GEOLOGICAL AND HISTORICAL CONNECTIONS

Devil's Punch Bowl in Wildcat Den State Park

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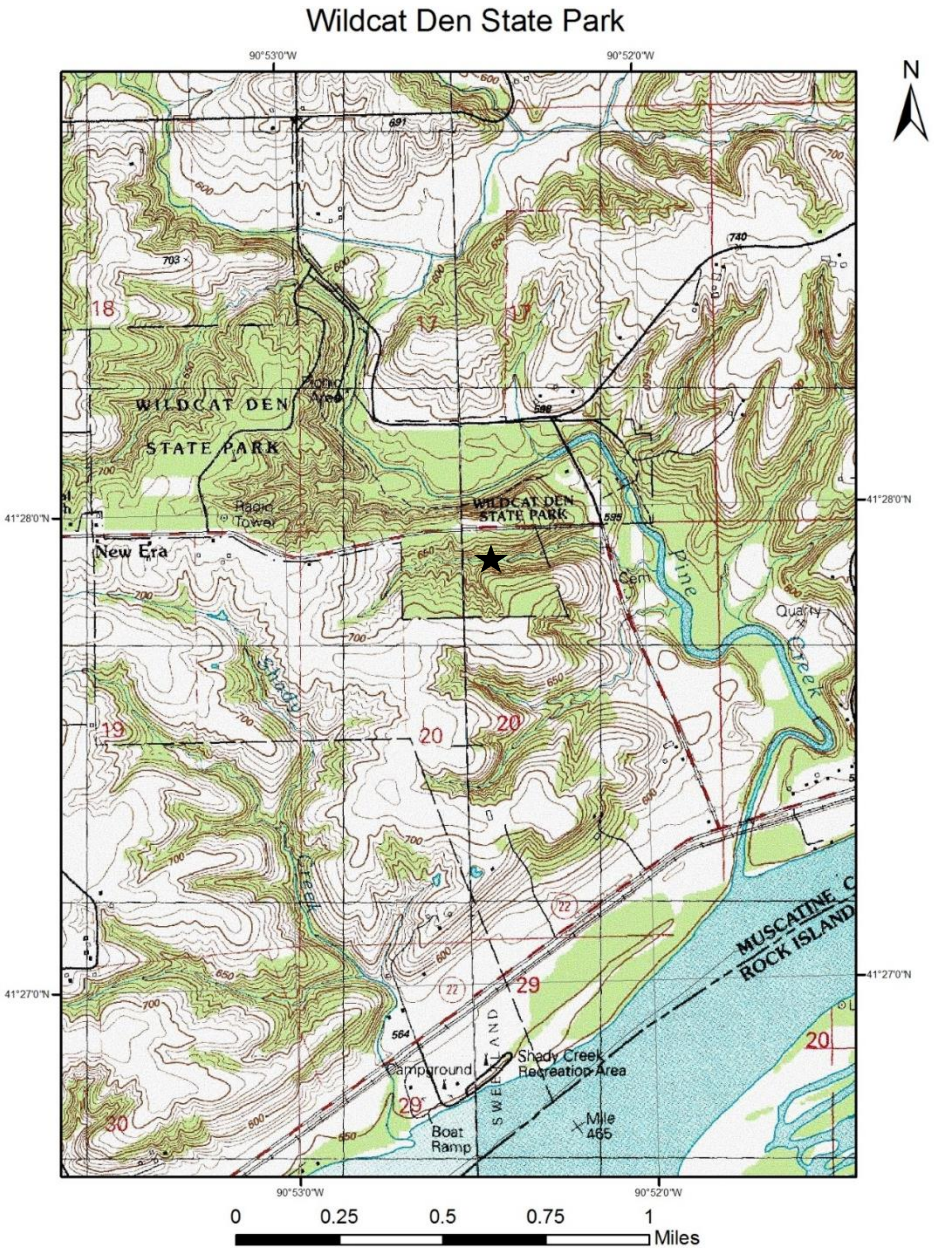
Geological Resources of Iowa Workshop

Site Identification

Location: Wildcat Den State Park – Devil's Punch Bowl (near Muscatine, IA)
County: Muscatine
USGS 7.5' Quadrangle: Montpelier Quadrangle
Public Land Survey System: T77N, R1E, Sec. 20, N ¼
Latitude/Longitude: 41°28′10″N 90°52′56″W
Elevation: 627 feet (range 600-700 feet)
Area: 423 acres (entire park)
Rock/Feature Images: Most from Devil's Punch Bowl area of the park



Historical Record

The area surrounding Wildcat Den has many benefits when it comes to settlement and the presence of natural resources. It's location between Pine Creek and the Mississippi River leads to a plethora of water resources and was a major pathway for travel beginning in the early to mid-1800s. White settlement did not begin until the 1830s in the Muscatine region. Up until that time, the region was occupied by the Native American tribes Fox and Sac. It was after the "Black Hawk Purchase" that ended the Black Hawk War in 1832 that Native Americans were forced to leave the region and large white settlements began to form. When the area was purchased from the Native American tribes, it was a part of the Wisconsin Territory and one of only two counties that make up the current Iowa area (Hawker, 1914). Recent archaeological findings have suggested that there is some affiliation with the Hopewell Tribe near the once existing Pine Creek Mounds. It is believed that this association occurred prior to the takeover of the lands from Native Americans, possibly around 1700 to 2100 years ago (Bettis III, 1992).

The first settlement of the region was in what would now be known as Muscatine in 1833 and was a trading post for the white man. After the trading post was established on the Mississippi River, the ability to trade for necessary materials led to the formation of more settlements that began to appear throughout what is now known as Muscatine County (Hawker, 1914). One of the first settlements in the region was that of the Benjamin Nye and his cousin, Stephen Nye. This settlement was located on Pine Creek, just upstream of where it met the Mississippi River. In fact, Benjamin Nye was considered the first settler after the end of the Black Hawk War and was responsible for opening the first trading post in the Muscatine area. After successfully establishing this settlement, Nye went back to retrieve his family and prepare to open one of the most successful and useful industries in the region at that time (Pitner, 1995).

Upon his return, Nye built the first mill on Pine Creek in 1835. This grist mill was used for less than a year before it was washed out by flooding in the region and it was determined to be too close to the Mississippi River. Nye built a new saw mill about one-half mile further upstream on Pine Creek at this time and it was located on the opposite bank as the current mill is located today. In 1837, Nye built a grist mill that stood at the same location as the grist mill that is still present at Wildcat Den State Park today. It was very successful, outgrew its building, and was the main provider of meal to the settlers in the surrounding area. After the building of Nye's fourth and largest mill in 1848, the mill was able to meet the demands of the settlers and, other than minor repairs due to various flooding events, has managed to survive to current day (Pitner, 1995).

Figure 1 - Current image of Pine Creek Grist Mill at Wildcat Den State Park near Muscatine, Iowa (Roadtrippers, 2015).

Many of the original building projects as the settlements grew, including Nye's various mills, used lumber that was native to the region. There is a high volume of pine trees within Wildcat Den State Park and, based upon this information, the same was probably true for areas nearby before farmland became a priority in the region (Pitner, 1995). The land area surrounding the Muscatine region is known for its well-developed glacial till and, therefore, a good soil environment for crop production. This is not necessarily true for all regions of the county, however. Muscatine proper has long been known as a manufacturing hub due to its prime

location on the Mississippi River and near main railway lines throughout the county (Hawker, 1914). This still holds true today and has led to Muscatine and its surrounding areas to continue to be a major hub of manufacturing, transportation, and commercial business into the 21st century.

Bedrock Geology

The bedrock geology of Wildcat Den State Park is a combination of Devonian Age and Pennsylvanian Age rocks. Along the banks of the Pine Creek, one is likely to locate a large number of sandstone cliffs and limestone and/or dolomite floor features due to the Devonian Age rock formations that are present (Muscatine County, n.d.). One is more likely to locate various forms of sandstone and shale within the Devil's Punch Bowl feature of the park. Within Devil's Punch Bowl, the floor of the bowl is mostly shale and

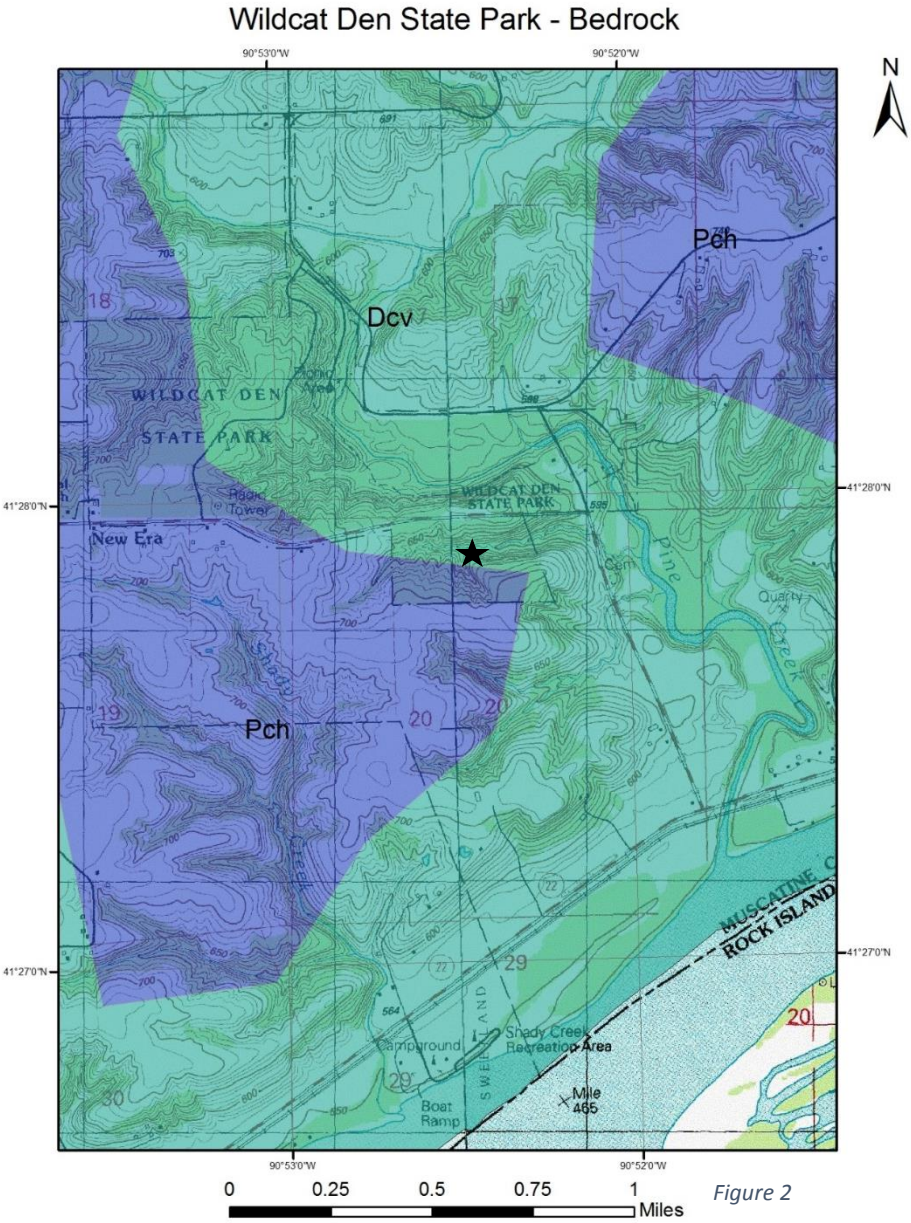


Figure 2

the face of the cliffs are made of sandstone. These observations from our experience at the park are supported by the bedrock map in Figure 2. Images of rock samples from each of these locations have been included within this section as well (Figures 3-6). For my project, I have chosen to focus on the Devil's Punch Bowl feature within Wildcat Den State Park. While many of these features are tied together through the natural processes that led to their formation, the Pennsylvanian Age shale and sandstone have been deemed the bedrock for this particular region of the park (Bettis III, 1992). According to Anderson, the presence of Pennsylvanian rocks in Scott and Muscatine counties are an "erosional outlier." This means the rocks present have been found to more closely match the corresponding strata in Illinois than the strata found in the Forest City Basin of southern Iowa. The separation from the original strata is due to the formation of the Mississippi River. Due to the matching compositions and fossil record, these rocks

Figure 3 – Spoon Formation sandstone sample from wall of Devil's Punch Bowl.

Figure 4 – Caseyville Formation shale sample from floor of Devil's Punch Bowl.

are referred to by the formation terms from Illinois instead of those from Iowa (Anderson, 1998).

Figure 5 – Caseyville Formation shale sample from Devil's Punch Bowl.

The two main formations found within the Pennsylvanian rock record at Wildcat Den State Park are the Caseyville and Spoon Formations. While the two formations are part of the same rock unit they are located within two different series (Morrowan and Atokan respectively), meaning that the Caseyville Formation is older (and therefore located farther underground) than the Spoon Formation. Since the naming process between Illinois and Iowa formations are different, it can be complicated to compare the types of rocks that are expected to rock types in other locations around Iowa. For instance, the Spoon Formation is often referred to as the Lower Cherokee Group when found in locations other than Eastern Iowa (Anderson, 1998).

Figure 6 – Caseyville Formation sandstone sample from Devil's Punch Bowl.

<u>Caseyville Formation – Morrowan Series</u>

The Caseyville Formation is Iowa's oldest Pennsylvanian rock unit and is often viewed as a coal-bearing strata in Muscatine County. This formation is believed to be about 315 million years old. While Pennsylvanian rock tends to rest on Mississippian strata; however, the oldest

Pennsylvanian rocks of Muscatine County rest on either Devonian or Silurian strata instead. The Caseyville Formation consists of mostly sandstones, shales, and mudstones as seen in the Devil's Punch Bowl portion of the park, but can also have conglomerates and discontinuous coal beds as well. Most of the Morrowan series rocks are identified by the presence of fossil spores especially as one moved closer to Wyoming Hill, which is about five miles southwest of Wildcat Den State Park. It is believed that this formation was formed during either a highly fluvial or deltaic depositional environment and the source rock was most likely the recycling of older Paleozoic rocks (Anderson, 1998). According to well records, it has been documented that the Caseyville Formation would be located from at least one hundred feet below the surface until the Devonian units begin at 168 feet below the surface (Iowa Geological Survey, 1964).

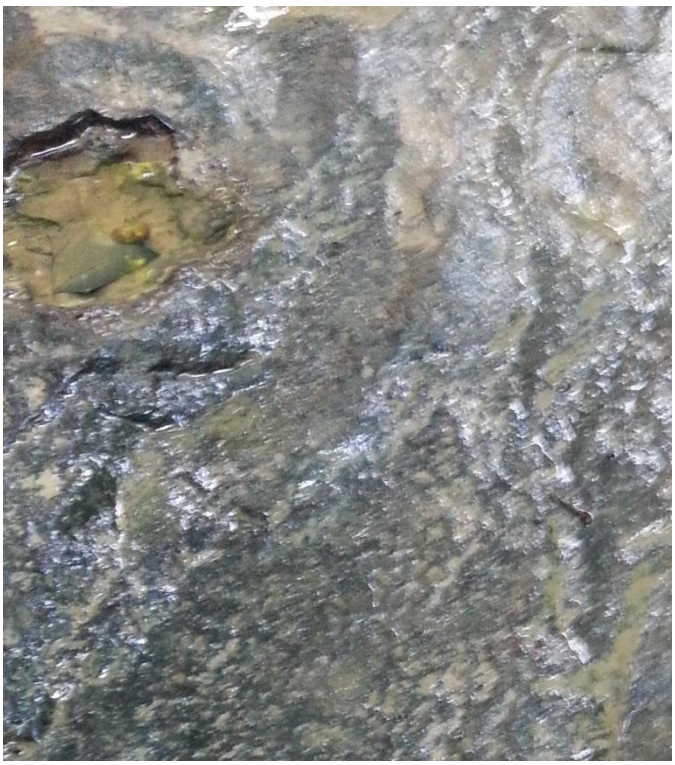


Figure 7 – Shale floor of Devil's Punch Bowl.

<u>Spoon Formation (Lower Cherokee Group) – Atokan Series</u>

The Spoon Formation rests on top of the Caseyville Formation when looking at the rock record of Wildcat Den State Park. The presence of what appears to be shifting sandstone cliffs in Figure 8 are explained by the Spoon Formation sandstone slowly moving down the sloped surface of the Caseville Formation shale. The rocks of the Spoon Formation would be located from fifty feet below the surface (just under the quaternary till) to at least one hundred feet below the surface

where it would meet the Caseyville Formation (Iowa Geological Survey, 1964). As previously mentioned, the naming methods vary from state to state. When comparing the Spoon Formation (an Illinois name) to the features in Iowa, it is believed to include some of the same features as the Kilbourn, Kalo, and Floris Formations in Iowa so these formations are often grouped and referred to as the Lower Cherokee Formation. Regardless of the names given, there are very distinct features found within this formation type. To begin, this formation consists primarily of sandstone that has been able to create cliffs, similar to those seen previously in Figure 3. Unlike the sandstone in the Caseyville formation, these tend to have distinct strata and a reddish tint due to the abundance of feldspar in the chemical composition of the rocks. The larger particle sizes suggest that they were deposited in a fluvial environment and that the water was running in a southwesterly direction. Unlike the previous formation, the source rock of this formation is believed to be Precambrian terranes northeast of Iowa. The rocks of the Spoon Formation are also a bit younger than those of the Caseyville, as they are estimated to be 310 million years old. There are no fossils that are

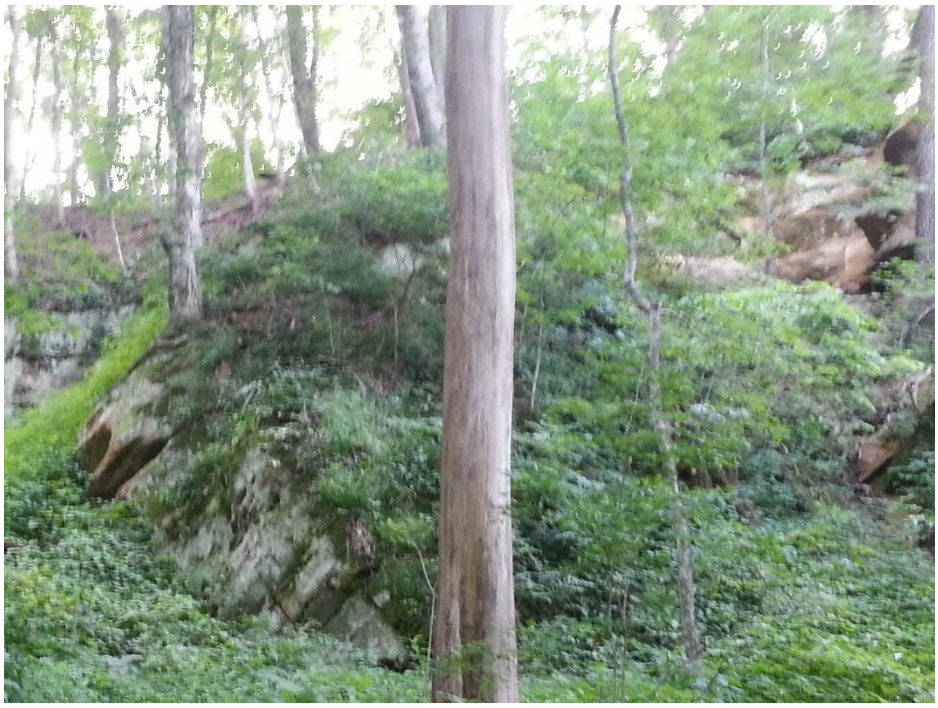


Figure 8 – Spoon Formation sandstone sliding downhill on Caseyville Formation shale

directly attributed to the Spoon Formation; however, the accumulation of peat has led to the small coal beds that have been interspersed throughout the region (Anderson, 1998).

Quaternary Geology & Topography

The topography of Wildcat Den State Park is dependent upon the characteristics of the Southern Iowa Drift Plain, which encompasses most of the southern half of Iowa. This topography is explained as the "typical Iowa landscape" as it includes the rolling hills, winding rivers, and valley-like features that most individuals think of when referring to this prairie state. The Southern Iowa Drift Plain is a region that has been determined based upon the age of the glacial drift which is present in the region. Unlike the northeastern parts of the state, the materials from the glacial drift in the southern portions are hundreds of thousands of years older (Prior, 1991). Since the materials were deposited at a much earlier date, there have been more opportunities for the glacial drift to have been eroded by either wind or water events to expose the underlying bedrock and additional geological features. As the glacial drift has eroded away, bluffs have been

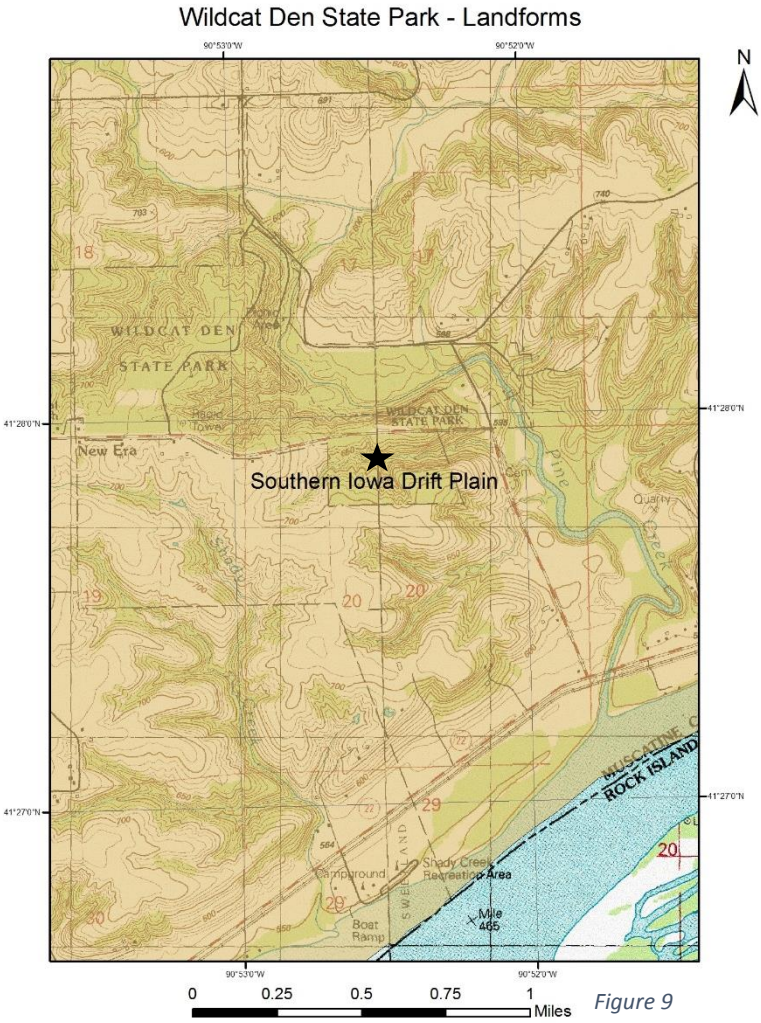


Figure 9

exposed (similar to those along Pine Creek) and the alluvium deposits in new river channels have begun to accumulate (Muscatine County, n.d.).

After the retreat of large glaciers, there are typical features that geologists expect to be present. They can include bogs, lakes, moraines, and kames that are spread throughout the region. However, the Southern Iowa Drift Plain does not have these tell-tale features. This is attributed to the fact that water which would have once been stagnate or slow to drain on the relatively flat surfaces has now created a drainage pattern through ravines and river valleys. It is important to note that the hills were not carved out in a steady and continuous process, but more than likely took place in various "episodes of rapid erosion [that is] accompanied by valley deepening and lengthening" (Prior, 1991). This is the most common explanation for the creation of the Devil's Punch Bowl at Wildcat Den State Park. There is currently a small trickle of water that is found throughout the geologic feature, but with high rains or other sudden intakes of water, this region can have an enhanced drainage and erosional presence in the park. In fact, the Illlinoian Drift Plain is also believed to have a presence within the Montpelier Township as the rock records overlap similar to that of the bedrock maps mentioned previously (Udden, 1899).

As the water-based erosional processes were taking place, there was also a wind-driven process taking place as well. This process was depositing a substance known as loess on the land surface. The composition of loess is usually quite silty (with some sand intermixed) and can range in depth from five to thirty feet in various locations. The loess found in the valleys near Wildcat Den State Park are from the late-Wisconsinan and Holocene ages. This means that they are relatively young (Iowan surface and postglacial, respectively) and are also considered lower in elevation. Since the area near the park is known for its late-Wisconsinan background it is not surprising that there is little to no loess or paleosols within many of the geologic features.

However, the presence of small coal beds has led to previous attempts at surface mining, before determining the lack of usefulness due to the sulfurous coal that has been formed (Prior, 1991).

Soils of Wildcat Den State Park

The soils of Wildcat Den State Park are classified as having a glacial origin considering its presence in the Southern Iowa Drift Plain and that the region has been covered at least twice in its history with ice sheets from the north. However, the majority of the soils are not found in the original depositional environment from the glacial sheets, but have been redistributed by the erosional features of wind and water. In addition, it is unknown the original parent material due to the large amount of distance that is assumed to be covered by glacial movements. It can be assumed that some of the soil material was taken from the Paleozoic sandstone, shale, and limestone that had formed prior to the last glacial time. As time has progressed, the glacial till has eroded and alluvial plains have begun to form as drainage pathways have been reestablished. Any loess that exists within the soil layers has been created in large part from the limestone and sandstone features nearby and is often referred to as Mississippian Loess (Hawker, 1914).

The specific soil types in the region of Wildcat Den State Park are quite varied, as can be seen by the large variety of colors in Figure 10. However, this image can be misleading as a large majority of the colors represent a specific type of silt loam and the various slopes of the land surrounding the park. Each of these variations are related to the Muscatine Silt Loam Series. In the Devil's Punch Bowl, there is not a noticeable presence of soils, other than a very small layer that may have been deposited in recent rain or drainage processes. Due to the large amount of erosion that has taken place and the forested areas that encompass the park, most of the soils are relatively light in color and would not be considered rich in nutrients or respectable for farming. In fact, the color of the soil is often said to be yellowish-brown or gray (Hawker, 1914). While

the soils close to the cliffs and geologic features are not conducive to farming, the areas directly surrounding the park are used for farming practices today. It appears that the most common crops growing this season are corn and soybeans.

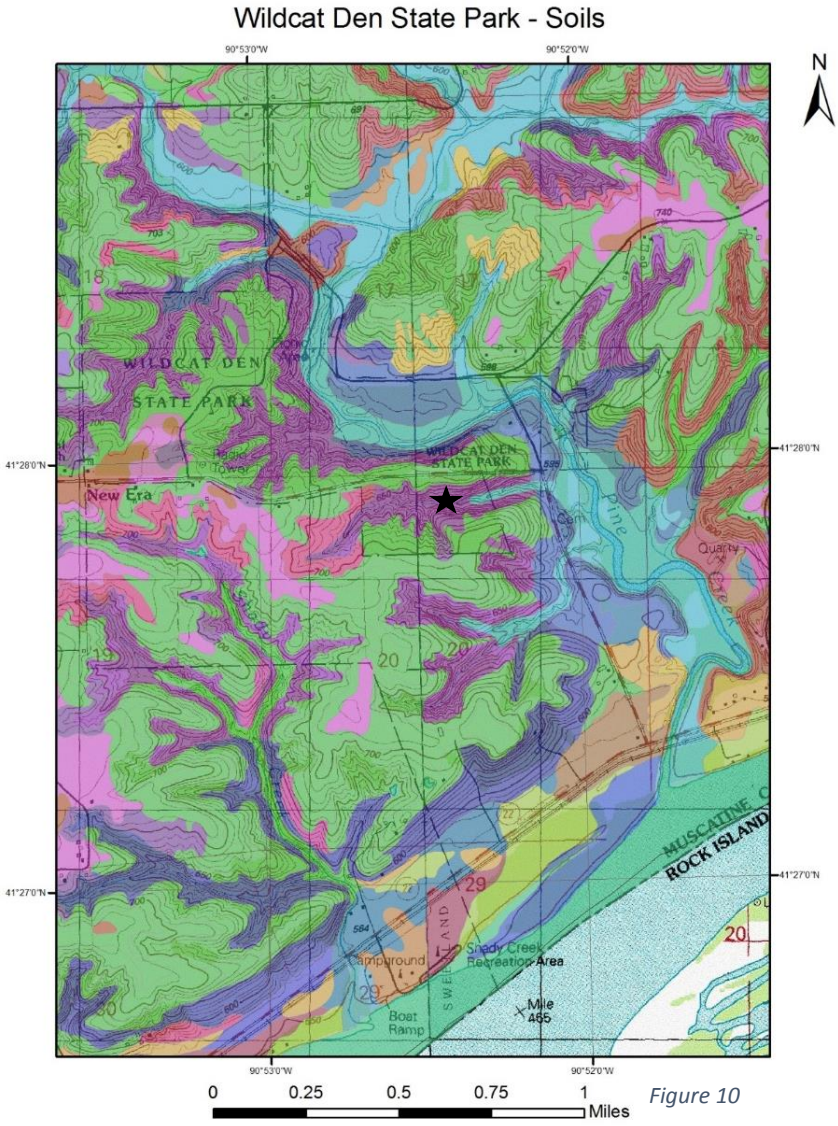


Figure 10

Geologic Evolution & Local Earth History

Many of the geological features found within Wildcat Den State Park can be attributed to either the bedrock geology or glacial history of the region. Through the many complex processes that formed each of these features, the current landscape was shaped. The bedrock of the park is attributed to the Devonian Age on the outskirts of the park and the Pennsylvanian Age within the Devil's Punch Bowl feature. The transition between the Devonian and Pennsylvanian rock groups at this location suggest a transition between a fluvial or depositional environment and a shallow sea environment over 300 million years ago. The formation of limestone and dolomite near the current location of Pine Creek suggests that there may have been a fluctuation of the coastal region during the Devonian Age. Limestone and dolomite are created similarly as the accumulation of calcium carbonate-rich organisms and debris collects in layers on the floor of a shallow sea. As time elapses, the debris is covered, compressed, and eventually cemented until limestone is formed. As the limestone materials are continuously exposed to other chemicals, it is possible for the calcium to be replaced by magnesium and, therefore, create dolomite (Anderson, 1998). While these rocks are not visible within in my project site, the presence of the materials in the same vicinity provide important clues as to the geologic history of the area.

The most prominent rock type within the Devil's Punch Bowl are the Pennsylvanian sandstone, shale, and (nearby) coal deposits. The presence of each of these rock types and the layering that is present within both the Spoon and Caseyville Formations can be attributed to the cyclotherms or repetitive cycles of marine and nonmarine deposits due to a changing shoreline throughout the Pennsylvanian time from 300 to 318 million years ago. The shale that is seen in the Devil's Punch Bowl can be attributed to one of two time frames within each cyclotherm. The shale was formed either during the maximum water depth (more than 500 feet) or it formed

offshore when the water at the lowest level and terrestrial deposits were present. The coal beds that are found inconsistently throughout the area near Wildcat Den State Park are the sign that a new cyclotherm was beginning as the sea level was rising and a swampy environment was present once again. The last rock type that has been attributed to this time period is the sandstone that is abundant within the state park. In general, the presence of sandstone suggests a fluvial environment, especially those that were formed as part of the Spoon Formation. The Spoon Formation has sandstone with larger particles than those from the Caseyville Formation and has a very specific chemical composition. The composition of the Caseyville Formation is believed to be of quartz origin while the Spoon Formation has a large presence of feldspar minerals in addition to quartz (Anderson, 1998). The sand was deposited in very distinct beds that have left the stereotypical banding effect that is often discussed with sedimentary rock types as seen in Figure 11.

Figure 11 – Banding of sedimentary sandstone found on wall of Devil's Punch Bowl in Wildcat Den State Park.

In addition to the history that the bedrock geology can provide for the area, the soils and other materials above the bedrock can provide vital information regarding the more recent history of a particular area. For instance, Wildcat Den State Park is located in the Southern Iowa

Drift Plain, which is a region that was glaciated within the Quaternary time period. A glaciation is known to provide a region with a very specific subset of materials that are referred to as glacial till. The glacial till consists of any deposits of clay, silt, sand, or pebbles that are left behind by glaciers or the streams that formed from their melting process (Prior, 1991). The glacial till can be quite deep depending on the size of the glacier and will cover any bedrock or other geological features that may have previously formed. When the till is first laid, it tends to be in a relatively flat plain that leads to poor drainage and the formation of retention ponds throughout the landscape. As time continues, the water and wind continue to erode the glacial till, eventually revealing new ravines, creeks, valleys, and eventually major rivers. It is through these erosional processes that bedrock is exposed and views such as those in the Devil's Punch Bowl are revealed (Prior, 1991).

It would be expected that the current processes will continue to occur through our current understanding of uniformitarianism. Through this knowledge, we can make assumptions that for the foreseeable future erosion by both water and wind processes will continue to add personality to the landscape of southern Iowa. As rivers and creeks continue to flow through their streambeds, more rock features will be exposed and new pathways will be cut. It is through these processes that we will continue to piece together the geologic history of our region and determine the detailed processes by which our current landscape has formed.

Lesson Plan & Student Activity Worksheets

Unit Title: Geologic Time & History of Wildcat Den State Park
Intended Audience: Earth Science Course (Grades 9-12)
Length of Plan: 2 days (entire unit ranges 2-3 weeks)

Pre-Enactment

Performance Objective:

1. Students will develop an understanding of geologic time periods and the process by which these time periods are determined.
2. Students will determine the types of rocks present at Wildcat Den State Park based upon observations and explain the formation processes.
3. Students will explain the geologic processes that led to the formation of Devil's Punch Bowl in Wildcat Den State Park.
4. Students will create a story (or detailed and labeled image sequence) to incorporate geologic features and historical data into a chronological explanation of the history of Wildcat Den State Park.

Rationale:

Students will be introduced to various topics regarding geologic time, rock types and rock formation processes prior to the beginning of this unit. Some of the prior knowledge and skills that are assumed in this unit plan include: types of rocks (metamorphic, igneous & sedimentary), ability to recognize examples of each rock type, processes to explain how rock types are formed (common processes), a general understanding of geologic time periods, Law of Superposition, weathering and erosion (as well as their differences), processes that lead to erosion (and types of rock that these processes are most commonly found in), topographic maps & contour lines. This field trip has been planned to fall after the general introduction to the material so that it can be used as an extension activity and allow students to apply their new knowledge of geologic processes. This activity will also prepare the students for our future units that will continue to build on these same concepts and begin discussing natural disasters. By conducting a lesson using both hands-on and discussion-based learning, I will be able to complete an assessment of the students' understanding in a real-life scenario and application of their knowledge.

Standards Addressed:

NGSS Performance Expectation:

- MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Iowa Core Standards:

- Understand and apply knowledge of origin and evolution of the earth system. (S.9-12.ES.3)
- Understand and apply knowledge of the structure and processes of the earth system and the processes that change the earth and its surface. (S.6-8.ES.1)

Assessment Strategy:
Students will have been previously assessed on their understanding of geologic time, rock types, and rock formation processes. This will have occurred at a formative level to ensure that students are prepared for the activities that will take place on site at Wildcat Den State Park. During the introduction to the site visit, students will be given the opportunity to view the park location using various map types. Students have been previously introduced to these map types, but will now be asked to apply their knowledge in order to make predictions as to the geologic features, rock types, and age of rocks that they will be viewing during their visit. During the site visit itself, students will be asked to complete a lab report/worksheet that will focus on the various concepts that have been previously discussed in class. After answering the more directed questions early in the worksheet, the students will be asked to complete a more creative component in order to construct a detailed explanation of the geologic features and the processes that would have had to occur for these features to form. Students will be asked to use observations and evidence from their trip to the Devil's Punch Bowl at Wildcat Den State Park in order to complete this assignment. This assessment will inform the instructor as to how well the students are able to relate classroom concepts to a real-life situation.

Accommodations for Exceptional Learners:
This lesson will not need many accommodations for exceptional learners in my classroom. However, the level of answers expected from students can be adjusted to meet ability levels as needed. The opportunity for students to either draw a storyline/comic strip will allow those students with writing and/or reading difficulties to complete the same task in a different manner. One accommodation that may need to take place (depending on student population for a given year) would be for students with mobility disabilities. Those students that are unable to navigate the stairs that are present into the canyon of Devil's Punch Bowl will be provided with images from my report above in order to complete their analysis of the geologic history. Overall, this assignment includes aspects of visual and kinesthetic instruction and will benefit individual differences of learning styles.

Grouping Strategy:
Students will complete this activity either on their own or in their preassigned lab groups from the classroom setting. These groups have been developed based upon learning styles and organized to have students of mixed ability levels. The students will be given the option to work in groups or independently, but it will be made apparent to students that they must complete their own work and turn in answers that are in their own words and are NOT identical to those of their partners.

Materials:
Day 1 – Google Maps access, topographic maps of Wildcat Den State Park, Trail Map of Wildcat Den State Park, Pre-Lab Worksheet/Questions
Day 2 – Trail maps, transportation, cameras (documentation of student observations/evidence), clipboards, Student Worksheets

Enactment (45 minute class period + field trip)

Day 1 – Introduction to Wildcat Den State Park & Site Visit Procedures

- Students will be provided with materials to complete a background study of the geologic features of Wildcat Den State Park. The objective would be for students to complete the accompanying pre-lab questions as preparation for their site visit the following day. Materials will include Google Maps, topographic maps of the region, trail maps, and internet access to research the historical records of the region.
- To begin, as an entire class, I will introduce the park using Google Maps satellite view. We will take a look at various features both in and surrounding the park. I will then direct the students to focus on what is known as the Devil's Punch Bowl in the middle of the park area. This region is adjacent to Pine Creek.
    - We will take a look at location in terms of county, city, and keep zooming in as much as physically possible
    - Take a look at features compared to regional water sources (Mississippi River, Pine Creek, other water features)
- Students will complete the remainder of the pre-lab questions in their lab groups using the same resources that have been provided.

Day 2 – Site Visit to Wildcat Den State Park

- Students will complete the provided Lab Handout during their time at the park. We will begin our trip at the Devil's Punch Bowl as the students have been asked to focus on this location for their study of geologic processes.
- After making observations, recording important features through digital or artistic renderings, and completing the lab worksheet, students will be encouraged to explore other regions of the park (specifically the sandstone cliffs near Pine Creek, lower bowl trails, and the Pine Creek Grist Mill) before leaving for the day.

Name_____ Period_____ Partners_____

Wildcat Den State Park Site Visit: Understanding Geologic Features & Processes

We will be visiting Wildcat Den State Park near Muscatine, IA in order to observe geological features and processes that are common in our region of Iowa. During this trip, you will be asked to make observations, record evidence, and use the information that we have discussed in class in order to make predictions as to why particular events are occurring in this region. In order to prepare for our visit, I am asking you and your lab group to perform some research regarding Wildcat Den State Park. We will complete the Google Maps section as a class, but I would like you to complete the rest using topographic maps, trail maps, and other resources that you are able to locate online.

Pre-Lab Questions:

1. Using Google Maps, answer the following questions….
    a. What county is Wildcat Den State Park located in?

    b. What is the largest body of water in that region?

    c. What body of water flows through the park?

    d. Now, click on satellite view….what are the main features that you notice near and in the park? (Make sure to include vegetation, water features, trails/roads, etc.)

    e. Based upon the satellite view, what do you predict the surface of the park will look like?

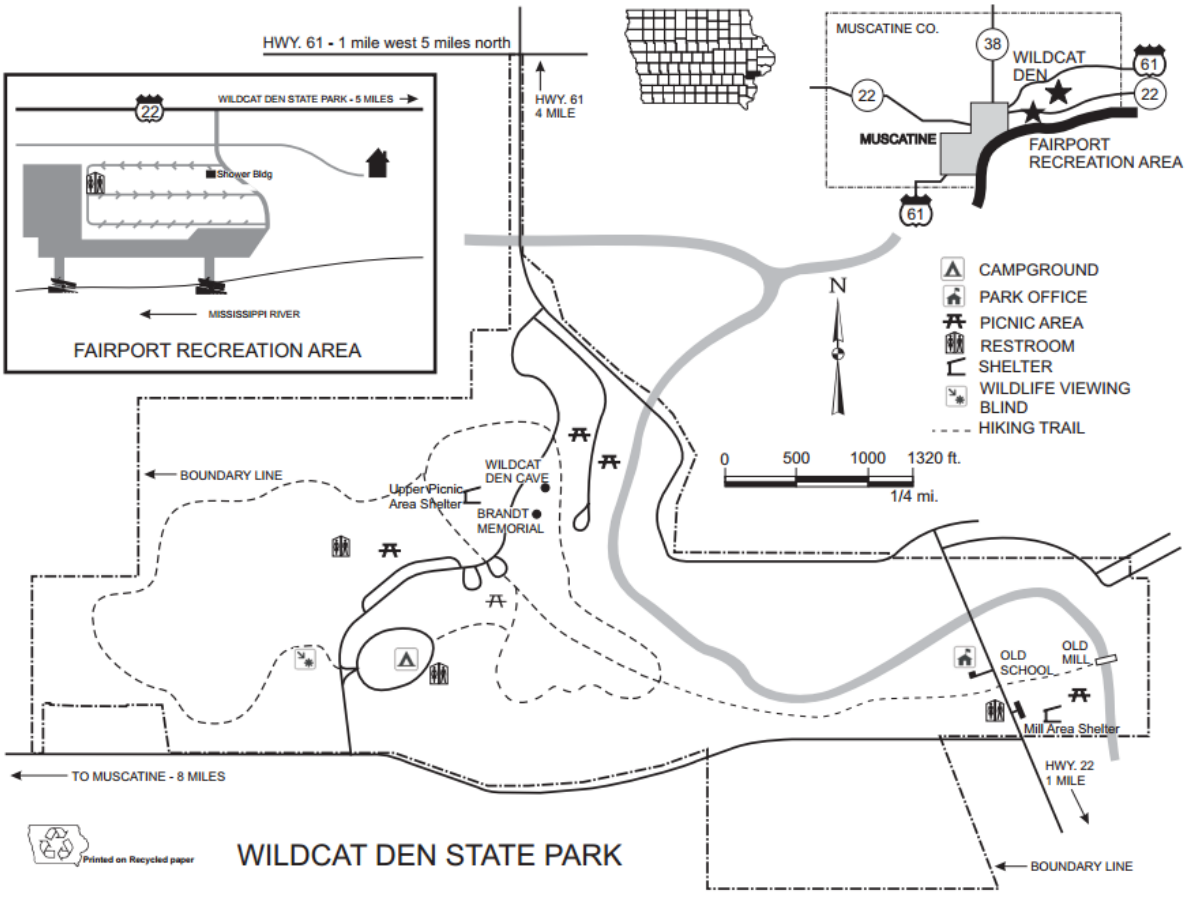
    f. What types of vegetation do you expect to see?

2. Take a look at the topographic/trail maps of the park and answer the following questions:
    a. What do you notice about the contour lines in this region?

b. What do the contour lines tell you about the feature present?

c. What do you predict the surface will look like?

d. How do you think these features will affect the vegetation, soils, and rock types found in the area?



Site Visit Questions:

1. Which of the three main rock groups is found in this geologic feature? What evidence leads you to that answer? Make sure to include a picture of your evidence.

2. What type of rock makes up the walls of the punch bowl within that group? How do you know?

3. What is different about the rock found on the floor of the punchbowl? Provide evidence.

4. The Law of Superposition gives scientists information about the rocks in front of you…what information does it tell us? What does this mean in terms of the rock type on the floor of the punchbowl compared to the rock type that makes up the wall/bluffs?

5. Follow the path to the west end of the punchbowl…what unusual feature do you notice on the lower portion of the walls? What do you think might cause this change?

6. What is one example of mechanical weathering in this feature? Explain your reasoning.

7. What is one example of chemical weather in this feature? Explain your reasoning.

8. Using the data that you have collected, knowledge from classroom discussions, and deductive reasoning, create a story or comic strip that explains the formation of this geologic feature. Make sure to consider the rock types that are present, rock types that might have appeared prior, how features would have changed over time, and any geologic processes that may have occurred. Include a labeled and detailed drawing if that helps you to explain specific events in your story.

Resources

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