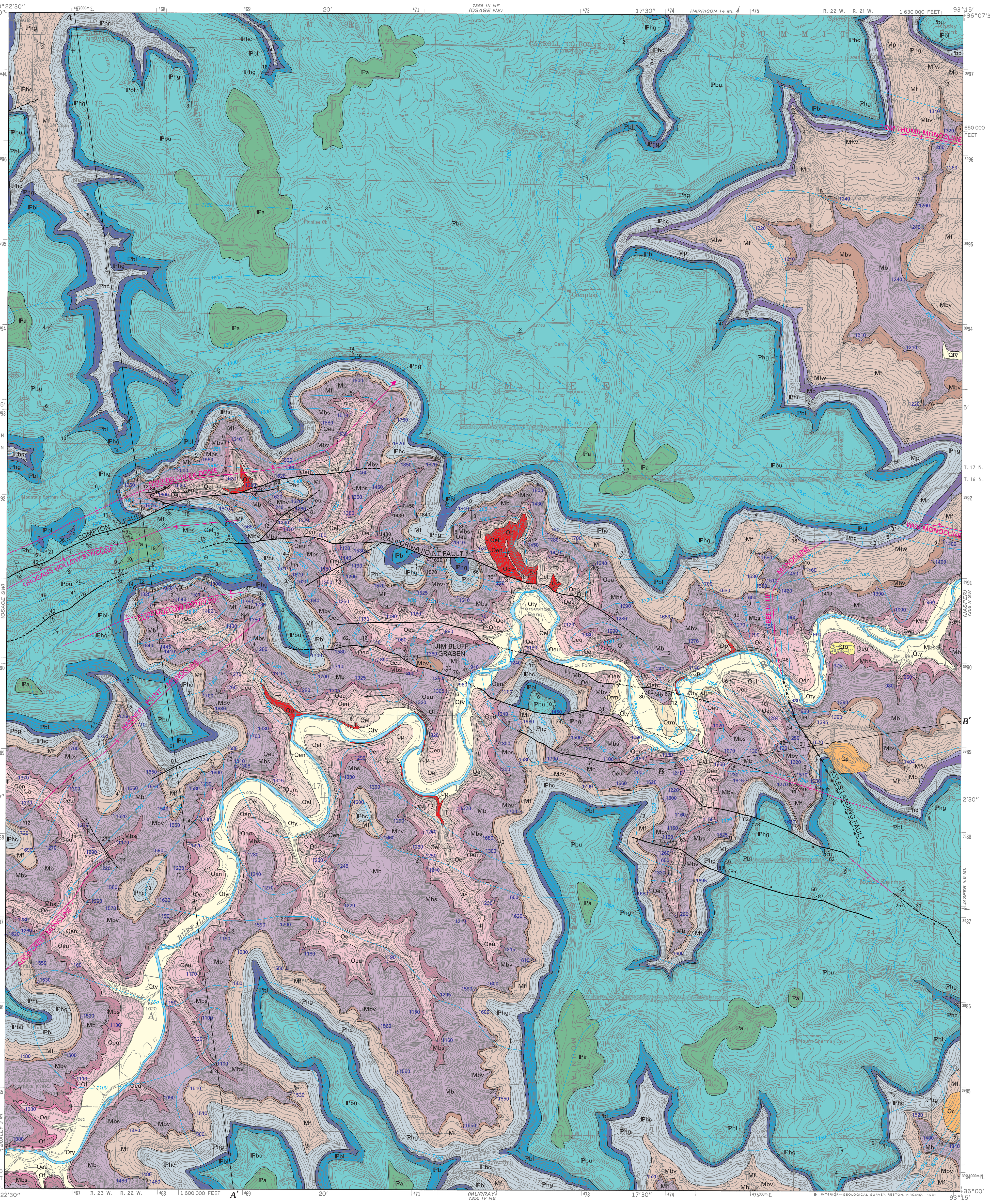
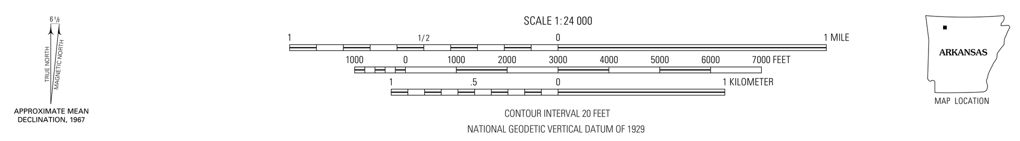
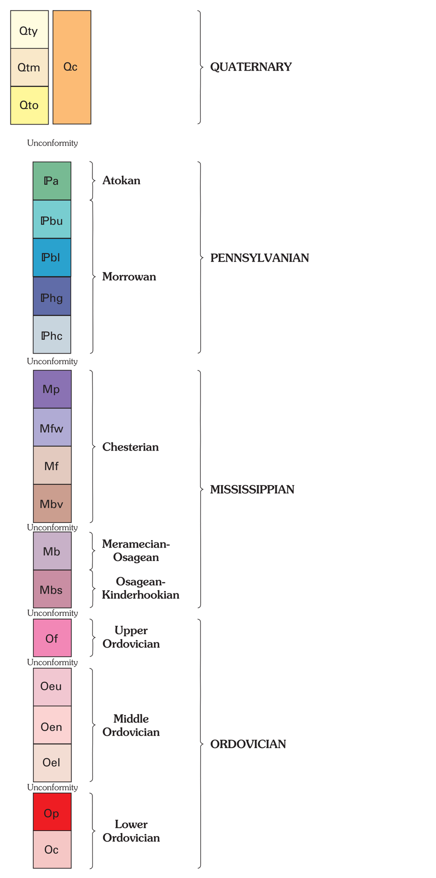


Base from U.S. Geological Survey, 1967
Universal Transverse Mercator, Zone 15



Geology mapped by M.R. Hudson intermittently during 1996–2000
Digital database compilation by K.E. Murray during 2001–02
Digital cartography and map layout by Gayle M. Dumonceaux and Nancy Shock
Edited by F. Craig Brunstein
Manuscript approved for publication January 3, 2003

CORRELATION OF MAP UNITS



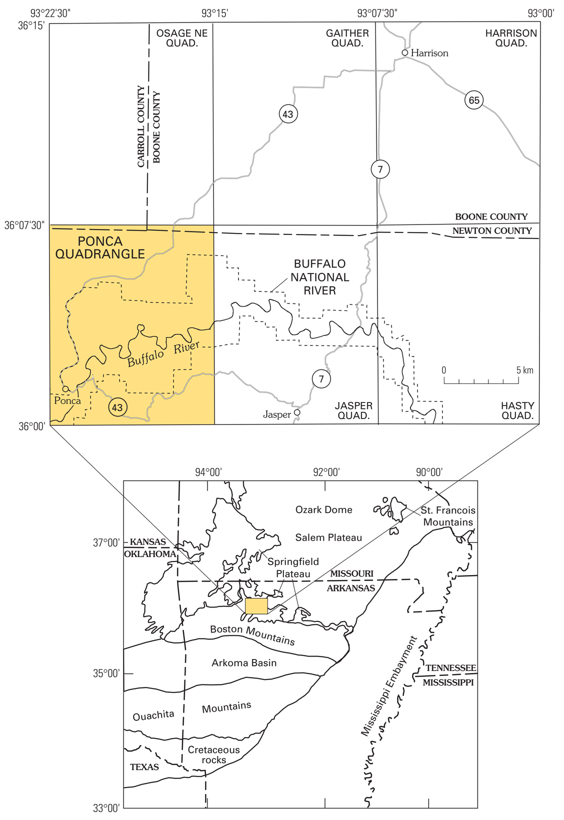


Figure 1. Location of study area within northern Arkansas, in and adjacent to the western part of Buffalo National River. Lower regional map illustrates geological and selected physiographic provinces of Arkansas and adjacent areas.

INTRODUCTION

DESCRIPTION OF MAP UNITS

STRATIGRAPHY

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. 3*A*). The orientation of this fold axis and the geometry of sparse small-scale reverse faults (fig. 3*B*) and conjugate deformation bands (fig. 3*C*) 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. 3*D*), 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. 3*E*) 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. 3*G*) 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-the-southeast 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 orogeny.

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. 3*H*), 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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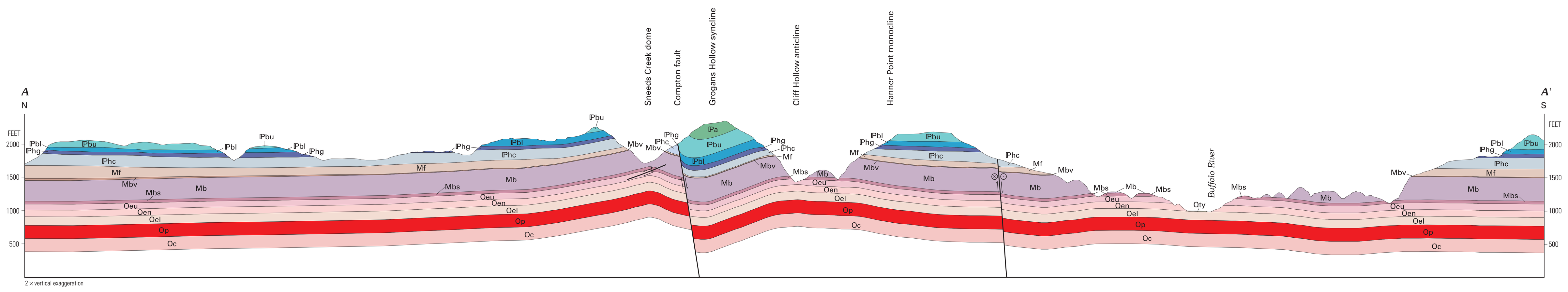

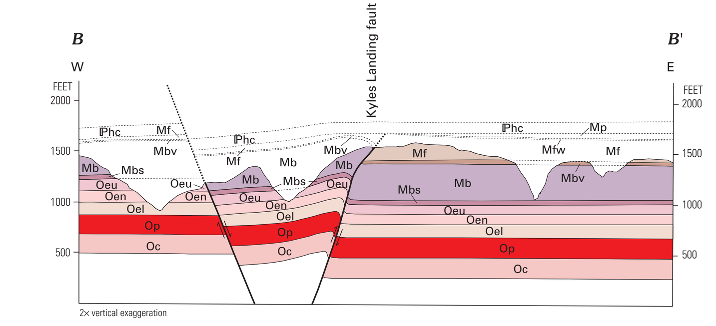

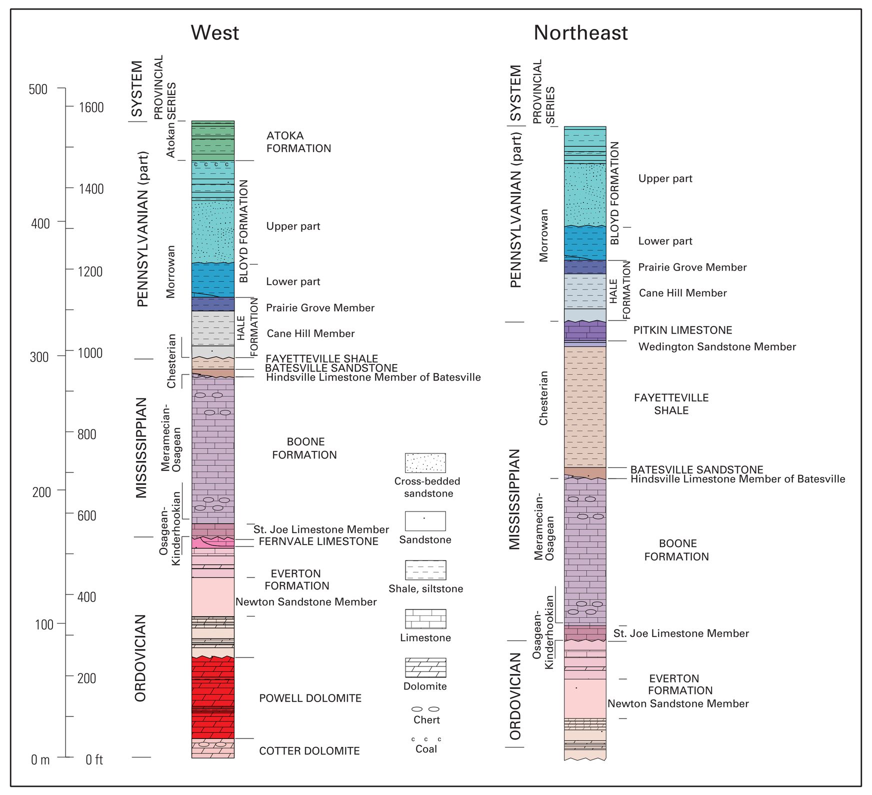

Figure 2. Stratigraphic columns for Paleozoic rocks of the map area. Column for west area generally reflects exposed stratigraphy near Hemmed-In-Hollow. Column for northeast area reflects stratigraphy exposed in the Cecil Creek drainage. Provincial series are from Purdue and Miser (1916) and McFarland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

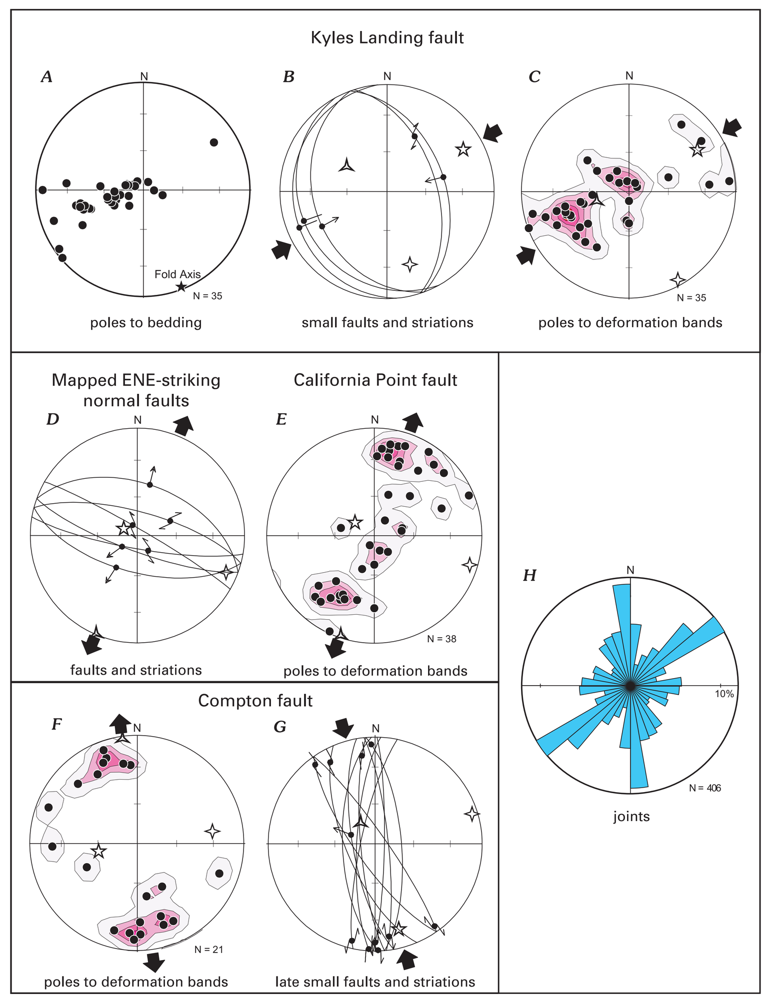

Figure 3. Structural data for the map area. (***A***) Equal-area projection of poles to bedding adjacent to the Kyles Landing fault, with model fold axis. (***B***) Striated faults within the hanging wall of the Kyles Landing fault. Great circles and dots are lower hemisphere projections of fault planes 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 the map area.

GEOLOGIC MAP OF THE PONCA QUADRANGLE, NEWTON, BOONE, AND CARROLL COUNTIES, ARKANSAS

By
Mark R. Hudson and Kyle E. Murray

2003