STATE OF ARKANSAS

ARKANSAS GEOLOGICAL SURVEY
BEKKI WHITE, DIRECTOR AND STATE GEOLOGIST

INFORMATION CIRCULAR 42

GEOLOGY OF THE BIG FLAT AND BUFFALO CITY QUADRANGLES, BAXTER, MARION, AND SEARCY COUNTIES, ARKANSAS

by

Angela Chandler

Little Rock, Arkansas

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Geology of the Big Flat and Buffalo City Quadrangles, Baxter, Marion and Searcy Counties, Arkansas

Introduction

This report is one in a series of companion reports to accompany the Digital Geological Quadrangle Maps published by the Arkansas Geological Survey (AGS). Its purpose is to provide: 1) more detailed discussion of the stratigraphy in the quadrangles, 2) surface and subsurface geologic interpretations and 3) information pertaining to economic natural resources in the area.

The Big Flat and Buffalo City quadrangles, hereafter referred to as the field area, are located south of Mountain Home, Arkansas in the north-central part of the state (Fig. 1). The field area is rural with the largest community being Big Flat with a population of approximately 100. The small resort community of Buffalo City is located on the White River near the confluence of the Buffalo National River. The Lower Buffalo Wilderness straddles the quadrangles and encompasses 22,500 acres. A majority of the 16,900 acres of the Leatherwood Wilderness is located within the eastern half of the Big Flat quadrangle. Approximately 17 miles of the Buffalo National River is located in the two quadrangles. The White River meanders for almost 14 miles across the Buffalo City quadrangle.

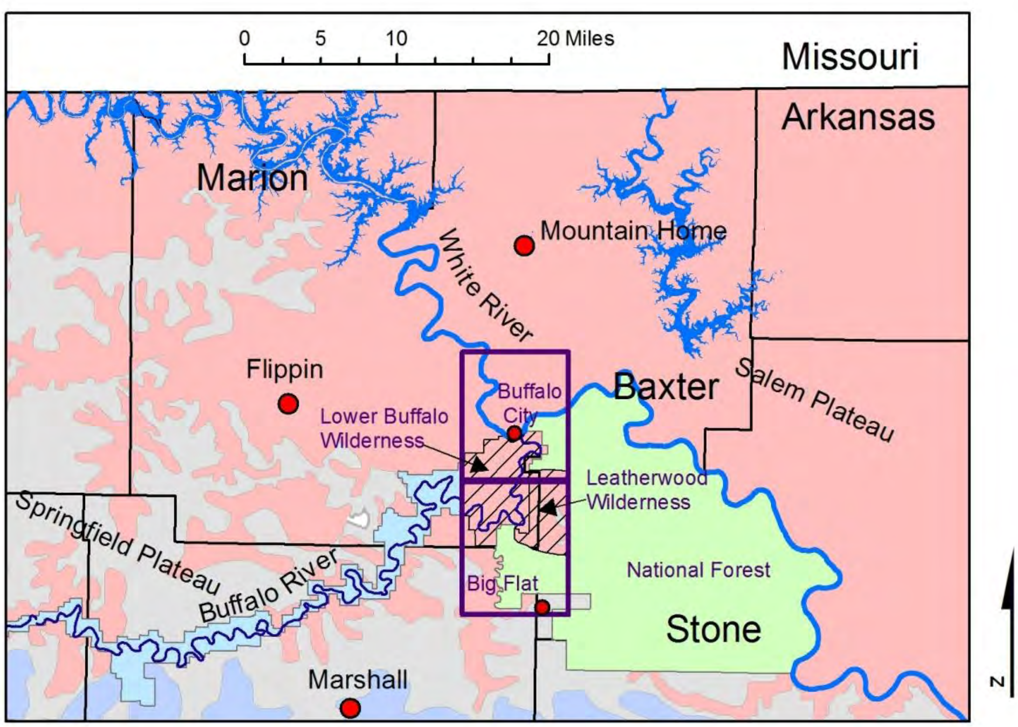


Figure 1. Location map of the Buffalo City and Big Flat quadrangles (field area).

The field area is located within the Ozark Plateaus of north-central Arkansas. The majority of the Buffalo City quadrangle is located on the Salem Plateau which is capped by Lower Ordovician age dolostones. The topography is fairly flat or gently rolling. On the Big Flat quadrangle, however, the plateau surface is heavily dissected by steep drainages.

Several outliers of the Springfield Plateau are preserved above the Salem Plateau on the southern half of the Buffalo City quadrangle and are capped by cherty limestones of the Mississippian Boone Formation.

The escarpment between the Salem and Springfield Plateaus is present on the Big Flat quadrangle. On this quadrangle tributaries to Big Creek and the Buffalo River have dissected the Springfield Plateau surface creating steep-sided hollows. Lower Mississippian cherty limestone is exposed on all of the ridges.

Previous research in the field area is limited to two publications regarding lead and zinc mining. Branner, 1900, reported on the lead and zinc mines but noted the geology of the area had never been worked out in detail. McKnight (1935), elaborated upon Branner's work with descriptions of rock formations and detailed accounts of the condition of mines.

Reconnaissance geologic maps for the Buffalo City and Big Flat quadrangles were compiled from field observations and subsurface data by E.E. Glick in 1970 and 1973 respectively. These were done during preparation of the 1: 500,000 scale Geologic Map of Arkansas, 1976.

New detailed geologic maps of the Big Flat and Buffalo City quadrangles were compiled from field observations during the interval from July 2009 until May 2011. The work was conducted by Angela Chandler, Ty Johnson, Lea Nondorf and Cody Traywick through a contract (C2360086145) with the National Park Service. GPS points were taken at formation contacts, karst features, structures and other features. These field points are incorporated in a geodatabase at the Arkansas Geological Survey.

Stratigraphy

Approximately 1300 feet (396 meters) of Lower to Middle Ordovician, Mississippian and Quaternary age strata is exposed in the field area (Fig. 2). The Lower to Middle Ordovician Cotter through St. Peter Formations comprise the surface rock over the majority of the field area. Middle to Upper Ordovician Joachim, Plattin and Fernvale Limestones are locally present in steep drainages. The Osagean Boone Formation crops out on ridges throughout the field area and its Kinderhookian to Osagean St. Joe Limestone Member is locally present at its base. The Chesterian Batesville Sandstone forms a small plateau around the community of Big Flat, Arkansas. The Meramecian Moorefield Shale is present beneath the sandstone. Quaternary terrace and alluvium deposits are present in the valleys of the Buffalo River, White River and their tributaries. Two terrace levels are well developed along the Buffalo and White Rivers – a younger and medial. Very old terraces are located over 200 feet (61 meters) above the Buffalo and White Rivers.

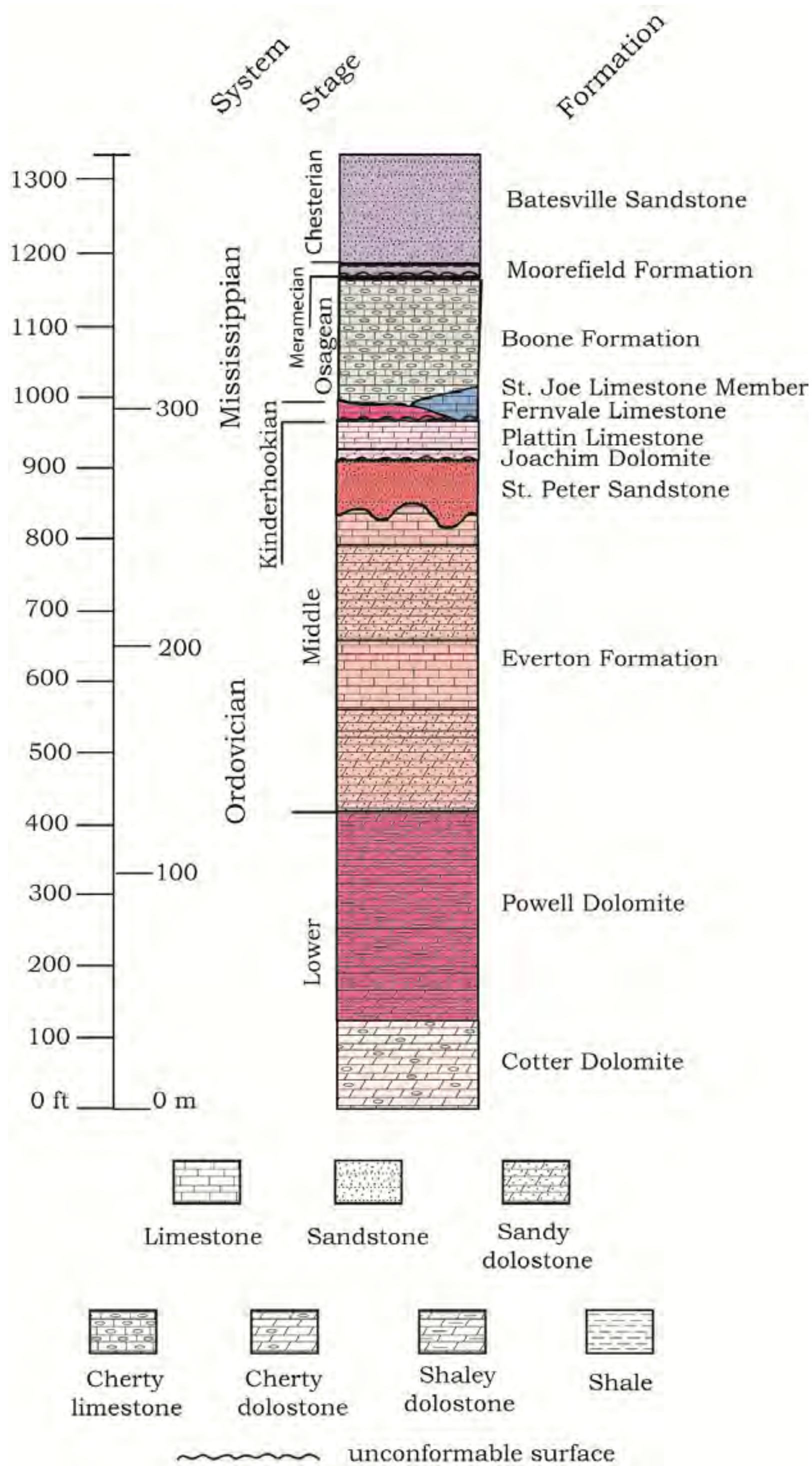
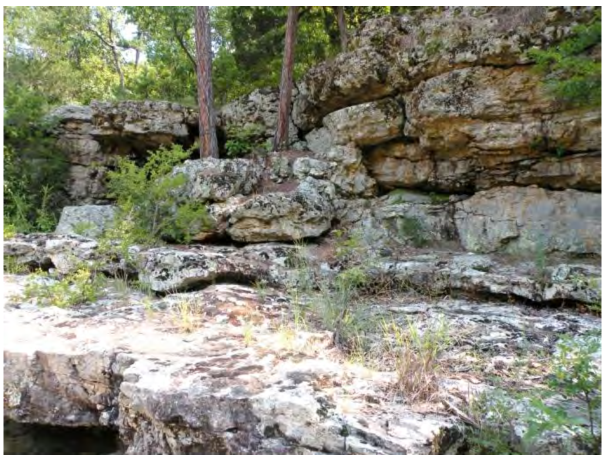


Figure 2. Stratigraphic column for the field area.

Lower Ordovician
Cotter Dolomite

The Cotter Dolomite was named by E.O. Ulrich for the town of Cotter, Arkansas where it is well exposed (Purdue and Miser, 1916). A type section at the White River Bridge in Cotter, Arkansas was designated by Cullison in 1944. The Cotter ranges up to 400 feet (121 meters) in thickness, however only 60-180 feet (18-55 meters) are exposed on the northern portion of the Buffalo City quadrangle. The Cotter is overlain conformably by the Powell Dolomite.

The Cotter Formation consists of thin- to medium-bedded fine- to medium-crystalline dolostone that contains banded chert nodules and chert breccia. The dolostone is locally laminated and contains quartz druse-filled vugs. Along Warrior Creek the Cotter is predominantly medium- to massive-bedded chert (Fig. 3). The Cotter is differentiated from the Powell by its coarser dolostones, lack of argillaceous content and abundance of chert.


(A)


(B)

Figure 3. (A) Bedded Cotter chert in Warrior Creek. (B) Cotter dolostone along railroad track Sec 34 T 13 N, R 14 W.

Lower Ordovician
Powell Dolomite

The Powell Dolomite was named by E.O. Ulrich for Powell Station, Arkansas where it is well exposed on the White River branch of the St. Louis, Iron Mountain & Southern Railway (Purdue and Miser, 1916). The Powell is present on the northern half of the Buffalo City quadrangle and ranges from 200 – 340 feet (61-103.5 meters) thick. This formation is overlain conformably by the Everton Formation. The basal contact of the Powell is placed at the appearance of banded chert nodules and/or chert breccia in the upper portion of the Cotter Dolomite.

The Powell Dolomite consists of thin- to medium-bedded, gray to white argillaceous dolostone interbedded with very thin-bedded dolomitic shale (Fig. 4). The dolostone is laminated and very finely crystalline. The dolostone is referred to as "cotton rock" by Cullison (1944) and contains mudcracks and stromatolites. Locally, this unit contains small quartz geodes, banded nodular chert or chert fragments and pink dolomite. Bedded black chert was seen at one locality.

A fairly persistent chert bed is present approximately 40-60 feet (12-18 meters) above the base of the Powell Dolomite. This bed is referred to as the Black Ledge Chert (McKnight, 1935 and Cullison, 1944) because it generally weathers dark. The classic Black Ledge is a vuggy chert in which the vugs are filled with drusy quartz and often contain gastropod molds (Fig. 4). It is very distinct in appearance and is used to construct fence rows and as decorative stone. The drusy chert probably occurs at the top of two to three beds of chert. They are medium to massive-bedded and weather orange. The Black Ledge was recognized by prospectors as a bed that usually carried ore (McKnight, 1935) but no zinc was found associated with this unit in the mapping area. This chert unit is thin to medium bedded, ranges from 0-10 feet (0-3 meters) and locally forms small glades.

(A) (B)

Figure 4. (A). Classic Black Ledge chert. (B) Powell dolostone near the mouth of Cunningham Creek, Buffalo City quadrangle.

Middle Ordovician
Everton Formation

The Everton Formation was named for the town of Everton, Boone County, by E.O. Ulrich (Purdue, 1907). The Everton Formation is thickest in the Salem Plateau region and ranges from 350-650 feet (106-198 meters) thick along the valleys of the Buffalo and White Rivers (Suhm, 1970), in north-central Arkansas. The average thickness of the Everton in the field area is approximately 440 feet (134 meters) with the thickest section on the Buffalo City quadrangle reaching 640 feet (195 meters). The formation is overlain unconformably by the St. Peter Sandstone. The basal contact is placed below the last occurrence of thin beds of sandstone, sandy dolostone and fine-grained limestone.

The Everton Formation consists primarily of interbedded dolostone, limestone, sandy dolostone and minor amounts of sandstone. At the top contact just underlying the St. Peter, is very thin-bedded fine-grained to micritic limestone that is persistent throughout the field area (Fig. 5). The limestone contains stromatolites and is referred to as the Jasper Limestone (Purdue and Miser, 1916). This unit is approximately 30 feet (9 meters) thick and grades downward to a thick section of interbedded dolostone, sandy dolostone and thin-bedded sandstone (Fig. 5). The dolostone is light- to dark-gray, fine- to coarsely-crystalline and commonly sandy, laminated and petroliferous. The sandstone intervals are very thin- to medium-bedded and vary in thickness from 1 inch to 10 feet (3 meters). They are locally silica-cemented and contain ripple marks.

An ostracod hash and oolitic chert are present in float but were never seen in place. Silicified gastropods are present locally. Crackle breccias containing dolomite and calcite as well as rock-matrix breccias are present locally in the dolostone section. One paleokarst sandstone body was seen in the middle of the formation near Cartney access to the White River.

Another limestone unit is present in the lower part of the formation. This limestone is approximately 40-80 feet (12-24 meters) thick and is very similar to the Jasper Limestone. Micro-karst commonly develops on the surface of the limestones. Oncolites, nautiloids and various fossil fragments are present in the limestone. The lower limestone unit also grades downward to interbedded dolostone and sandy dolostone. A chert breccia containing silica-cemented sandstone fragments is present near the base of the formation. Former workers use this as the base of the formation. However, it is usually seen as float and is not considered the base of the unit since there is sandy dolostone and sandstone interbedded below it in most places.

Suhm (1970) described several sections along the Buffalo National River and identifies a sandstone unit in a couple of his sections as the Newton Sandstone Member. The Newton Sandstone Member is named for outcrops in northern Newton County and is present in the middle of the formation. The Calico Rock Sandstone, named for exposures along the White River at the town of Calico Rock, is another sandstone member of the Everton Formation (Giles, 1930). This sandstone unit is present in the lower part of the formation and is exposed near the field area. However, none of the sandstone units in the field area were found to be persistent or thick enough to map as the Newton Sandstone Member or the Calico Rock Sandstone Member.

(A)

(B)

Figure 5. (A)Thin-bedded limestone at the top of Everton Formation. Hammer resting on stromatolite bed. (B) Thin-bedded sandstone (3-4 inches) in Everton Formation.

Middle Ordovician
St. Peter Sandstone

The St. Peter Sandstone is named for exposures on the Minnesota River, formerly called the St. Peter River in southern Minnesota (Owen, 1847). The St. Peter Sandstone ranges up to 200 feet thick (Giles, 1930) throughout northern Arkansas. The average thickness of the St. Peter in the field area is approximately 80 feet (24 meters) with the thickest section being 100 feet (30.5 meters). On the Buffalo City quadrangle, around Prince Fred Knob, just north of the Hathaway Mountain Fault and on the north side of Warrior Creek Mountain, the St. Peter thins to 3 feet (.9 meters) or less so that it is not mappable at 1:24,000 scale (Fig. 6). The St. Peter is overlain conformably by the Joachim Dolomite where present locally. Otherwise, it is overlain unconformably by the Plattin Limestone or the St. Joe Limestone Member of the Boone Formation. It is underlain unconformably by the Everton Formation with as much as 20 feet (6 meters) of relief at the contact (Fig. 7). The St. Peter Sandstone is a prominent bluff former throughout the Big Flat quadrangle and on the southern half of the Buffalo City quadrangle.

(A) (B)

Figure 6. (A) Thin outcrop of St. Peter Sandstone overlying Everton Formation on Prince Fred Knob. (B) Sandstone pipe in glade on top of St. Peter Sandstone bluff on Hathaway Mountain.

The St. Peter is a fine-grained, medium-to massive-bedded sandstone with sub-angular to sub-rounded quartz grains. The sandstone is commonly white to tan on fresh surfaces but weathers light-brown to gray and locally may be reddish or greenish in color due to iron or clay content. The vertical trace fossil *Skolithos* is common in the sandstone and weathers in relief to resemble icicles (Fig. 7). Cylindrical columns of sandstone referred to as "sandstone pipes" are present at various localities throughout this area (Fig. 6). They are usually located near a structure such as a fault or monocline and are a type of dewatering feature. Balds or glades commonly develop locally on the St. Peter Sandstone.

(A) (B)

Figure 7. (A) *Skolithos* trace fossils weathering in relief in St. Peter Sandstone. (B) St. Peter Sandstone overlying the Everton Formation. Notice undulating unconformable contact.

Middle Ordovician
Plattin Limestone and Joachim Dolomite

The Plattin Limestone is named for exposures near the mouth of Plattin Creek, Jefferson County, Missouri (Ulrich, 1904). It is thickest near Batesville, Arkansas where it reaches a thickness of 200 feet (61 meters) (Miser, 1922). This limestone is absent to approximately 80 feet (24 meters) thick in the field area. It is fairly persistent on the Big Flat quadrangle but is only present in the extreme southeast and southwest portions of the Buffalo City quadrangle. The Plattin Limestone is overlain unconformably by the Fernvale Limestone, St. Joe Limestone Member or the Boone Formation. It is locally underlain conformably by the Joachim Dolomite, but more commonly underlain unconformably by the underlying St. Peter Sandstone.

The Plattin Limestone is a thin-bedded, micritic to finely crystalline, stylolitic limestone (Fig. 8). It is light-to dark-gray on fresh surfaces but weathers white to light-gray. Locally, an argillaceous dolostone is present at the top of the formation. Stromatolites, chert and pyrite are present locally.

The Joachim Dolomite is named for exposures along Joachim Creek, Jefferson County, Missouri (Winslow, 1894). It is thickest near Batesville, Arkansas, where it ranges from 40 to 100 feet (12 to 30.5 meters) thick (Miser, 1922). This dolostone occurs sporadically throughout the Big Flat quadrangle where it attains a maximum thickness of 15 feet (4.5 meters), thus it is mapped with the Plattin Limestone. The Joachim is overlain unconformably by the St. Joe Limestone Member, interbedded chert and limestone in the Boone Formation or conformably by the Plattin Limestone. It is underlain conformably by the St. Peter Sandstone.

The Joachim Dolomite is a finely crystalline dolostone that is medium-bedded (Fig. 8). The dolostone is medium- to dark-gray on fresh surfaces but weathers light-gray to white. The Joachim contains sand in the lower portion close to the contact with the underlying St. Peter Sandstone. The dolostone is petroliferous and locally contains calcite veins. This unit could be misidentified as the Everton (because of its similarity), in areas where it is not known to be present.

(A)

(B)

Figure 8. (A) Joachim Dolostone exposed on ridge along Rand Road. (B) Thin-bedded Plattin Limestone.

Upper Ordovician
Fernvale Limestone

The Fernvale Limestone is named for the community of Fernvale, Williamson County, Tennessee (Hayes and Ulrich, 1903). The Fernvale is thickest near Batesville averaging 100 feet (30.5 meters) but thins westward (Miser, 1922). This limestone is present only in the southern portion of the Big Flat quadrangle and ranges from 20-40 feet (6-12 meters) thick. The Fernvale Limestone is overlain unconformably by the St. Joe Limestone Member or interbedded chert and limestone of the Boone Formation. It is underlain conformably by the Plattin Limestone.

The Fernvale Limestone is a medium- to coarse-grained limestone that contains barrel-shaped crinoids. It is white to pink or red on fresh surfaces but weathers dark-gray. A fossil hash consisting mostly of crinoids and brachiopods was seen at one locality. The limestone weathers to rounded moss covered boulders (Fig. 9) and locally contains calcite vugs and pyrite.

(A) (B)

Figure 9. (A) Fernvale outrcrop in headwaters of Short Creek and (B) in a tributary to Spring Creek.

Mississippian (Kinderhookian –Osagean)
St. Joe Limestone Member of the Boone Formation

The St. Joe Limestone was named for the town of St. Joe, Arkansas by J.C. Branner, where it was first studied by the Arkansas Geological Survey (Hopkins, 1893). Girty (1915) states that the type locality is probably beside the railroad along Mill Creek, a short distance northwest of St. Joe. The St. Joe Limestone Member ranges from absent to approximately 40 feet (12 meters) thick throughout north Arkansas and appears to be the thickest and most persistent in northwest Arkansas. The St. Joe Limestone is typically 5 feet or less throughout the field area except on the north side of Warrior Creek Mountain where it thickens to approximately 60 feet and is a depictable unit at the 1:24,000 scale. The St. Joe Limestone Member is conformably overlain by interbedded chert and limestone of the Boone Formation and underlain unconformably by the Fernvale Limestone, the Plattin Limestone or the St. Peter Sandstone.

The St. Joe Limestone is a thin-bedded crinoidal limestone. It is red to gray on fresh and weathered surfaces and contains green clay buttons and manganese locally (Fig. 10). A sandstone referred to as basal Mississippian sandstone is present locally at the base of the St. Joe Limestone. This sandstone is fine- to medium-grained and attains a maximum thickness of 4 feet (1.2 meters) on the Big Flat quadrangle.


(A)


(B)

Figure 10. (A) St. Joe Limestone at manganese prospect and (B) in Lower Buffalo Wilderness.

Mississippian (Osagean)
Boone Formation

The Boone Limestone was named by J.C. Branner for Boone County, Arkansas where cherts and cherty limestones are the dominate rock type (Penrose, 1891). The Boone Formation (including the St. Joe Member) can range up to 400 feet (121 meters) thick throughout north Arkansas. The Boone Formation ranges from 60-160 feet (18-49 meters) on the Buffalo City quadrangle but is thicker on the Big Flat quadrangle averaging 340 feet (103.5 meters). The Boone Formation is overlain conformably by the Moorefield Formation. It is unconformable with the underlying Fernvale Limestone, Plattin Limestone or St. Peter Sandstone.

The Boone Formation consists of interbedded thin- to medium-bedded limestone and chert (Fig. 11). The limestone is fine-grained and light- to medium-gray on fresh surfaces but weathers white. The chert is white, various shades of gray or less commonly green. Quartz crystal mineralization is present locally. There is a relatively chert- free zone in the Boone that has been quarried for building stone.

A regolith of unconsolidated rock material forms a mantle over the Boone at various localities in the field area. This regolith is comprised of a sequence of thin to thick intervals of chert and cherty beds of clay. The clay is typically red to red-orange in color, while the chert is predominately white in color. Most of regolith exhibits relict bedding. The thickness of the regolith varies from 0-20 feet (0-6 meters).


(A)


(B)

Figure 11. (A) Cherty Boone Formation in quarry near Buffalo City Fault and (B) in zinc prospect.

Mississippian (Meramecian)
Moorefield Formation

The Moorefield Formation is named for the town of Moorefield, near Batesville, Arkansas (Adams et al, 1904). It is thickest near the town of Batesville ranging from a thin edge to 200 feet (61 meters) thick (Gordon, 1944). The Moorefield thins to the west averaging 80 feet (24 meters) thick near the Mountain View area. It is present only on the southeastern corner of the Big Flat quadrangle. The formation is mapped with a thickness of 20 feet (6 meters) but is poorly exposed and was seen at only one locality (Fig 12). The Moorefield Formation is conformable with the underlying Boone Formation.

The Moorefield Formation consists of clay to silty shale and calcareous siltstone that is black to dark-gray on fresh surfaces but weathers gray to light-gray. The siltstone is very thin to thin-bedded and contains trace fossils.

(A)

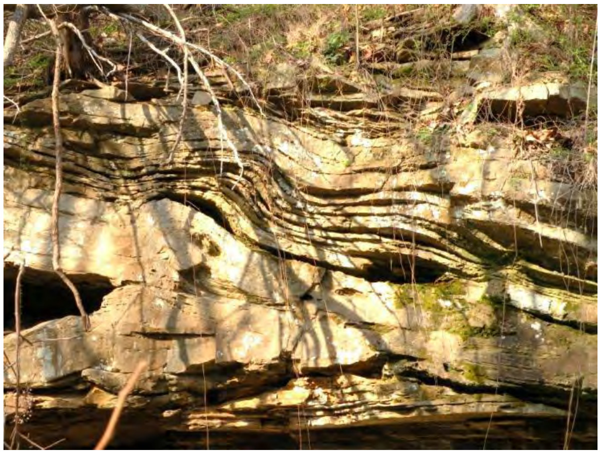
(B)

Figure 12. (A and B) Batesville- Moorefield contact near Highway 14 east of Big Flat, Arkansas.

Mississippian (Chesterian)
Batesville Sandstone

The Batesville Sandstone was named by J.C. Branner after the town of Batesville, Arkansas where it is well developed (Penrose, 1891) and averages 70 feet (21 meters) in thickness (Gordon and Kinney, 1944). The Batesville Sandstone ranges from 60 to 160 feet (18-48 meters) thick in the eastern and north-central portion of north Arkansas. Approximately 150 feet (46 meters) of the sandstone is present in the southwestern portion of the Big Flat quadrangle. It is underlain conformably by the Moorefield Formation.

The Batesville Sandstone consists of very fine-to fine-grained sandstone with angular to sub-angular sand grains. The sandstone is thin-bedded and channel-bedded (Fig. 13) and contains abundant iron blebs and stringers. It is light- brown on fresh surfaces but weathers buff to gray.


(A)


(B)

Figure 13. (A and B) Channel sands in the Batesville Sandstone along Highway 14 east of Big Flat, Arkansas.

Quaternary
Alluvium and terrace deposits

Alluvium and terrace deposits are present in stream valleys in the field area. Within the relatively larger Buffalo and White River valleys, these deposits are sub-divided into three units: young terrace and active channel deposits, medial terrace deposits and very old terrace deposits.

Alluvium and terrace deposits in smaller streams consist of unconsolidated clay, silt, sand and gravel. Gravel bar deposits are approximately 5-8 feet (1.5-2 meters) thick. The largest tributary to the Buffalo River, Big Creek, contains terraces that range from 10-30 feet (3-9 meters) thick.

Young terrace and active channel deposits are the youngest deposits present along the Buffalo and White Rivers (Fig. 14). They consist of unconsolidated clay, silt, sand and gravel in gravel bar and sandy point bar deposits. The top of the terrace is generally flat but can be hummocky and dissected by tributaries. These deposits are approximately 20-30 feet (6-9 meters) thick. These units are distinguished by their elevation above river level. Medial terrace and alluvial deposits consist of unconsolidated clay, silt and sand approximately 40 feet (12 meters) above the White or Buffalo Rivers. They range in thickness from 20-40 feet (6-12 meters). Very old terrace deposits are present approximately 200 feet (61 meters) above the Buffalo and White Rivers. These deposits consist of coarse sand to cobble-sized angular to rounded chert (Fig. 14).


(A)


(B)

Figure 14. (A) Very old terrace above the Buffalo River near confluence of Leatherwood Creek and (B) active and young terrace deposits along the Buffalo River at confluence of Big Creek.

Structure

The field area is located on the southern flank of the Ozark Dome, an area of uplift, centered in southeast Missouri. Rock strata in northern Arkansas have an average regional dip of one to two degrees to the south; however faulting can produce localized dips up to 34 degrees in the field area.

Little geological work was done prior to 1970 and only one fault north of Big Flat was mentioned in the literature by Branner (1900). Glick produced a reconnaissance map of the Buffalo City quadrangle in 1970 in preparation of the 1976 Geologic Map of Arkansas. He also produced a preliminary map of the Big Flat quadrangle in 1973. His mapping revealed a northeast trending fault north of the White River near Buffalo City but no additional faults on the Big Flat quadrangle. Recent mapping discovered several small faults and monoclines that were previously undocumented.

Faults

The location of a fault is determined by many factors in the field. In an ideal situation, a fault is exposed at the surface and can be verified by visual inspection, its orientation measured and its location directly recorded. It is rare that the actual fault plane is seen in every location along the fault. Consequently, other geologic data is used to establish with certainty where a fault is drawn on the map. As a result extrapolations are made where the fault plane is not exposed.

Other features used to determine the location of faults are the presence of deformation bands and mineralization. Deformation bands are localized zones of small faults with relative displacement of a few millimeters to a few centimeters that occur in porous sandstones (Aydin, 1978).

These bands appear as raised white ridges which are approximately one millimeter thick (Fig. 15). In areas where zones of abundant and thick or intertwined deformation bands are present in the rock, we infer that a fault is located nearby. Other mineralization used to locate faults is the presence of quartz crystals in the Boone Formation. Most commonly seen are boulders of Boone chert with a coating of quartz crystals concentrated in a localized area (Fig. 16).

The most extensive normal faults present on the Big Flat quadrangle are the Spring Creek Fault and the Fish Trap Fault. The Spring Creek Fault is named for Spring Creek and crosses the creek in two places. The Spring Creek Fault is downthrown to the south with an offset of approximately 100 feet (30 meters) at the western end, 160 feet (49 meters) near Spring Creek and 60 feet (18 meters) at the eastern end where it terminates in a monocline. The Fish Trap Fault is named for Fish Trap Hollow on the Cozahome quadrangle. The fault extends south of Horseshoe Bend, across the Buffalo River, parallel to Cold Spring Hollow until it reaches Huffman Gap where it separates into multiple faults. The Fish Trap Fault averages 200 feet (61 meters) of offset and is downthrown to the north. Numerous smaller faults and monoclines are present throughout the quadrangle.

(A) (B)

Figure 15. (A and B) Deformation bands in the St. Peter Sandstone in the headwaters of Boat Creek.

(A)

Figure 16. (A) Quartz crystal mineralization on chert boulder in the Boone Formation on Warrior Creek Mountain.

On the Buffalo City quadrangle, extensive normal faults occur along Barren and Perry Creeks, near Buffalo City, and across Hathaway Mountain. None of these faults were previously named; however, Glick (1973) previously mapped the Buffalo City Fault. The Barren Creek Fault crosses Barren Creek, its namesake, and is downthrown to the south. It has a displacement of approximately 40-80 feet (12-24 meters) and exposes the Cotter Dolomite at the surface. The Buffalo City Fault (Fig. 18) parallels the White River just north of the small community of Buffalo City, its namesake. It may continue to the unnamed fault just north of Warrior Creek Mountain on the west side of the White River; however the fault could not be identified in the Cotter outcrops near the river. This fault is downthrown to the south and has a displacement of approximately 300 feet (91 meters). The Perry Creek Fault (Fig. 18) crosses Perry Creek just south of the White River on the western edge of the quadrangle and is downthrown to the north. It has a displacement of 280 feet (85 meters). The Hathaway Mountain Fault crosses the northern edge of Hathaway Mountain and extends across Hathaway Hollow along the southern edge of Warrior Creek Mountain to the edge of the quadrangle and extends west on the Cozahome quadrangle. Less extensive faults on and near Warrior Creek Mountain extend onto the Rea Valley quadrangle for several miles.


(A)


(B)

Figure 17. (A) Fault plane along St. Peter outcrop that contains abundant deformation bands. (B) Normal fault in the St. Peter Sandstone above Big Creek. Arrows show sense of displacement.


(A)


(B)

Figure 18. (A) St. Peter Sandstone outcrop in quarry near Buffalo City Fault. (B) Inclined sandstone bed in the Everton Formation along Perry Creek Fault.

Karst

Karst is a type of topography that develops in limestone, dolostone, gypsum and other rocks by solutioning. This process involves the dissolving of calcium carbonate, the main constituent in carbonate rocks, by carbonic acid that rainwater produces during its passage through the atmosphere and soil. Once the dissolved calcium carbonate is removed by groundwater, open spaces are left within the rock that eventually becomes connected. These open spaces can become inter-connected to form karst related features such as springs (Fig. 19 and 20), caves, disappearing streams and sinkholes. Research in the last 30 years has made it evident that these same landforms can form in quartz sandstones as well (Wray, 1997, Young et.al., 2009). Therefore, the term karst should not be restricted to carbonate terrains but should be seen as the process of significant rock dissolution (Wray, 1997).

All of the limestone and dolostone formations in this area are susceptible to karstification. Sandstone in this area is also susceptible to forming sinkholes and springs. All of the units contain solutionally enlarged joints. The majority of the carbonate units have disappearing streams and/or dry valleys. The fine-grained limestones in the Plattin Limestone and in the Everton Formation contain rillenkarren (Fig. 19). Rillenkarren are minor solution grooves or channels with sharp fine ridges that occur on a karst surface and are about 1 to 2 cm deep (Sweeting, 1973).

(A) (B)

Figure 19. (A) Rillenkarren in limestone of the Everton Formation. (B) Wet weather spring near tributary to South Prong Creek, Big Flat quadrangle.


(A)


(B)

Figure 20. (A) Cold Spring in Cold Spring Hollow, Buffalo City quadrangle. (B) Spring at Plattin-St. Peter contact, Big Flat quadrangle.

The rock types that form most of the surface in the field area are dolostones and limestones in the Powell, Everton and Boone Formations. Ten springs and two sinkholes were recorded in the Powell Dolomite. Thirty-four springs, eight sinkholes and three caves were recorded in the Everton Formation. Sixteen sinkholes and four springs were recorded in the Boone Formation.

Other limestone and dolostone units also contain karst features. Two springs were recorded in the St. Joe Limestone Member of the Boone Formation. Two sinkholes were recorded in the Fernvale Limestone. Twenty-two springs were recorded in the Plattin Limestone. They typically occur at the basal contact with the St. Peter Sandstone (Fig. 20). Two springs were seen at the contact of the Joachim Dolomite and the St. Peter Sandstone. One spring and two sinkholes were seen in the Cotter Dolomite.

Sandstone in the area also contains karst features. Three springs were recorded in the Batesville Sandstone in the town of Big Flat. Fifteen sinkholes were recorded in the St. Peter Sandstone. More karst features would be discovered if a karst inventory was undertaken.


(A)


(B)

Figure 21. (A) Sinkhole in St. Peter Sandstone. (B) Sinkhole in Boone Formation.

Paleokarst

Paleokarst is a rock or area that has been karstified and subsequently buried under sediments (Glossary of Geology 1987). Paleokarst is exposed at the St. Peter/Everton contact (Fig. 22). Limestone is present at the very top of the Everton Formation. After deposition of the limestone, the sea that covered much of what is now the central part of the United States retreated and exposed the limestone. This limestone was exposed to erosion for up to tens of millions of years, during which an extensive karst surface developed (Sloss, 1963). Subsequently, the St. Peter Sandstone was deposited and in-filled the karst at the top of the Everton. This is evidenced by the tens of feet of relief at the unconformable contact and paleokarst features that are present at various localities (Fig. 22).

(A)

(B)

Figure 22. (A) Unconformable undulating St. Peter- Everton contact. (B) Paleokarst at St. Peter-Everton contact.

Paleokarst is also present as breccias within the Everton Formation. A majority of the breccias contain sphalerite (ore of zinc) and dolomite. These deposits are commonly referred to as Mississippi Valley Type (MVT) deposits because they were originally recognized in the Mississippi River Valley region of the United States. The breccias record a model of cave formation, infill and collapse (Kerans, 1990). There are two main types of breccias 1) crackle or mosaic and 2) matrix (Sangster, 1988, Kerans, 1989 and Loucks, 1999). Crackle and mosaic breccias are highly fractured but the fragments in the breccia are only slightly separated. There is no rotation or collapse of the fragments in a crackle breccia, however there is rotation of fragments and the displacement is greater in matrix breccias (Loucks, 1999). Matrix breccias are divided into two or more types by different authors. Sangster divides matrix breccias into 1) rock-matrix and 2) ore-matrix, while Kerans divides these breccias into matrix versus clast-supported breccia and adds the term chaotic as a descriptor. Chaotic breccias are characterized by extensive rotation and displacement of clasts (Loucks, 1999). Crackle, mosaic, and matrix breccias are present at all of the zinc mines and prospects in the Everton Formation. Rock-matrix breccias are present within dolostones in the Everton Formation outside of the mine and prospect areas (Fig. 23).

(A) (B)

Figure 23. (A) Ore-matrix breccia in Everton Formation at a zinc mine. (B) Rock-matrix breccia in the Everton Formation.

Travertine

Travertine is a chemically-precipitated continental limestone composed of calcite or aragonite that forms around seepages, springs and along rivers and streams (Pentecost, 2010). Precipitation results primarily through the transfer of carbon dioxide from or to a groundwater source leading to supersaturation with crystal growth occurring upon a surface. Travertine cascades and dams are present on many of the small streams that are sourced by springs in the limestone and dolostone of the Everton Formation (Fig. 24).

(A) (B)

Figure 24. (A) Travertine cascade on Cook Hollow. (B) Travertine cascade along Perry Creek.

Economic Geology

Economic resources for the two field area were reported as early as 1893, when Hopkins reported dolostone outcrops near the mouth of the Buffalo River and along the White River. He also reported the development of quarries in the St. Joe Limestone. Lead and zinc was exploited in the late 1800's from mines in the field area (Branner, 1900; Adams, 1904 and McKnight, 1935). Few mineral resources have been developed since that time. Current mineral resources of the area consist of crushed stone and sand and gravel. Quarries and mines from an AGS database (Howard, 2010) and McKnight (1935) were field checked during field mapping.

Crushed Stone

Stone that is crushed and suitable for use as aggregate or as a base for paved and unpaved roads, is present in the Boone, Powell and Everton Formations. The upper portion of the Boone Formation is currently quarried north of Cartney, Arkansas (Fig. 25). There are several inactive quarries in the dolostones of the Powell and Everton Formation on the northern half of the Buffalo City quadrangle.

Figure 25. Cherty Boone Formation in quarry near Buffalo City Fault.

Dimension Stone

Stone suitable for use as dimension stone is present in the St. Joe Limestone Member of the Boone Formation and chert-free limestones in the Boone Formation. Several abandoned quarries are present in these units. The Batesville Sandstone and the Cotter Dolomite are used as dimension stone in other parts of the state and although they are present in the field area, there are no quarries located in these formations. Thin-bedded dolostones in the Powell Dolomite have been used as building stone in the past as can be seen in churches and other buildings in the area.


(A)


(B)

Figure 26. (A) Quarry in St. Joe Limestone. (B) Quarry in chert free limestone of Boone Formation.

Sand and Gravel

Sand and gravel is used for construction purposes such as concrete aggregate and products, and road base and coverings. Sand is also used as a proppant in the frac process when drilling for oil or gas. The alluvium and terrace deposits from the larger streams in the field area contain sand and gravel (Fig. 27). Regolith from the Boone Formation is also used as fill. The regolith is rich in clay and when added to chert and limestone compacts more readily. Regolith in the Boone Formation is currently being recovered from an open pit mine north of Cartney, Arkansas. Sand that could be used as a proppant is present in the St. Peter Sandstone in the field area; however there are currently no mines for the sandstone located here.

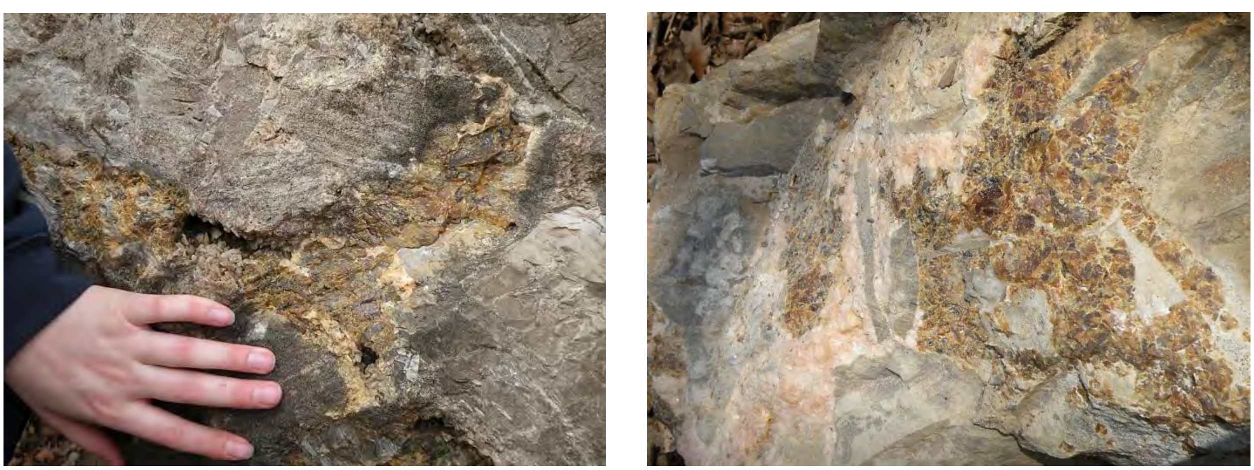
Figure 27. Gravel bar along Big Creek.

Lead and Zinc

This area was heavily prospected for zinc in the late 1800's and early 1900's. Zinc occurs primarily in the mineral sphalerite in breccias of the Mississippi Valley Type (MVT) deposits (see write-up under paleokarst section). Dolomite is commonly found with the sphalerite (Fig. 29). Zinc mines and prospect pits are present throughout the field area (Fig. 28); however locations are not shown within the National Park since they are considered sensitive park resources. Refer to McKnight (1935) for a complete discussion of the lead and zinc prospects in northern Arkansas. The majority of the prospects and mines were visited and a GPS point taken. The status of the mine or prospect was noted for resource management and safety purposes. There is no current zinc mining taking place in the area.

(A) (B)

Figure 28. (A) Typical prospect pit in the Everton Formation. (B) Zinc mine in the Everton Formation.



(A) (B)

Figure 29. (A and B) Sphalerite (ore of zinc) and dolomite at mines in the Everton Formation.

Manganese

Manganese was mined in the state as early as the mid 1800's, however, the majority of manganese was mined from 1915 to 1958 (Kline and Brown, 1981). The manganese was mined mainly from the Batesville District. It was probably during this latter period that the manganese was mined in the Big Flat area. The St. Joe Limestone contains considerable quantities of manganese (Fig. 30). The manganese occurs in the primary minerals rhodochrosite, hausmannite and braunite which are disseminated in the limestone (Stroud, 1981). It is thought that a manganese-rich solution replaced calcium carbonate in the limestone (Stroud, 1981).

(A)

(B)

Figure 30. (A) Manganese prospect with cherty Boone outcrop. (B) St. Joe Limestone at manganese prospect.

Acknowledgments

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