SPS-04

STATE OF ARKANSAS

ARKANSAS GEOLOGICAL SURVEY
BEKKI WHITE, DIRECTOR AND STATE GEOLOGIST

STATE PARK SERIES 04

THE GEOLOGY OF
HOBBS STATE PARK-CONSERVATION AREA
WITH GEOLOGIC TRAIL MAPS

by
Angela Chandler and Lea Tipton

Little Rock, Arkansas
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THE GEOLOGY OF HOBBS STATE PARK-CONSERVATION AREA

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INTRODUCTION

Hobbs State Park-Conservation Area (HSP-CA) is Arkansas' largest state park. It covers over 12,000 acres and includes many trails that exhibit diverse geological features. Features such as steep valleys, ridges, and bluffs are a result of the downcutting of streams into the rock. Karst features such as reappearing and disappearing streams, sinkholes, and springs developed in the area as a result of chemical weathering.

In a few locations, fossils are visible within the rock float, or fist-sized fragments of rock scattered throughout the landscape.

LOCATION

HSP-CA is located in northwest Arkansas ten miles east of Rogers along the southern shores of Beaver Lake, within the Ozark Plateau Physiographic Province (Fig.1). A physiographic province is an area that is made up of similar geologic features and climate. The Ozark Plateau is subdivided into three plateau surfaces: Salem Plateau, Springfield Plateau, and Boston Mountains Plateau based on elevation and the age of the rocks exposed at the surface.

More specifically, HSP-CA is located on the Springfield Plateau, a fairly flat surface which consists of Mississippian-aged rock. The plateau surface around Hobbs State Park is dissected by many streams that form steep hillsides. The escarpment**,** or steep edge, of the Springfield Plateau is exposed along the shoreline of Beaver Lake. Rocks there range from Devonian to Ordovician in age.

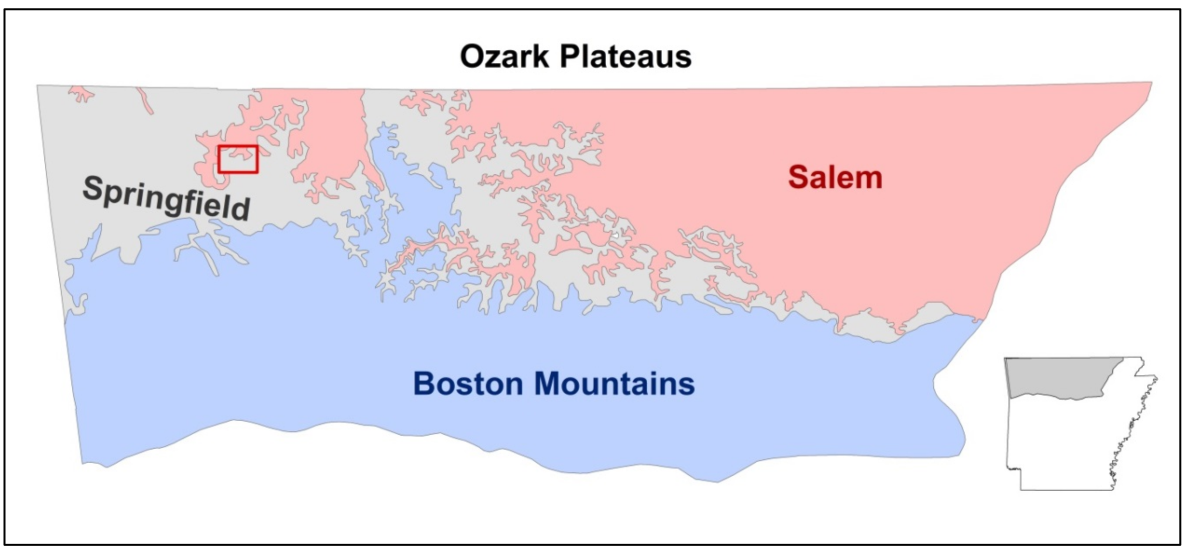


Figure 1. Map showing the location of Hobbs State Park within the Ozark Plateaus.

GEOLOGY IN THE PARK

The majority of rocks exposed at HSP-CA formed during the Mississippian Period around 360 to 330 million years ago. These rocks make up most of the hilltops and hillsides in the park and consist of limestone and chert. Underneath the limestone and chert are rocks that formed from the Ordovician to the Devonian Periods around 465 to 360 million years ago. These rocks consist of shale, sandstone, and dolostone that formed when northern Arkansas was covered by a shallow sea.

All of the rocks exposed in the park are sedimentary rocks. They are rocks made up of grains of minerals and fragments of other rocks that range in diameter from less than a millimeter to several millimeters. In some rocks, grains are visible with the naked eye such as sand grains in sandstone, but in chert you will need the help of a magnifying glass, hand lens, or even a microscope to see the tiny grains. Limestone is composed of the mineral calcite (chemical composition: $CaCO_3$). Chert is composed of very tiny grains of the mineral quartz (chemical composition: SiO_2). Sandstone in this area consists of grains of quartz sand (SiO_2). Dolostone is a calcium, magnesium carbonate (chemical composition: $Ca\,Mg(CO_3)_2$) similar in composition to a limestone, but is made up of the mineral dolomite. Shale is a thinly layered rock made up of very small grains of clay and mud.

GEOLOGIC FORMATIONS IN THE PARK

The most widely exposed rock layers in the park are limestone and chert. Geologists classify rock layers as named formations, or a body of rock largely composed of one or more rock types. The first part of the formation name comes from the location in which the rock unit was first described (Clifty Formation from Clifty, Arkansas; Chattanooga Shale from Chattanooga, Tennessee; Boone Formation from Boone County, Arkansas). The second part of the name usually comes from the dominant rock type in which the formation is composed such as Chattanooga Shale. The Boone Formation is composed of two rock types; therefore, it is more generalized and called the Boone Formation.

There are five formations within HSP-CA: (from oldest to youngest) Powell Dolomite, Clifty Formation, Chattanooga Shale, Boone Formation, and Batesville Sandstone (Fig. 2). Both the Boone Formation and the Batesville Sandstone consist of one or more rock types. The St. Joe Limestone and Hindsville Limestone are members, or subdivisions, of the Boone Formation and the Batesville Sandstone, respectively.

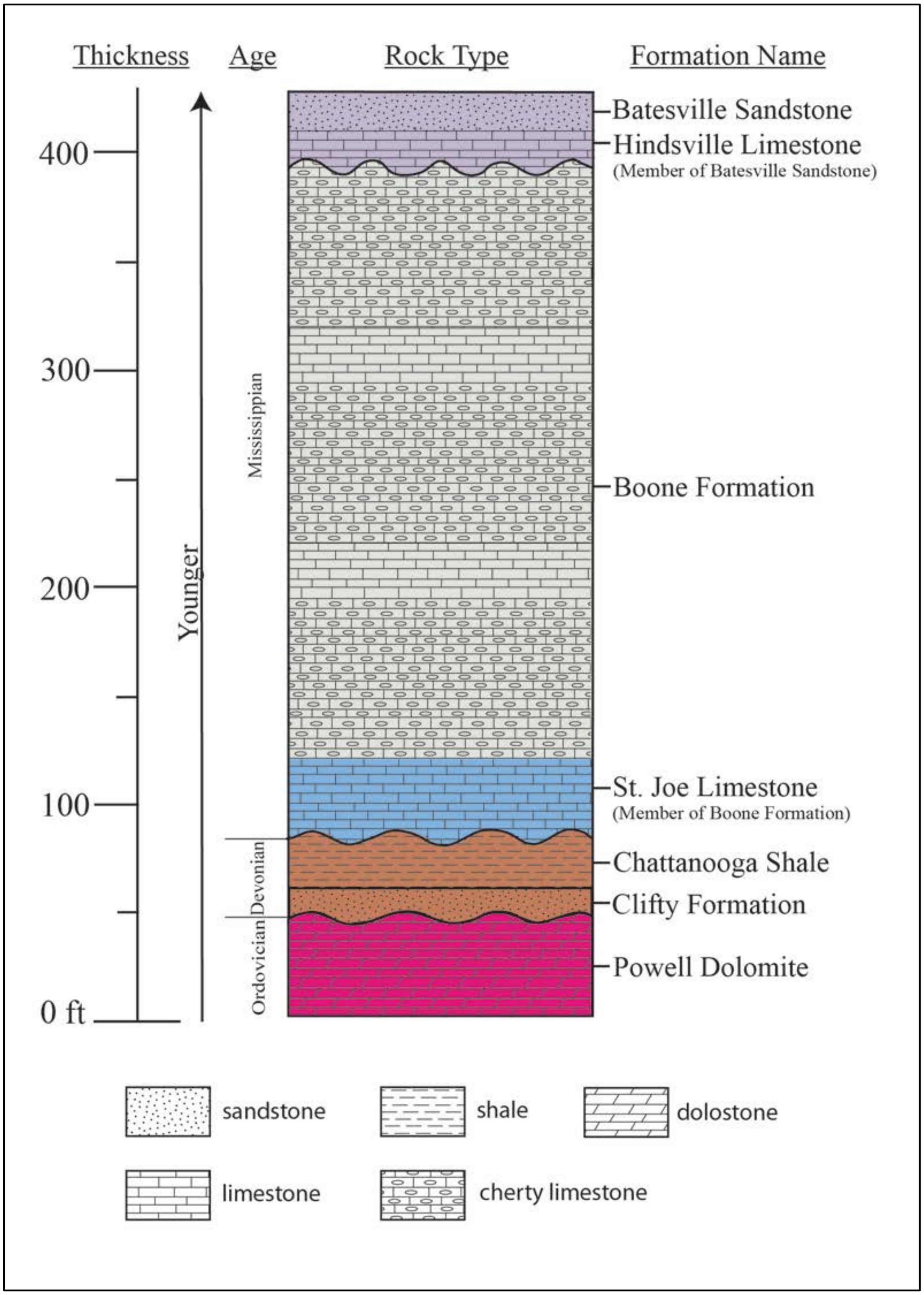


Figure 2. Stratigraphic column of the geologic formations present at Hobbs State Park-Conservation Area.

The **Powell Dolomite** is the oldest formation within the park (479-472 million years old) and present only along the fingers of Beaver Lake in the extreme northern sections of the park. Although the formation is called dolomite (the mineral name), the rock is actually a dolostone (Fig. 3A). The Powell is light gray and approximately 60 feet thick.

The **Clifty Formation** (393-383 million years old) is a light gray to orange sandstone ranging in thickness from 4 to 10 feet in the park (Fig. 3B). The Clifty is only present along fingers of the lake in extreme northern sections of the park.

The **Chattanooga Shale** (372-359 million years old) is black, brittle shale that breaks down, or weathers, into very thin flakes (Fig.4A). Since shale breaks down relatively quickly into tiny flakes, gentle slopes are formed, usually covered by vegetation. In the park, gentle slopes along with very dark soils are indicators that you are walking on the Chattanooga Shale. The average thickness of the Chattanooga is 30 feet.

The **Boone Formation** (359-331 million years old) is the thickest formation in the park at 250 feet. The Boone is composed mostly of layers of light-gray to buff-colored chert and light-gray limestone (Fig. 4B). Chert weathered from this unit is the dominant rock that is visible along the trails and in the park.

The **St. Joe Limestone** (359-347 million years old) is the basal member of the Boone Formation. The St. Joe is a light-gray limestone that is a prominent bluff former (Fig. 5A and B). It contains many fossils so it is classified as a fossiliferous limestone. Crinoids are common fossils found in the St. Joe and are described in more detail in the **Fossils in the Park** section of this publication. In the park, the St. Joe is approximately 40 feet thick.

(A) (B)

Figure 3. (A) Powell Dolomite exposed along Beaver Lake. (B) Sandstone in the Clifty Formation exposed along Beaver Lake.

(A) (B)

Figure 4. (A) Chattanooga Shale exposed at Slate Gap. (B) Boone Formation exposed along War Eagle Creek.

(A) (B)

Figure 5. (A) St. Joe Limestone exposed along Beaver Lake on Pigeon Roost Trail. (B) St. Joe Limestone exposed along Beaver Lake on Bashore Trail.

The youngest unit in the park is the **Batesville Sandstone** (331-323 million years old) located on the eastern side of the park. The Batesville is very fine-grained sandstone that is light brown to gray in color and is about 15-20 feet thick (Fig. 6B). A small 20 foot section of the **Hindsville Limestone Member** is present at the base of the Batesville Sandstone (Fig. 6A). The Hindsville is a thin-bedded, light-to dark-gray, fossiliferous or oolitic crystalline (visible calcite crystals) limestone that usually releases a strong petroliferous odor (smell of oil) once broken.


(A)


(B)

Figure 6. (A) Hindsville Limestone along Highway 127 near the community of Rock. (B) Sandstone float of the Batesville Sandstone near the Fayetteville Fault.

GEOLOGIC HISTORY

The geologic history of the area is shaped by the rise and fall of an ocean that once covered the area. Sea level lowered, or regressed, and rose, or transgressed, many times throughout its history. This changing sea level controlled the type of rock that eventually developed in the area. The geologic history is divided into two main periods of marine transgression that formed the rocks seen in the area today: Ordovician and Devonian Seas, and Mississippian Seas.

The Ordovician and Devonian Seas

In the Ordovician Period, around 472 million years ago, Arkansas was part of a much larger land mass called Laurentia that was covered by a large shallow sea. Carbonate mud, a clay-sized sediment that contains calcite, was deposited and eventually lithified creating the Powell Dolomite. This formation started out as limestone, but magnesium-rich water flowed through the area changing the calcite to dolomite, a process called dolomitization. After the Powell was deposited and sea level regressed, it was exposed to weathering and erosion. An extensive karst surface developed during this time creating depressions or sinkholes at the top of the Powell. This resulted in an unconformity or gap in the geologic record at the top of the Powell. In other places throughout northern Arkansas, younger Ordovician- and Silurian-aged units were deposited upon the Powell Dolomite, however in northwest Arkansas these units never were deposited or they were weathered away after deposition.

In the Devonian Period, around 390 million years ago, after karst developed on the Powell, sand was brought into the area from the north (Great Lakes region) by rivers. As the sea advanced again, it spread the sand over the area filling in the depressions and forming a thin deposit known as the Clifty Formation. The sand that filled the sinkholes lithified into sandstone masses now called paleokarst since the karst features that formed them developed millions of years ago (see **Paleokarst** section). Present day weathering and erosion of the surrounding dolostone has exposed these masses along the shoreline of Beaver Lake.

Later in the Devonian Period, the sea eventually deepened and organic-rich clay accumulated. Pyrite precipitated in the sediment due to low amounts of oxygen and eventually formed nodules. Finally, the clay lithified into shale called the Chattanooga.

Mississippian Sea

In the Mississippian Period, around 360 million years ago, the sea became shallow again and a continental shelf or ramp was present that extended from northern Missouri and deepened southward. Animals such as crinoids, bryozoans, corals, and brachiopods lived on this shallow shelf. After the animals died, their bodies were broken into fragments during transport down the ramp where they eventually became part of a fossiliferous limestone called the St. Joe Limestone Member of the Boone Formation.

As sea level rose and the ocean deepened, limestone was still forming due to fossil material, however, silica or quartz was also introduced. It is thought the silica may have come from ash blown into the area from volcanoes that formed south of what is now Arkansas at the beginning of the mountain building event that created the Ouachita Mountains. Silica also came from organisms living in the ocean whose shells were made of quartz. The silica replaced portions of the limestone and formed nodules and beds. The rock unit that contains limestone and interbedded chert is called the Boone Formation. After deposition of the Boone Formation, sea level lowered and the top of the Boone was exposed to weathering which created another unconformity in the rock record.

Sea level eventually rose and a shoreline developed surrounding northwest Arkansas. The sea covering the area was shallow and marine animals were abundant. Small round grains called ooids developed due to wave action along the shore. The fossils and ooids eventually formed the Hindsville Limestone. Sea level fell again, and a river system developed northeast of the Batesville, Arkansas area that created a delta that carried sand into northwest Arkansas. This sand lithified to form the Batesville Sandstone.

THE FORMATION OF KARST

The Ozarks have been exposed to weathering since the ancient ocean regressed or lowered in the Pennsylvanian Period around 300 million years ago. Since that time, a karst landscape and plateau surfaces have formed in the area. A karst landscape refers to features that develop when rock, such as limestone or dolostone, is dissolved by naturally acidic rain and groundwater. Rain water becomes acidic by absorbing carbon dioxide to create carbonic acid as it falls through the atmosphere. As it passes through the soil horizon, it becomes even more acidic and is called groundwater. As it continues to move downward, through fractures (cracks) and open spaces within the rock below, it dissolves the rock along these natural pathways through a process called chemical weathering (Fig. 7A). As the process continues, those spaced enlarge until they are connected (Fig.7B). When groundwater meets an obstruction such as a rock that it cannot dissolve, or reaches the water table, the flow changes from vertical to horizontal.

(A) (B)

Figure 7. (A) St. Joe Limestone showing fracture system along with a small conduit. (B) St. Joe Limestone that has been solutioned or dissolved in a creek bed.

Features of karst landscapes include springs, caves, sinkholes, disappearing and reappearing streams, and dry valleys or drainages. All of these features are present in the Ozarks and at HSP-CA. Water travels underground until it emerges at a low point along a creek or on a hillside as a spring. The majority of springs are located in the Boone Formation, either at the base or within the St. Joe Limestone (Fig. 8A). Sinkholes are formed when water dissolves the rock at or below the ground surface creating a depression. All of the sinkholes recorded for this project are located within the Boone Formation (Fig. 8B). Several sinkholes started as enlarged fractures in the top of the St. Joe Limestone. Many caves are also present in the area, all of which, recorded for this project are present in the St. Joe Limestone, the fairly chert-free basal member of the Boone Formation (Fig. 9A). Dry streams and valleys are abundant on the tops of the hills composed of the Boone Formation (Fig. 9B). This unit is highly fractured which allows water to travel underground until it flows to the surface as a spring.


(A)


(B)

Figure 8. (A) Small spring in the St. Joe Limestone. (B) Sinkhole in the Boone Formation along Pigeon Roost Trail.


(A)


(B)

Figure 9. (A) Small solutioned bluff-shelter at the base of the St. Joe Limestone. (B) Dry stream valley in Van Winkle Hollow.

Paleokarst

Paleokarst is karst features that formed in the geologic past and were preserved in the rock record. Paleokarst is represented in the area by large sandstone masses protruding out of the lake or near the edge of the lake. Some stand tall like towers while others appear to be irregular to rounded masses.

These sandstone masses started out as sand that was deposited in the area on top of a karst surface. Around 470 million years ago in the Ordovician Period the Powell Dolomite was deposited in northwest Arkansas. After sea level dropped, or regressed, it was exposed to weathering and sinkholes developed on the exposed land surface. Later, sand filled the depressions and younger geologic formations were deposited on top. Weathering and erosion of the surrounding rock have now exposed these features (Fig. 10 A and B).

(A)

(B)

Figure 10. (A) Sandstone paleokarst cylinder along Beaver Lake. (B) Sandstone paleokarst mass in Rocky Branch swimming area.

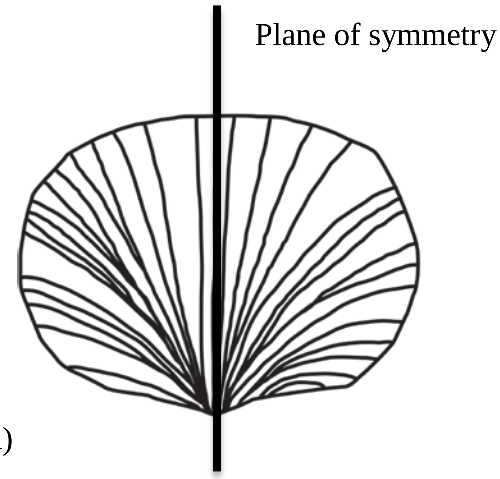
FOSSILS IN THE PARK

Several marine animal fossils such as brachiopods, bryozoans, crinoids, and trilobites can be observed within the park. Traces or tracks of marine organisms are also preserved in the park. These include horizontal and vertical worm burrows and a feeding trace called *Zoophycus*. The presence of these marine animals further supports that these rock formations were deposited in a marine environment.

Marine Invertebrates

Brachiopods (Brachiopoda) are invertebrates characterized by having two bilaterally symmetrical valves, meaning that the shell is a mirror image when split in half perpendicular to its hinge (Fig.11A). Brachiopods range in age from the Cambrian Period (541 million years) to present day. The majority of brachiopods preserved in the park are in the Boone Formation (Fig. 11B).

Bryozoans (Bryozoa) are invertebrate animals that live on the ocean floor as filter feeders. They are characterized by exhibiting colonial growth with a branching, net-like skeleton. There are many different varieties of bryozoans. The most common variety in the park is a fenestrate bryozoan with many “branches” joining together to form a net-like shape (Fig. 12A). Bryozoans range in age from Ordovician (485 million years ago) to present. They are preserved in the Boone Formation (Fig. 12B).



(A)

(B)

Figure 11. (A) Brachiopod drawing showing plane of symmetry. (B) Brachiopod fossils in the Boone Formation.

(A)

(B)

Figure 12. (A) Fenestrate bryozoan illustration of branches that join together to form a net-like shape. (B) Fenestrate bryozoan external mold in a sample of chert from the Boone Formation.

Crinoids (Echinodermata) are invertebrate animals that also live on the ocean floor as filter feeders. Crinoids are attached to the sea floor by the "root" or holdfast that is attached to a flexible stem, or columnals (Fig. 13A). The calyx is attached to "arms" or the crown that extends radially and captures food. The columnals are typically what are preserved as fossils; the holdfast, calyx, and crown are rarely preserved. Crinoids lived long ago in the Ordovician (485 million years ago) and are still living today. It is rare to find a complete crinoid fossil in the rocks in the Ozarks. Fragments of the columnals and arms, or their molds, are commonly preserved in the Boone Formation (Fig. 13B).

(A) (B)

Figure 13. (A) Crinoid diagram and crinoid columnals in the St. Joe Limestone. (B) Crinoid columnal molds in chert within the Boone Formation.

(A) (B) Left

Figure 14. (A) Trilobite drawing showing the three body segments. (B) Trilobite head (cephalon and upper thorax) with two eyes visible and pygidium. Both fossils are the size of a fingernail.

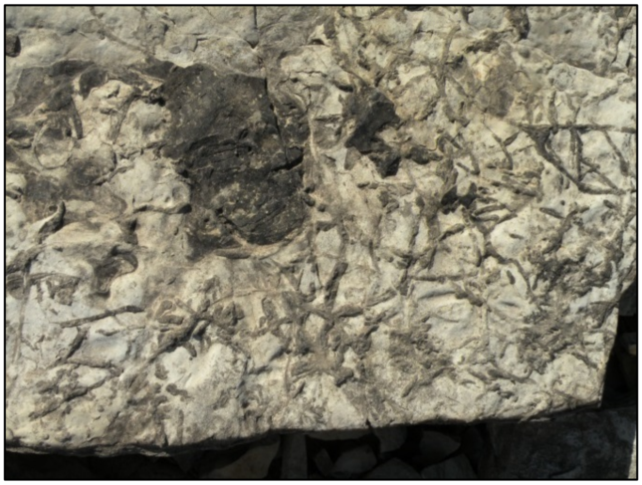
Trilobites (Arthropoda) are extinct marine animals that lived as predators, scavengers, or filter feeders. They are characterized by having an outer skeleton divided into the cephalon (head), thorax (middle), and pygidium (tail) (Fig. 14A). It is rare to find a complete trilobite in Arkansas. The tail portion is typically found (see Fig. 14B).

Trace Fossils

Trace fossils are the tracks or trails of animals as they moved, burrowed, or searched for food in sediment. Trace fossils in this area consist mostly of horizontal traces but vertical traces are present as well. As animals move across the surface of sand or mud looking for food or just crawling around, they leave horizontal and vertical trails. These types of traces are referred to as moving, resting, and feeding traces.

Various horizontal traces are thin to thick tubes made by worms moving through the sediment. These traces are called *Planolites* and *Paleophycus* (Fig. 15A and B). Other horizontal traces appear as flat feathery spiral patterns that are called *Zoophycus* (Fig. 16A).

Almond-shaped traces are called *Lockeia* and are the resting trace of a bivalve. Vertical tubes resembling icicles are called *Skolithos* and are the dwelling structures of worms (Fig. 16B).



(A)

(B)

Figure 15. (A) *Planolites* traces in the Powell Dolomite. (B) *Paleophycus* traces in sandstone of the Clifty Formation.

(A)

(B)

Figure 16. (A) *Zoophycus* traces in sandstone of the Clifty Formation. (B) *Skolithos* traces in sandstone of the Clifty Formation.

GEOLOGIC TRAIL MAPS

The trails at HSP-CA offer a variety of geologic features to be observed. The state park contains many karst features including spectacular paleokarst. Look closely at rock outcrops to determine rock type, fossils content, and formation. To aid in the search, use the trail maps on the following pages. On these maps are locations with pictures showing wonderful examples of the features discussed in this publication. Next time you visit Hobbs State Park-Conservation Area, you can look at it in a whole new way- with a geologist's eye!

For more information contact:

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