Bedrock Geological Map of the Rockhouse Quadrangle, Carroll and Madison Counties, Arkansas

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Bedrock Geologic Map of the Rockhouse Quadrangle,
Carroll and Madison Counties, Arkansas
Bedrock Geological Map of the Rockhouse Quadrangle, Carroll and Madison Counties, Arkansas

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Geology

By

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University of Arkansas
Bachelor of Science in Geology, 2010

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This thesis is approved for recommendation to the Graduate Council.

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ABSTRACT

A digital geologic map of the Rockhouse quadrangle, Carroll and Madison counties, Arkansas, was created on a 1:24,000 scale using ArcMap 10 and Photoshop CS4. The data obtained in the field are digitized onto the United States Geological Survey (USGS) digital raster graphic (DRG) of the Rockhouse quadrangle. The geology in the Rockhouse quadrangle consist entirely of sedimentary rocks that are Paleozoic ranging from Lower Ordovician to Mississippian in age. The Ordovician System is represented by the Cotter, Powell, Everton, and St. Peter Formations. The Cotter and Powell are the prominent bluff forming units throughout the quadrangle and along the Kings River. The Devonian unit in this area is the Chattanooga Shale; however the thickness of this unit in the mapping area was too thin to be accurately mapped. The Mississippian units are represented by the St. Joe Limestone and the Boone Limestone. The St. Joe is also a bluff forming unit but does not reach the thickness of the Cotter and Powell. The Boone forms only small scale bluffs, on the order of 10-12 feet in height, but has a very distinctive chert and red clay regolith that dominates the landscape. The only two structural features in the Rockhouse quadrangle are a fault, located in the southwest corner of the mapping area, and the Highway 71 anticline that trends northeast approximately through the middle of the quadrangle. This geologic map represents the first attempt to digitize the lithological contacts of this area. A detailed geologic map gives insight into the formation of the Ozark Dome as well as depositional histories and the features that form the topography of the mapping area. Geologic mapping of the Rockhouse Quadrangle and the surrounding areas is important to the understanding and development of northern Arkansas throughout the Paleozoic and the Ozark plateaus.
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INTRODUCTION

The purpose of this project is to create a geologic map of the Rockhouse quadrangle at the scale 1:24,000. This map will consist of the bedrock lithologies present in the mapping area. Geologic maps are very useful agricultural/industrial development. This geologic map will be used to identify possible springs and groundwater flow paths. The formations in the Rockhouse Quadrangle are all sedimentary in origin and range from Lower Ordovician to Middle Mississippian in age. The Lower Ordovician units are, in ascending order, the Cotter Dolomite and Powell Dolomite. The middle Ordovician units are the Everton Formation and the St. Peter Sandstone. There are no Silurian rocks due to a long period unconformity. The Clifty Sandstone and the Chattanooga Shale are Devonian in age, however the Clifty was not observed in the quadrangle. The Mississippian units are the St. Joe Formation with the four members associated with it (the Bachelor, the Compton, the Northview, and the Pierson) and the Boone Limestone. The Boone Limestone is also Mississippian in age and is the uppermost unit in the Rockhouse Quadrangle. Using these rock units, lithology changes, and field measurements aided by GPS measurements a bedrock digital geologic map can be made. The advantage of a digital geologic map is that it can be manipulated easily to identify other features of the area and a digital map also makes for simple exportation and manipulation. This geologic map is the first digital attempt at a geologic map of the Rockhouse Quadrangle.
LOCATION AND ACCESS

The Rockhouse Quadrangle is in both Madison and Carroll counties, Arkansas approximately 50 miles northeast of Fayetteville (Figure 1).

![Figure 1: Rockhouse Location within the state of Arkansas (Figure created by author)](image)

The county line is almost exactly through the center of the quadrangle. The quadrangle is named for the town of Rockhouse, Arkansas, which is in section 29 of township 19 and range 25. The town of Rockhouse is no longer there; all that is left is a cemetery by the Kings River. The coordinates of the corners of the mapping area are: NW-93”45’N 36” 22’30”W, NE-93”37’30”N 36”22’30”W, SE-93”37’30”N 36”15’W, SW-93”45’N 36”15’W. The Rockhouse quadrangle is approximately bordered on the west by highway 23.
Access to most parts of the mapping area is limited due to the rural nature of the quadrangle. Highway 23 trending North-South along the east boundary of the map provided a good starting point but other routes were required. The Mcilroy State Game Management Area covers nearly half of the mapping area in the south. In this management area there are several horse and hiking trails that provide relatively easy access to the creek beds and bluffs where most outcrops and mapped. The Kings River runs North-South through the western edge of the mapping area and the Kings River Outfitters provided canoes to float the river and gain access to bluffs that would be otherwise inaccessible. County road 221 runs East-West through the center of the quadrangle and was used in accessing road cuts and Trigger Gap. For the rest of the mapping area permission was obtained from landowners to take measurements on their property.

**PHYSIOGRAPHY AND DRAINAGE**

The Rockhouse Quadrangle is part of the Ozark Plateaus Province of Northern Arkansas (Figure 2). The Ozark Plateaus is made up of three plateau surfaces and is a structural dome, the Ozark dome is composed of nearly flat-lying strata, Chinn and Konig (1973) call this area the northern Arkansas structural platform. The three plateau surfaces are identified by the lithologies present beneath each. The Salem Plateau is the oldest and the lowest comprised mainly of dolomites, the Springfield rests on the Salem Plateau and is mainly limestone and the Boston Mountain Plateau is the uppermost plateau surface underlain by Pennsylvanian sandstones. The Rockhouse Quadrangle is located almost entirely in the Springfield Plateau save for the northeast corner that is in the Salem Plateau (Figure 3).
Figure 2: Physiographic Regions of Arkansas
(geology.ar.gov/education/physio_regions.htm)
The Eureka Springs Escarpment separates the Salem Plateau from the Springfield Plateau and is most prominent near the Arkansas and Missouri border. It becomes undetectable to the South and is not present in the mapping area. The Salem Plateau is comprised mainly of Cambrian and Ordovician age strata. The Springfield Plateau is underlain Mississippian and Devonian age strata.

The Rockhouse Quadrangle is entirely within in the Kings River drainage system, which is a tributary of the White River. The Kings River flows north through the mapping area. Rockhouse Creek and Kneels Creek feed the Kings River, both flow towards the northeast. The entire drainage pattern is dendritic in nature with a watershed divide between Rockhouse Creek
and Kneels Creek that trends east to west, just south of the Carroll and Madison County boundary. All the streams in the Rockhouse quadrangle are v-shaped and intermittent. The exceptions to intermittent streams are Kneels Creek and the Kings River, which have flowing water, although not navigable, throughout the year.

The bedrock type and outcrops in the area control the topography of the Rockhouse Quadrangle. The Boone Formation forms steep slopes that are comprised of chert and red clay regolith as well as small bluffs that resemble small shelves. The St. Joe forms small bluffs, but is not observed along the Kings River in the quadrangle. The St. Peter Sandstone forms smooth creek beds and fine grain sand regolith. The Everton Formation is mainly represented by the Kings River Sandstone, and is a bluff former. The Cotter and Powell formations are resistant formations that form the major bluffs along the Kings River in the Rockhouse Quadrangle.

METHODS

Field Mapping Methods:

The field-mapping portion of this thesis was conducted in the spring and fall of 2012 and the spring and of 2013. Fieldwork could not be done in late spring, summer, and early fall due to heavy vegetation cover rendering most locations inaccessible. Locations of contacts between different lithologies were determined using a combination of aerial photographs obtained from Google Earth, topographic maps obtained from the Arkansas Geological Survey, and a photo geologic map created by Bush and Haley (1973). After possible contact points were determined the locations were accessed by a combination of 4WD vehicles, using various county roads in Madison and Carroll counties, by foot, and by canoe. Outcrops along the Kings River were
mapped using a canoe. Contacts that could not be accessed in a vehicle or canoe were accessed on foot via game trails and streambeds.

The contacts at each outcrop were recorded using a Trimble GeoXM handheld GPS receiver and logged into the Pathfinder software to be used in the generation of the geologic map. Each GPS coordinate was labeled in the GeoXM and a corresponding point was described in the field notebook for correlation in the lab as well as a photo taken of the contact point. Locations were recorded on a 1:24,000 topographic map in the field and the pathways traveled were also labeled for the creation of the geologic map.

**Generation of Geologic Map:**

The geologic map was made using a combination of ArcMap 10 and Photoshop CS4. After the contact locations were determined and recorded they were transferred into Pathfinder to be correlated as well as have the exact GPS location determined using a known GPS stations in the Pathfinder software. They were then cataloged into the various lithologies of the quadrangle. Due to the percent error in the Trimble GeoXM, each group of contact elevations needed to be averaged to find the best fitting contact elevation for all points gathered. The GeoXM had an average error in elevation height of ten feet, and therefore only geologic units that exceeded ten feet in thickness could be mapped. Due to the difficulty in distinguishing the Cotter and Powell formations when the conglomerate layer between them is not visible, they were grouped together as Lower Ordovician Dolomites (LOD). After the contact elevations were grouped together the elevation for the lithologic contact was created in ArcMap by manipulating a Digital Elevation Model (DEM) obtained from Geostor (geostor.arkansas.gov) and plotting the polyline across the mapping area. Next polygons were created from the polyline to simulate the actual rock layers. Each polygon, representing a specific formation, was built in ascending order from the LOD to
the Boone Formation so that the younger formation was directly on top of the older and therefore allowing an accurate representation of the bedrock located in a specific point on the map. When these base layers were completed a topographic map of the Rockhouse Quadrangle was overlain to add the PLSS (public Land Survey System), county roads, waterways, GPS collars, declination, scale, contour interval, and location. A map explanation was created in ArcMap10 to distinguish the different rock layers and structural features. The map was then exported into Photoshop CS4 for cosmetic touch ups.

**GENERAL LITHOLOGY**

All of the rocks in the Rockhouse Quadrangle are of sedimentary origin and vary in age from lower Ordovician to middle Mississippian age (Figure 4). The sedimentary rocks consist of mainly dolomite, limestone, friable sandstone, shale, chert and sparse outcrops of conglomerate. There are eight major formations identified in the Rockhouse quadrangle with nine smaller members or informal names also present (Johnson, 2008). Of the 17 formations and members only five are present (Purdue and Miser, 1916). The five members that are not truncated by unconformities are the Boone Limestone of Middle Mississippian age and the Ordovician formations; the Cotter Dolomite, the Powell Dolomite, the Everton Formation and the St. Peter Sandstone.
Figure 4: Stratigraphy of the Rockhouse Quadrangle (Modified from Johnson, 2008)
Ordovician Units

The rocks from the Ordovician Period in the Rockhouse Quadrangle consist of very thick dolomite sequences as well as sandstone units. They are well exposed on the Kings River where it flows through the Rockhouse Quadrangle. The two major components are the Cotter Dolomite and the Powell Dolomite which are grouped in this thesis as Lower Ordovician Dolomites (LOD). The Cotter is the lowermost unit in the area with several dozen outcrops in the valleys throughout the area, as well as the Powell. The shear bluff and cliff faces along the Kings River throughout the Rockhouse Quadrangle are all Cotter and Powell dolomite. Due to the similarities between the Cotter and Powell formations they are combined into one unit that will be called the Lower Ordovician Dolomite (LOD).

Cotter Formation (OC)

Definition:

The Cotter Formation is a dolomite formation that contains some shale and sandstone and is named Cotter because it is well exposed in the town of Cotter in Baxter county AR. It was known as Magnesium Limestone by the Arkansas Geological Survey and was classified as the Yellville Formation by G. I. Adams in 1904; however, the Yellville Formation was separated into two formations, the Cotter Dolomite and the Powell Limestone with the Powell stratigraphically on top (Purdue and Miser, 1916).

Distribution:

The Cotter Dolomite is the oldest rock type in the Rockhouse Quadrangle dating to the early Ordovician (McKnight, 1935). The Cotter Formation is the lowest unit stratigraphically in the Rockhouse Quadrangle and easily found along the Kings River and the topographic low
points in the mapping area. The northeast corner of the mapping area is almost exclusively Cotter Dolomite except for a topographic high point named “Round Mountain” which has Powell Dolomite and the lower part of the Everton Formation. Outcrops of the Cotter Formation dominate the length of the Kings River throughout the mapping area. The Bluffs and shear cliff faces observed on the King’s river are all Cotter Dolomite. Cotter Dolomite bedrock and outcrops also dominate the major tributary streams feeding the Kings River. These tributaries are Rockhouse Creek and Knolls Creek.

Character:

The lower contact of the Cotter was not observed anywhere in the Rockhouse Quadrangle. The upper contact with the Powell Dolomite is seen in only one place in the Rockhouse Quadrangle and identified by a conglomerate layer approximately one foot thick. The only identified location of this conglomerate layer is found in the northwest corner of the quadrangle near Lake Lucerne in a road cut just south of the lake at an elevation of approximately 1320 feet above sea level. The dolomite is light grey and has a smooth blocky appearance, and it is commonly referred to as “Cotton Rock” (Johnson, 2008) and found in the upper section of the Cotter Dolomite. Near the base of the Formation and the topographic low points in the Rockhouse Quadrangle, the Cotter becomes more of a tan to buff dolomite. There are banded chert nodules in the Cotter Dolomite about 20 to 30 feet below the upper contact. The chert is dense and resistant to weathering as well as having a hardness approaching seven on Moh’s Hardness Scale. The Cotter chert was formed by replacement of dolomite as indicated by continuous bedding laminations from the dolomite into the chert which indicates that the chert formes after deposition (McKnight, 1935). The Cotter Dolomite is mostly void of fossils but there have been gastropods and cephalopods found in the weathered outcrops and the genus
Cryptozoon, a colonial algal form, is also well represented (McKnight 1935). There were no examples of these fossils found in the Rockhouse Quadrangle.

**Powell Formation (OP)**

**Definition:**

The Powell Limestone consists of dolomite, some shale, and in most places a bed of conglomerate at the base (Purdue and Miser, 1916). The name Powell was taken from an abandoned settlement Powell Station on Crooked Creek near the center of the Yellville Quadrangle where only the top of the Formation is exposed (McKnight, 1935). Ulrich (1904) compiled the Powell within the Yellville Formation, which contained the Everton, Cotter and the Jefferson City Dolomites.

**Distribution:**

The Powell Formation is Early Ordovician in age (McKnight, 1935) and has outcrops throughout the Rockhouse Quadrangle. It is most easily observed in the northwest corner of the quadrangle directly south of Lake Lucerne where the conglomerate is identifiable. The Powell ranges in thickness from 30 to 130 feet, 30-60 feet near Winona Springs; 50-130 feet at Trigger Mountain; and 110 feet at the town of Rockhouse (Purdue and Miser, 1916). There is no place where the top and bottom of the Formation are both present. Most outcrops of the Powell are exposed along Kings River and the tributaries at a minimum elevation of 1330 feet above sea level. The slope of the Powell formation is between 1 and 3 degrees throughout the Quadrangle and treated as essentially flat lying and does not affect the stratigraphic position of the unit.

**Character:**

The Powell is mostly a fine-grained argillaceous dolomite that is locally called “Cotton Rock” (McKnight, 1935). The Powell consists of dolomite, shale and a conglomerate at the base (figure
5). The Powell sits unconformably on the Cotter with conglomerate at the base. The basal conglomerate consists of chert pebbles and dolomite from the Cotter Formation and is a dark argillaceous magnesian limestone (Purdue and Miser, 1916). The sorting of the conglomerate varies with location and the grain sizes vary from approximately one foot to one inch. The conglomerate is not everywhere visible and the changes in grain size are probably gradational. All Lithologies of the Cotter and Powell are present in the conglomerate (Johnson, 2008) “Most of the limestone effervesces rather freely with dilute hydrochloric acid showing that the proportions of magnesium carbonate is no so great as in the underlying Cotter Dolomite which is more nearly a true dolomite” (Purdue Miser, 1916). There are a few beds within the Powell that contain zinc and lead ore, those beds are generally coarser grained. One such bed, named the “Black Ledge” by those who have prospected for lead and zinc due dubbed it because of its tendency to weather darker (McKnight, 1935).
Figure 5: The Powell Formation on top, conglomerate at the base between the red lines, and the Cotter Formation exposed beneath the lower red line (Photo by Author)
Everton Formation (OE)

Definition:

The Everton shows considerable differences in lithologic character from one place to another (McFarland, 1998) and it has varying proportions of alternating limestone, dolomite, and sandstone with minor amounts of shale and are not continuous over any great area (McKnight, 1935). The Everton, named by E. O. Ulrich from Everton, Arkansas where it is well developed, consists of three subdivisions; the basal Sneeds Limestone, the Kings River Sandstone, and upper fine-grained magnesium limestone interbedded with sandstone (Purdue and Miser, 1916).

Distribution:

The Everton Formation sits unconformably on top of the Powell (Figure 6) and is middle Ordovician in age. Two main lithologies make up the Everton Formation in the Rockhouse Quadrangle. The Sneeds Limestone is at the base and only present in a few places where as the Kings River Sandstone is the main unit used to identify the Everton Formation, and the Kings River Sandstone does not occur throughout the Rockhouse Quadrangle. The upper dolomite most closely resembles the “B” dolomite from Suhm (1970) where he proposed eight different members within the Everton, however for this project only three units are being used due to the instrument limitations of the handheld GPS units in that they are only accurate to within 8-12 feet and several of the smaller units are unidentifiable in that tolerance and on the 1:24000 scale used in this mapping project. The Kings River Sandstone is a bluff former (Johnson, 2008) and therefore the easiest unit to locate in the field. The Cotter and Powell tend to form one continuous bluff and locating the base of the Everton by identifying the Sneeds Limestone proves is difficult. The Sneeds is not present throughout the entire area of the Rockhouse Quadrangle. As a result of this the best way to locate the Everton Formation is by identifying the
Kings River Sandstone (Figure 7) in the field that is continuous and has several outcrops along Williams Hollow, Rockhouse Creek, and is also observable near the base of Trigger Mountain.

Figure 6: Everton Formation over the Powell (Photo by Author)
Figure 7: Kings River Sandstone over the Powell Formation (Photo by Author)
Character:

There are three units in the Everton Formation. The Basal Sneeds Limestone is difficult to locate throughout the Rockhouse Quadrangle because it is not present everywhere like the Cotter and Powell. The Sneeds Limestone has a maximum thickness of approximately 10-12 feet and is easiest to identify at an outcrop on the east side of the road at Winona Springs in section six, township 20. The Limestone normally has a dense groundmass but always contain small irregular patches and individual crystals of calcite that are blue-gray to brownish gray (McKnight, 1935). The Kings River is continuous throughout the Rockhouse Quadrangle. It is often difficult to differentiate between the St. Peter Sandstone, which lies above the Everton Formation. The Kings River Sandstone Member is a thin bedded, saccharoidal, quartz sandstone cemented by calcium carbonate. The grains are subangular to rounded and fine to medium grained. Beds are friable to non-friable, cross-bedded, and often ripple marked, with occasional channels (Staley, 1962). This suggests that the Everton Formation was deposited in a shoreface-dune environment (Dowell, 2004). The Thickness of the Kings River Sandstone ranges from 15-40 feet thick throughout the Rockhouse Quadrangle. The defining feature of the Kings River Sandstone that aids in field identification is the cross-bedding and friable quality of the sandstone at outcrops. The Kings River Sandstone also displays pits on the surface of the outcrops. The pits are round and no more than one inch in diameter. They are probably formed from weathering of carbonate-cemented spherulits (Johnson, 2008). The uppermost unit in the Everton Formation is the “B Member” (Suhm, 1970). It is a dark gray to white dolomite with minor beds of sandstone and is usually overlain by the Newton Sandstone (Suhm, 1970).
St. Peter Sandstone (Osp)

Definition:

The St. Peter Sandstone is saccharoidal sandstone with some sandy dolomite and shale (McKnight, 1935). The St. Peter was named from the St. Peter (now known as the Minnesota) River, in Minnesota, where it is well developed (Purdue and Miser, 1916). Branner named the sandstone the Saccharodial Sandstone and Adams labeled it the Key Sandstone. In 1905 Ulrich believed that the Key Sandstone at its type locality is Sylamore and used the term St. Peter in referring to the Ordovician saccharoidal sandstone (McKnight, 1935). The St. Peter sandstone has a character almost identical to the Kings River Sandstone below and the Clifty Formation above, making is very difficult to identify in the field, and hard to identify which unit is being discussed in previous works. Johnson (2008) stated that one should be prepared with knowledge of these units and their stratigraphic relations before working in the field. McKnight (1935) recognized three members within the St. Peter Sandstone. A dark brown gray dolomite intervenes in between two sandstone members. Purdue and Miser (1916) also recognized the middle member but said that it could be the top of the Everton Formation on top of the Kings River Sandstone (Johnson, 2008).

Distribution:

The St. Peter Sandstone is discontinuous throughout the Rockhouse Quadrangle. It is only present in the southwest quadrant the Rockhouse Quadrangle (Figure 8).
Figure 8: St. Peter Sandstone forms this creek bed (Photo by Author)
There was a single fault observed in the Rockhouse Quadrangle. It is a normal fault that has a northwest to southeast trend and is in sections 34 and 35 of township 19 range 26. The St. Peter is directly adjacent to the Boone Limestone along this fault line. The outcrops of the St. Peter in this area are very weathered and not bluff formers, but are observed along the creek beds. The St. Peter is not observed north of this area in the Rockhouse Quadrangle.

Character:

Only one lithology of the St. Peter has been recognized in the Rockhouse Quadrangle and it is the upper sandstone member. The upper member of the St. Peter Sandstone is saccharoidal and is composed of well-rounded medium-sized transparent quartz grains cemented by a small amount of calcium carbonate (Purdue and Miser, 1916). The sandstone is very friable and white upon weathered surfaces. Cross bedding and ripple marks occur but are not common (McFarland, 1998). The Basal Mississippian Sandstone overlies the St. Peter Sandstone.

Devonian Units

Devonian strata in the Rockhouse Quadrangle are the Clifty Formation and the Chattanooga Shale. There are no Silurian strata outcrops present in the Rockhouse Quadrangle due to a period of non-deposition and erosion. The Clifty formation was not observed during the mapping of the Rockhouse Quadrangle, although it is possible that it is in the subsurface.

Chattanooga Shale (DC)

Definition:

Simonds (1891) named the black shale underlying the Boone Formation in Washington County, Arkansas the Eureka Shale. In 1904 Adams and Ulrich used the name Noel Shale in lieu of Eureka Shale because the name was already being used for the Eureka Quartzite of Nevada. Adams and Ulrich (1904) named the shale and the basal sandstone (Sylamore Sandstone) the
Chattanooga Shale. Branner named the Sylamore Member in an unpublished report that was later used by Penrose in 1891. Branner named the Sylamore for exposures along Sylamore Creek, Stone County AR. The Sylamore is conformable with the Chattanooga, and rests unconformably on the Everton when the Clifty Formation is absent (Hutchinson, 2004). However in the Rockhouse Quadrangle the Sylamore was not observed and the only basal contact for the Chattanooga was observed directly on top of the St. Peter Sandstone.

Distribution:

The Chattanooga Shale crops out in only two places in the Rockhouse Quadrangle. One outcrop is approximately 8 feet think with the St. Peter directly beneath and St. Joe directly on top and is located in the NW ¼ of section 22 T19 R26 (Figure 8). The second outcrop observed was no more than one foot thick in the creek bed at Big Mill Hollow in section 13 T19 R26 (Figure 9). It would be expected that there would be more outcrops directly west of the two known location of the Chattanooga, but none were observed.
Figure 9: Chattanooga Shale between the St. Peter, below, and the St. Joe Above (Photo by Author)
Character:

The shale is black, dense, and clayey. It breaks into thin plates and slabs when struck. Freshly broken pieces smell like petroleum. The thickness varies from a few inches up to 70 feet, with an average of 20-30 ft (Branner, 1940). However as mentioned before the thickest point is no more than 8 feet thick. The beds are usually cut by prominent joints, creating polygonal blocks upon weathering (McFarland, 1998). The Sylamore Sandstone may dominate or fill the Chattanooga interval in some areas (McFarland, 1998) and tends to cap low escarpments and produces a narrow bench on which the black shale of the Chattanooga is exposed (Purdue and Miser, 1916). The Sylamore Sandstone is a mature, thin bedded, phosphatic pebble bearing orthoquartzite that commonly displays a chert breccia at the bottom (Hall, 1978). It has been proposed that the Chattanooga Shale was deposited as a shelf of mud and the Sylamore Sandstone and represents a shallow-water, near shore accumulation (Swanson and Landis, 1962).

**Mississippian Units**

The Mississippian strata of the Rockhouse Quadrangle consist of the St. Joe Limestone and the Boone Limestone. There is reason to believe that the Batesville Sandstone is also present, however it was not observed in outcrops. Mississippian transgression covered most of the Ozark Dome and deposition produced carbonate lithologies in northwestern Arkansas that suggest a ramp environment (Johnson, 2008). Approximately a third of the strata observed in the Rockhouse quadrangle are of Mississippian age. The bulk of the Mississippian rocks are in the western central areas of the quadrangle. The topographic highs in the eastern half of the quad are also Mississippian in age; namely Trigger Mountain.
**St. Joe Formation (Msj)**

**Definition:**

The St. Joe is the basal chert-free member of the Boone Formation and was named by Hopkins (1893). Girty (1915) formalized the name St. Joe as a member of the Boone Formation and assigned a railroad cut near St. Joe, Searcy County, Arkansas the type locality. In 1934 Cline proposed to make the St. Joe its own formation rather than a member of the Boone. Mehl in 1960 added the following members while working on the Chouteau Group (St. Joe in Arkansas), in ascending order: Bachelor, Compton, Northview, and Pierson.

**Distribution:**

The St. Joe is Lower Mississippian of Kinderhookian age (Shelby, 1986). The St. Joe rests unconformably on the Chattanooga shale and is conformable beneath the Boone Limestone (Figure 10). The St. Joe is present throughout the Rockhouse Quadrangle forming bluffs just beneath the Boone Limestone. The St. Joe is easily distinguished from the Boone due to the lack of chert in the formation. The thickness of the St. Joe averages between 40 and 60 feet throughout the Rockhouse Quadrangle. Caves also occur found in the St. Joe Formation in the central region of the mapping area (Figure 11). Undulations and anomalous thicknesses occurred during deposition (Johnson, 2008) creating an undulating contact with the overlying Boone Limestone. The deposition of the St. Joe Limestone is not in situ and occurs as debris flows off the Burlington Shelf (Johnson, 2008).
Figure 10: St. Joe and Chattanooga Shale contact, field assistant for scale (Photo by Author)
Figure 11: Boone on top of the St. Joe Formation with a small cave located in the central left of the image (Photo by Author)
Character:

The St. Joe is made up of four members that are distinguished on grain to matrix ratio and are in order from smallest number of grains present to the highest: bioclastic lime mudstone, bioclastic lime wackestone, bioclastic lime grainstone, and bioclastic lime packstone (Shelby, 1986). The base of the St. Joe Formation is a greenish-gray shale unit; the Bachelor Member (Manger and Shanks, 1977). The Compton Member overlies the Bachelor Member and consists of a pale greenish gray, fine-grained, unsorted, grain-supported, calcarenite (Shelby, 1986). The Northview Member is made up of terrigenous materiel and is thin bedded with silty shale and is pale green. The Northview helps to differentiate between the Compton and the Pierson Members, where the Northview is not present it is very difficult to differentiate between the Compton and Pierson. The Pierson Member is very similar to the Compton Member and is also a fine grained and unsorted calcarenite. McFarland (1975) separates the Pierson into two lithofacies: fine calcarenite, unsorted fossil lime wackestone and a fine calcirudite, unsorted fossil packstone. The Pierson is usually covered by Boone chert and/or regolith (Liner, 1980).

Boone Limestone (Mb)

Definition:

“The term ‘Boone’ was first introduced in 1891 by Penrose and Simonds simultaneously, although the name was proposed to them by J. C. Branner. The Formation is named for Boone County, Arkansas, where it crops out in over areas” (McKnight, 1935). The Boone Limestone consists of chert and limestone varying in amount horizontally as well as vertically (Purdue and Miser, 1916). Boone is a term used only in Arkansas, the unit extends into Missouri and Oklahoma but with a different nomenclature. The Boone is divided into the upper and lower sections based on the type of chert and the size of the grains. The chert tends to be dark in color.
in the lower part of the sequence and light in color in the upper part of the section (McFarland, 1998). The Short Creek Oolite is the only recognized member of the Boone Formation (Hutchinson, 2004). Development of the oolitic unit is sporadic throughout northern Arkansas (Shelby, 1986). The Short Creek Oolite was not observed in the Rockhouse quadrangle.

Distribution:

The Boone Limestone is the uppermost unit in the Rockhouse Quadrangle. It is present mostly in the central west portion of the quadrangle however Boone regolith occurs in the southwest and northwest corners of the Rockhouse quadrangle. Boone Limestone is exposed on three hilltops at Trigger Mountain and it is also exposed at Stanley Mountain and Round Mountain in small outcrops. In the western part of the map most of the ridges are capped with Boone regolith. Outcrops of the Boone are not common in the Rockhouse quadrangle; the outcrops found are less than 10 feet in height and mostly covered in chert and red clay soil. The best exposure of the Boone limestone in the mapping area is in a quarry along highway 23 in section 4 of township 19 and range 26.

Character:

The lower Boone Limestone is a fine-grained, grain supported, calcarenite that consists mainly of bryozoan detritus, while the upper Boone is more grain-dominated than the lower Boone (Shelby, 1986). When the Boone weathers it produces a chert and iron clay regolith that tends to form slopes. The upper contact of the Boone was not observed in the Rockhouse Quadrangle and therefore a thickness was not determined. The thickness of the Boone is 300 to 350 feet in most of northern Arkansas but as much as 390 feet has been reported (McFarland, 1998). Tripoli can be found above the Short Creek Formation and is most likely a result of erosion before the deposition of the Hindsville (Johnson, 2008). The upper Boone is easily
recognized by the larger grain size and it resembles the St. Joe formation. The contact between the St. Joe and the Boone is easily discernable due to the chert bedding in the Boone. Springs often can be observed in the Boone along the chert beds as well as caves. Caves are also found along the St. Joe Boone contact.

**STRUCTURAL GEOLOGY**

**Regional Structure:**

Northern Arkansas is situated on a stable mid continent craton with sedimentary strata resting on a Precambrian igneous rock basement. Chinn and Konig (1973) named this area the Northern Arkansas Structural Platform (Figure 12). This platform lies in the Ozark Highlands province and is the least deformed of the Paleozoic structural provinces of Arkansas (Chinn and Konig 1973).
Ouachita Mountains:

The Ouachita Mountains are located south of the Arkoma Basin and extend from southwestern Oklahoma to central Arkansas. This structural province is associated with Paleozoic rocks in Arkansas. The Ouachitas are comprised of highly deformed strata comprising imbricate thrust sheets, which were displaced approximately 80 km during the late Pennsylvanian orogeny (Handford and Manger, 1990). In east-central Arkansas, deformed
Paleozoic strata of the Ouachita Orogenic belt are buried by Cretaceous and Tertiary sediments of the Mississippi Embayment region (Handford and Manger, 1990).

**Arkoma Basin:**

The Arkoma basin is a foreland basin that is associated with the Ouachita Orogeny. The Basin extends from south-central Oklahoma to east-central Arkansas. In east-central Arkansas, the Arkoma basin is onlapped by Cretaceous and Tertiary strata of the Mississippi Embayment (Handford and Manger, 1993). The Arkoma Basin lies between the Ouachita Mountains and the Ozark Dome. Large normal faults are present throughout the basin. Many of these faults are syndepositional with the Pennsylvanian Atoka Formation and cut the basement rocks (Handford and Manger, 1993). The southern portion of the basin represents a transition zone where open folding and faulting of the Arkoma basin changes to more intensely folded and thrust faulted Ouachita Mountains (King, 1998).

**Northern Arkansas Structural Platform:**

The Northern Arkansas Structural Platform is located just south of the southern flank of the Ozark Dome that is situated in central Missouri. The dip in this area is $0^\circ$ to less than $5^\circ$ to the south. The Northern Arkansas Structural Platform contains three plateau surfaces: the Salem Plateau, the Springfield Plateau, and the Boston Mountain Plateau. The Rockhouse Quadrangle is situated entirely on this platform, and is entirely on the Springfield Plateau. The Northern Arkansas Structural Platform is the least deformed of the three provinces and is dissected by erosion (King, 1998). Characteristic structural features of the Northern Arkansas Structural Platform include: large northeast trending normal faults, smaller east-west normal faults, subsidence structures, and fractures. The transition from the Northern Arkansas Structural
Platform and the Arkoma basin is marked by thickening strata to the south, increased regional
dip (>3°), and numerous large faults trending east to west (Handford and Manger, 1993).

Local Structure

Faults and Fractures:
The Rockhouse Quadrangle is in the Northern Arkansas Structural Platform and is entirely on the
Springfield Plateau, although the Salem Plateau is the most observed due to the down cutting of
the Kings River and the tributaries feeding it. Faulting and folding in the Rockhouse Quadrangle
are not common due to a lack of major faults. One fault was identified. It is a minor unnamed
fault with a northwest trend which located in the southwest corner of the Quadrangle. Fractures
are common in outcrops of the Mississippian strata and are believed to be a result of karst
weathering (Figure 13). Gibbons (1962) searched for a correlation between the fractures in
northwest to central Arkansas and the timing of the Ouachita orogenic event. He concluded that
there are five distinct orientations of shear fractures that are oriented NE and NW that range in
age from Permian to post Mississippian.
Figure 13: Weathered joint in the Boone Limestone (Photo by Author)
**Folds:**

The Highway 71 Anticline is the prominent structural feature in the mapping area and has a northeast trending hinge from the southwestern corner of the Quadrangle to the central-western border of the Quadrangle. The Highway 71 Anticline is one of four major northeast trending anticlines Figure 14. They are, from west to east, the Cove Creek Anticline, the Highway 71 Anticline, the Highway 23 anticline, and the Boxley Anticline (Williams, 1963). These features have complementary synclines. Smaller anticlines and synclines are found on the flanks of the larger flexures (Williams, 1963). Out of the four major anticlines described by Williams in 1963 only the Highway 71 Anticline is present in the Rockhouse Quadrangle (Figure 14) and no other structural features intersect it.
Figure 14: Index map or northwest Arkansas western embayment after Quinn (Williams, 1995)
CONCLUSIONS

Using digital mapping techniques for creating a digital geologic map has many advantages over conventional analog techniques. A digital map can be easily shared, stored and accessed to other parties interested in the mapping area (via the internet). Once the map has been formatted it can also be easily manipulated. Digital maps are also of a higher and more accurate quality than maps drawn and colored by hand. The digital data can also be combined with other types of information (i.e. hydrogeologic data, geomorphological data, population distribution, etc.) to help plan or predict future events and possibilities. Using the same techniques used to create the digital map the information can be activated and manipulated to show different views and to even create an interactive image. The data can also be easily accessed for future endeavors to better understand the geologic history of the Rockhouse Quadrangle and the surrounding areas, ultimately providing a better understanding of the formation of the Ozark Dome and the three plateaus associated with it (the Springfield Plateau, the Salem Plateau, and the Boston Mountains Plateau).

The stratigraphic layers in the Rockhouse Quadrangle are Lower Ordovician to middle Mississippian in age and are essentially flat lying or having a regional dip of less than 3° to the south. This makes the topography controlled almost entirely by erosion and the down cutting of the Kings River and the tributaries to it.

There has only been one previously mapping project in the Rockhouse Quadrangle. It was conducted by Bush and Haley and published in 1973. There were very few revisions to this previous map but they include: 1) the inclusion of the location of the Highway 71 anticline, and 2) a revised extent of the various geologic units identified and located at that time. The previous map was a photogeologic map used in the creation of the 1:500,000 scale geologic map of
Arkansas and therefore lacks the detail obtained from this mapping project that is on the 1:20,000 scale. There is still possibility for more detailed geologic maps to be created to identify the units within the larger formations that could not be accurately mapped on this scale. Those units include (but are not limited to): the three units of the Everton Formation (the Sneed's Limestone, the Kings River Sandstone, and the upper limestone), the Chattanooga Shale, The Clifty Formation, and the four units that comprise the St. Joe Formation (Bachelor, Compton, Northview, and Pierson).

This mapping project, as well as several others that have been conducted in the recent past (M.E. King, 2001; Sullivan and Boss, 2002; Hutchinson, 2004; Dowell 2004; and Johnson, 2008), show insight into the formation of the Ozark Dome and the evolution of the history of the southern cratonic margin with relation to modern tectonics and sequence stratigraphy. These insights are changing the understanding and interpretation of the geologic processes that are associated with the collisions of tectonic plates, the formations of sedimentary rock types and the environments that had to be present to form them.
REFERENCES


Hopkins, T. C., 1893, Marbles and other limestones: Arkansas Geol. Survey Ann. Rept. for 1890, vol. 4, p. 253


Geologic Map of the Rockhouse Quadrangle