OKLAHOMA

GEOLOGICAL SURVEY GUIDE BOOK XV

ALABASTER CAVERN

AND WOODWARD COUNTY

OKLAHOMA GEOLOGICAL SURVEY

CHARLES J. MANKIN, *Director*

GUIDE BOOK XV

Guide to

Alabaster Cavern and Woodward County, Oklahoma

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The cover illustration, a scene typical of the frenzied starts of the runs that settled Oklahoma, is from a painting signed simply T. E. S., 1926, of "The Run" (1889), from the Western History Collections of the Division of Manuscripts, The University of Oklahoma Library.

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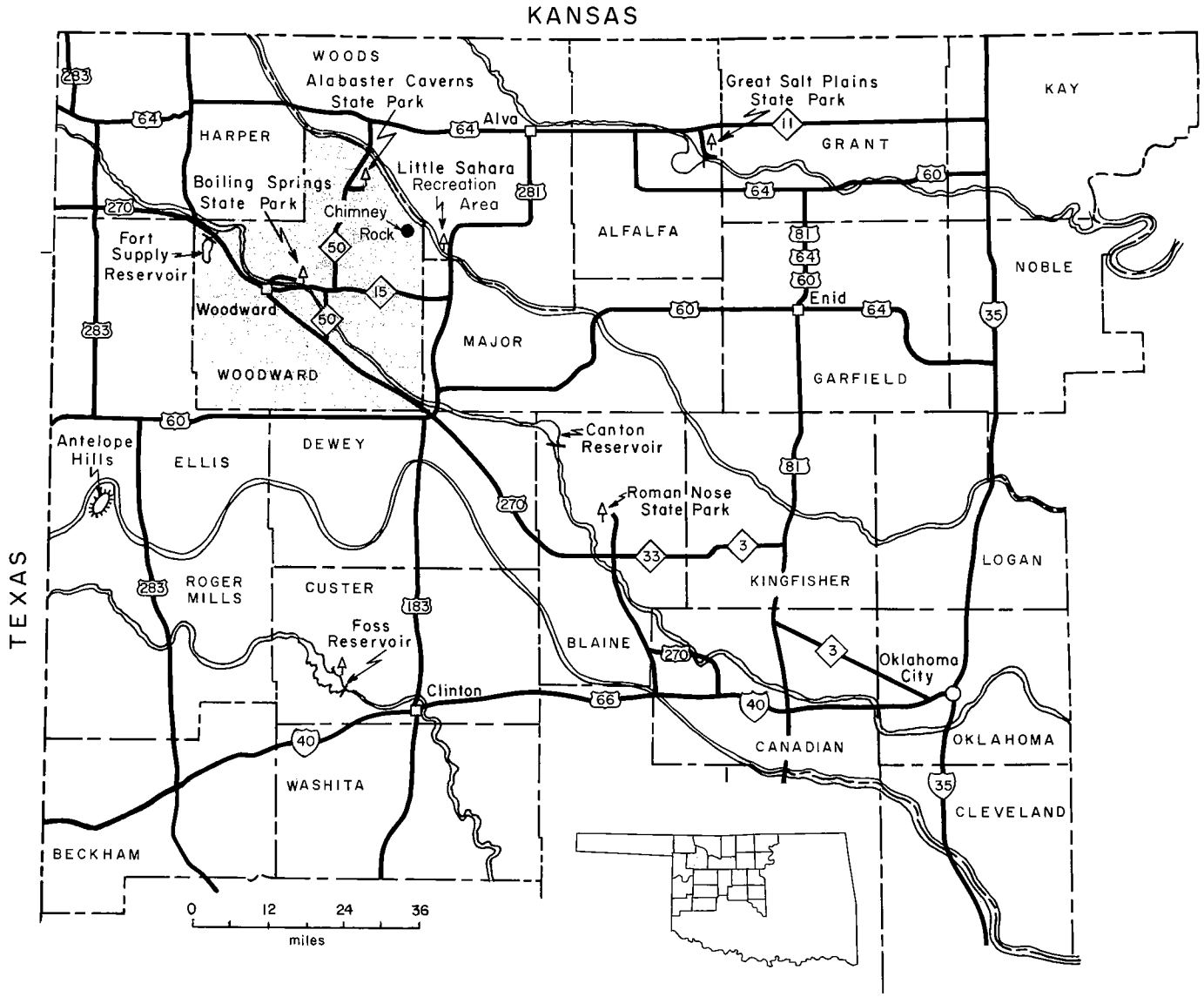

Figure 1. Map of northwestern Oklahoma showing routes of major highways and locations of state parks, reservoirs, and scenic areas. Shading shows location of Woodward County.

ALABASTER CAVERN

WOODWARD COUNTY

INTRODUCTION

The history of the Old West is reflected in Woodward County, where names such as General George Armstrong Custer, Black Kettle, and Temple Houston were alternately cursed and cheered as each left his mark on the land. Once part of the Cherokee Outlet (sometimes incorrectly referred to as the Cherokee Strip), the county was opened for settlement in the last mad scramble for land in the Run of 1893. Overnight, towns sprang up as men fought and died to own a plot of land; Woodward, county seat and principal city, acquired a population of 5,000 people between noon and sunset of September 16, 1893 (Ruth, 1957).

Today things have calmed down considerably, and the county now boasts several interesting, but relatively quiet, recreational facilities, foremost of which is Alabaster Caverns State Park. This picturesque feature of geologic development has one of the largest known gypsum caves in the world, extending more than half a mile underground. Guided tours take the visitor through tunnels of gleaming white gypsum, pink alabaster, and sparkling crystals of selenite, with names such as "Cathedral Dome," "Devil's Bathtub," and "Gun Barrel Tunnel." The cavern's most noteworthy inhabitants, the bats, often fly out of the cave in great clouds between sunset and dusk during the summer. Facilities for picnicking, hiking, and riding are near the cavern, and the park also includes scenic Cedar Canyon, with its 30-foot-high natural bridge carved from gypsum. The famous Oklahoma landmark, Chimney Rock, is also near the park.

Boiling Springs State Park, southwest of the cavern area, affords the visitor the only heavily timbered area within 100 miles. The rushing springs supply a 4-acre lake and a swimming pool, and facilities for picnicking, camping, boating, swimming, and fishing are readily available.

Northwest of Boiling Springs is Fort Supply Public Hunting Area with approximately 5,500 acres of land. Some of the best quail hunting in the State is found here. Fort Supply Reservoir, nearby, provides fishing, boating, swimming, and camping facilities.

Within the city of Woodward is Crystal Beach Park, site of the annual Woodward Elks Rodeo that is held four days before Labor Day and is approved by the Rodeo Cowboys Association of America.

Figure 1 shows the major highways and the locations of State parks and recreation areas and other points of interest in northwestern Oklahoma, and the people welcome you to enjoy the recreational facilities, scenic beauty, and historic past that make Woodward County one of northwestern Oklahoma's most attractive vacation areas.

Woodward County recreation areas: Boiling Springs State Park, Alabaster Cavern, and Chimney Rock.

GEOLOGY OF THE ALABASTER CAVERN AREA

ARTHUR J. MYERS*

The Earth is composed of inorganic chemical substances, called minerals, that form mixtures called rocks. At the surface the rocks are generally covered by a veneer of soil, vegetation, and water and can be seen only where the veneer is missing. Because of the semiarid climate of western Oklahoma, the veneer is thin or missing and much of the bedrock is exposed in large parts of Woodward County. Most of these rocks are buff, brown, red, and reddish gray; however, some are white, gray, or green. Their exposures (outcrops) frequently display vivid hues.

Whereas we commonly think of rocks as permanent, everlasting features, in truth they are being constantly changed, first by erosion, which destroys them, and subsequently by deposition, which reconstitutes them in a new form at a different place. It is the process of erosion that has sculptured the landforms, the plains, hills, and valleys, that characterize the scenery of Woodward County and has created the caves of Alabaster Caverns State Park.

ORIGIN OF ROCKS

For convenience, geologists have subdivided geologic time somewhat as a year is divided into months, weeks, and days. The largest units are eras, which are subdivided into periods, which are further subdivided into epochs. Figure 2 shows the geologic time scale as compared to a calendar year.

Shallow epeiric seas (inland seas), such as the present-day Hudson Bay, have invaded parts of the continents at various times in the geologic past. Rivers flowing into these seas transported sand, silt, and dissolved mineral matter that were spread out in layers by waves and currents. Rocks formed from sediments in this manner are sedimentary rocks.

The most characteristic feature of a sedimentary rock is its stratification; in other words, it consists of layers, which are called beds or strata. When deposited, the beds are essentially horizontal. The one at the lowest level, the first one laid down, is the oldest, and each successive overlying bed is younger than the one below. A unit of rock of the same rock type is called a formation. Formations are in most cases named for localities where they were first studied and described.

Sedimentary rocks, classified on the basis of texture (size of the mineral grains) and/or mineral compo-

	GEOLOGIC PERIOD	GEOLOGIC EPOCH	BEGINNING (MILLION YEARS AGO)	COMPARATIVE DATE DAY	HR	MIN	SEC
CENOZOIC	Quaternary	Recent	.01	December 31	23	58	50
		Pleistocene	1	December 31	22	03	12
	Tertiary	Pliocene	12	December 31	0	38	24
		Miocene	23	December 30	3	13	36
		Oligocene	35	December 29	3	52	
		Eocene	55	December 27	12	56	
		Paleocene	70	December 26	7	44	
MESOZOIC	Cretaceous		135	December 21	1	12	
	Jurassic		180	December 17	9	36	
	Triassic		220	December 14	3	44	
PALEOZOIC	Permian		270	December 10	2	24	
	Pennsylvanian		320	December 6	1	04	
	Mississippian		350	December 3	14	40	
	Devonian		400	November 29	13	20	
	Silurian		430	November 27	2	56	
	Ordovician		490	November 22	4	37	
	Cambrian		600	November 13	16	00	
	Precambrian		4,500	January 1	0	00	

Figure. 2. Geologic time scale compared to a calendar year.

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sition, are either clastic or nonclastic rocks. Clastic rocks consist of other rock (or fossil) particles that have been transported. A sandstone is a cemented sediment composed predominantly of sand-sized quartz grains. Shale is a laminated sediment in which the constituent particles are predominantly of the clay grade (less than 0.00015 inch in diameter). The sandstones and shales of Woodward County are primarily red because the grains are covered with a thin coating of iron oxide.

Nonclastic rocks form when dissolved mineral matter is precipitated on the sea floor. Limestone, composed of the mineral calcite, is the most common and is currently being precipitated at such places as in the seas around the Bahama Islands. Limestone of this type can be broken down (by weathering and/or erosion), transported, and redeposited; it is then a clastic limestone. When the loss of water by evaporation from the sea is greater than the amount brought to it by rivers, dissolved mineral matter is precipitated on the sea floor. Such deposits, called evaporites, include dolomite, gypsum, and salt (the mineral halite).

Salt is not found at the surface in the Woodward County area except as salt springs and salt flats along the Cimarron River. However, in the subsurface are several hundred feet of salt within 2,000 feet of the surface, and some of the salt beds are within 40 feet of the surface. As a result of shallow circulation of ground water (water below the surface of the Earth), the salt is dissolved and brought to the surface at salt springs. After long dry periods the water of the Cimarron River may become so saturated with salt that salt crystals are precipitated.

Gypsum is normally white, but, because of impurities, it may be shades of gray, red, or green. It is so soft that it can be scratched with the fingernail. Three varieties of gypsum are: (1) alabaster, a fine-grained massive variety that may be white, pink, gray, or even black and can be polished and made into attractive objects of art; (2) selenite, which occurs as clear, colorless crystals; and (3) satin spar, the fibrous gypsum with a silky luster.

Anhydrite is a rock generally associated with gypsum. It cannot be scratched with the fingernail and is normally white to gray. The principal distinction between gypsum (hydrous calcium sulfate, $CaSO_4 \cdot 2H_2O$) and anhydrite (anhydrous calcium sulfate, $CaSO_4$) is the absence of water (H_2O) in the chemical composition of the latter. The addition of water to the crystalline structure of anhydrite will change it to gypsum and cause an increase in volume. This expansion causes the altered rock to pull away from the surrounding material, forming mounds, such as the one shown in figure 3.

Figure 3. Mound resulting from alteration of anhydrite to gypsum.

GEOLOGIC HISTORY

Geology is concerned primarily with the problem of Earth history, to discover the events that produced the geologic features seen today. It has been barely 200 years since many respected scientists believed that the Earth was only a few thousand years old. Today it is known that the age of the Earth is measured in billions of years, instead, and that the rocks at the surface today are the product of a long and complex series of events, some of which can be deduced by examination of the rocks and others by logical inference. As the surface rocks of Woodward County are all Permian in age, only a brief history is given here, beginning with the deposition of the Permian strata.

The name "Permian" is derived from the province of Perm in northeastern European Russia, where rocks of this age were first studied systematically in the early 1800's. The Permian Period began about 270 million years ago and lasted 50 million years. Although periods of geologic time may seem phenomenally long, they are quite brief in contrast to the antiquity of the Earth. This relative brevity is demonstrated by the tabulation shown in figure 2. In this tabulation the 4.5-billion-year history of the Earth is contrasted with a 365-day year, with the beginning dates of the various periods being assigned corresponding calendar-year dates. In these terms, the Permian period began a little less than 22 days ago and lasted only about 4 days.

Early in the Permian Period an epeiric sea extended from the Gulf of Mexico across Texas and Oklahoma into southeastern Nebraska and eastern Kansas. Today the sediments that were deposited in this sea form an extensive area of shale, sandstone, and thin limestone outcrops of Early Permian age across Texas, Oklahoma, and Kansas.

In early Middle Permian time, the sea was approximately 500 to 600 miles wide and extended across eastern New Mexico, western Texas, and western Oklahoma into Kansas. Eastern Oklahoma was a land area of low relief, and streams flowing from this area into the sea carried fine clastics that were deposited along the shores.

Sea level fluctuated repeatedly during parts of Permian time. While the rocks of the Blaine Formation were being deposited, world-wide rises of sea level deepened the Permian sea in Oklahoma and were followed by periods of stillstand before the sea level declined. During those periods when the sea level was static, evaporation of the water increased the concentration of dissolved solids and brought about the precipitation first of thin layers of dolomite and then thick layers of gypsum. As the sea level declined, the precipitated deposits were covered by shales. This cycle of rise, stillstand, and fall of the sea level occurred at least four times and produced the alternating succession of gypsum and shale that characterizes the Blaine Formation (figs. 4, 5).

Eventually all the water disappeared, and streams flowing into the basin spread hundreds of feet of red muds and sands over its desert floor. For a time, extensive sand dunes covered part of Oklahoma. In this latter period, short intervals occurred during which the sea returned and precipitation took place, as shown by beds of anhydrite and gypsum. The younger Permian rocks present in west-central Oklahoma

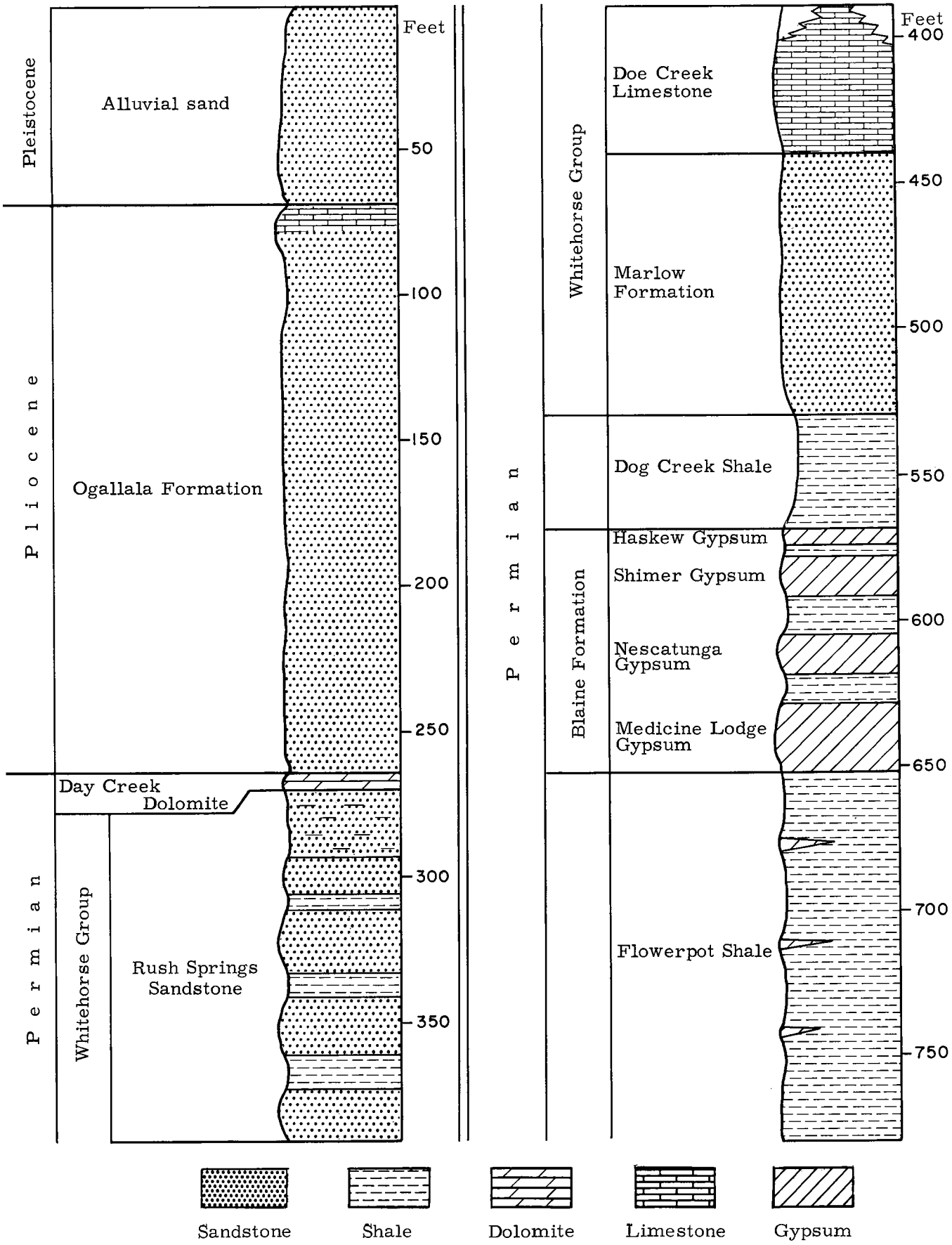


Figure 4. Composite columnar section of rocks in Woodward County.

consist of sandstones, shales, siltstones, gypsum, and anhydrite.

By the end of Permian time, more than 6,700 feet of clastic and evaporite sediments had been deposited in the area. The land was then raised above sea level, where it remained throughout the Triassic and Jurassic Periods. During Cretaceous time, most of the southern Midcontinent of the United States was inundated by a sea that probably also covered the area of Woodward County, but the rocks that were deposited in this part of Oklahoma were eroded away during the next period of uplift. Erosion continued to operate through most of the Tertiary Period until the Pliocene Epoch. During Pliocene and Quaternary time, streams covered the older rocks with about 200 feet of gravel, sand, and silt. Today we are still in the Quaternary Period, and the land is undergoing the cycle of erosion that has produced the present-day topography.

STRATIGRAPHY

In constructing a picture of the geology of an area, the geologist begins with an examination of the rocks in the field. He records such things as the thickness of rock layers, their color, the kinds of materials of which they are composed, their areal distribution, and their orientation (the direction in which they slope. From this information he compiles a detailed description of rock layers (formations), such as the following paragraphs of this chapter, a columnar section (fig. 4), and a geologic map, such as the one of Alabaster Caverns State Park (fig. 6).

Rock descriptions constitute that subdivision of geology known as stratigraphy. The stratigraphy of Woodward County is summarized by the columnar section in figure 4, which gives the name of each rock unit, its age, lithologic type, and average thickness.

The oldest formation exposed in Woodward County is the Flowerpot Shale, named for Flower-pot Mound in Barber County, Kansas. It consists primarily of red shale with thin interbedded layers and cross-cutting stringers of gypsum. The shale is relatively easily eroded and, as a result, cliffs or scarps are formed. An excellent exposure of the Flowerpot is along the south side of the Cimarron River near Freedom; in Alabaster Caverns State Park it can be seen in the lower part of Cedar Canyon. One of the more interesting topographic features of this formation is Chimney Rock, 8.5 miles southeast of the park (page 5).

Overlying the Flowerpot Shale is the Blaine Formation, named for Blaine County, Oklahoma. The Blaine Formation has four members, the oldest of which is the Medicine Lodge Gypsum, named for the Medicine Lodge River and the town of Medicine Lodge in Barber County, Kansas. The Medicine

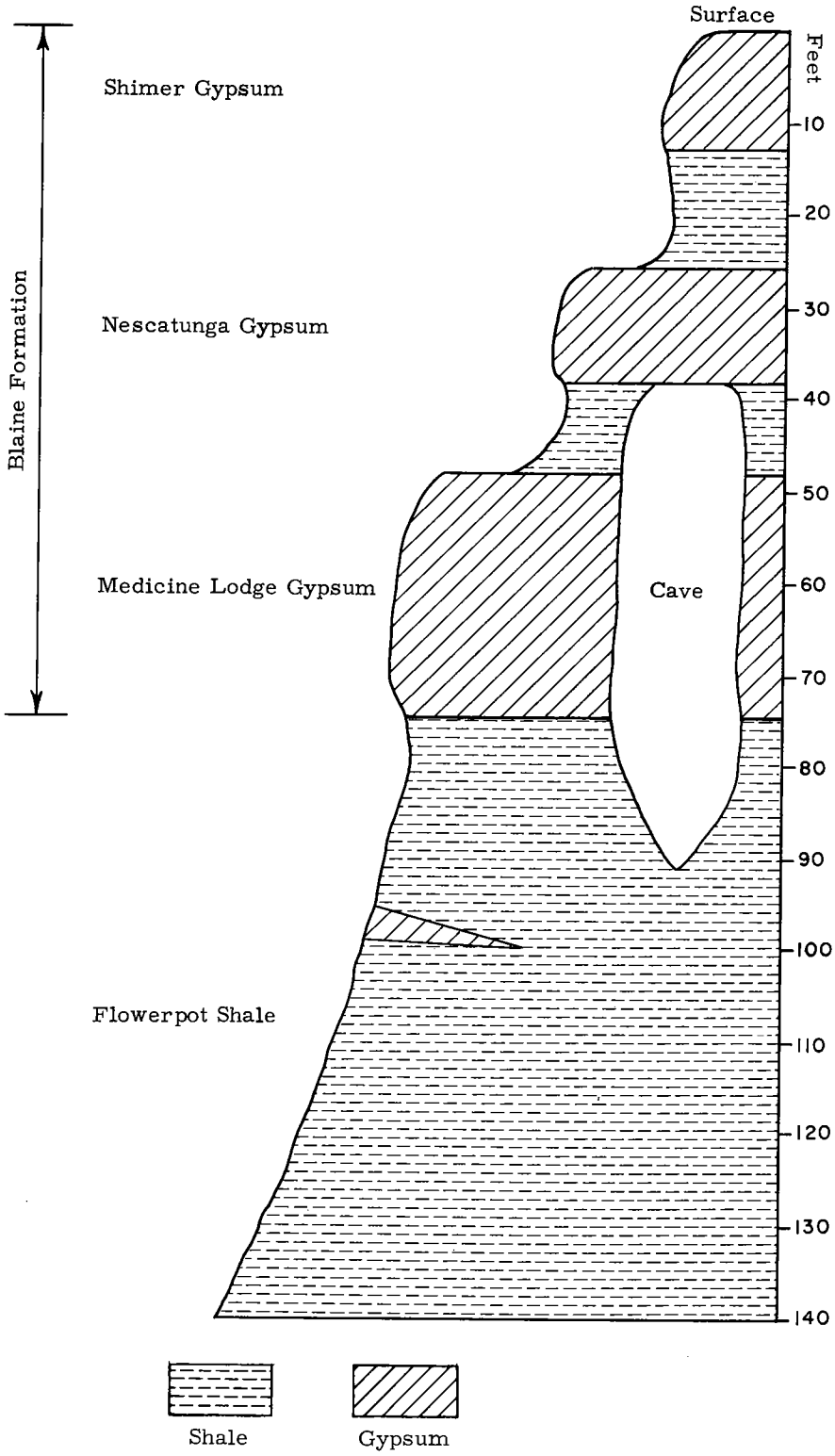


Figure 5. Stratigraphic level of Alabaster Cavern within the Blaine Formation.

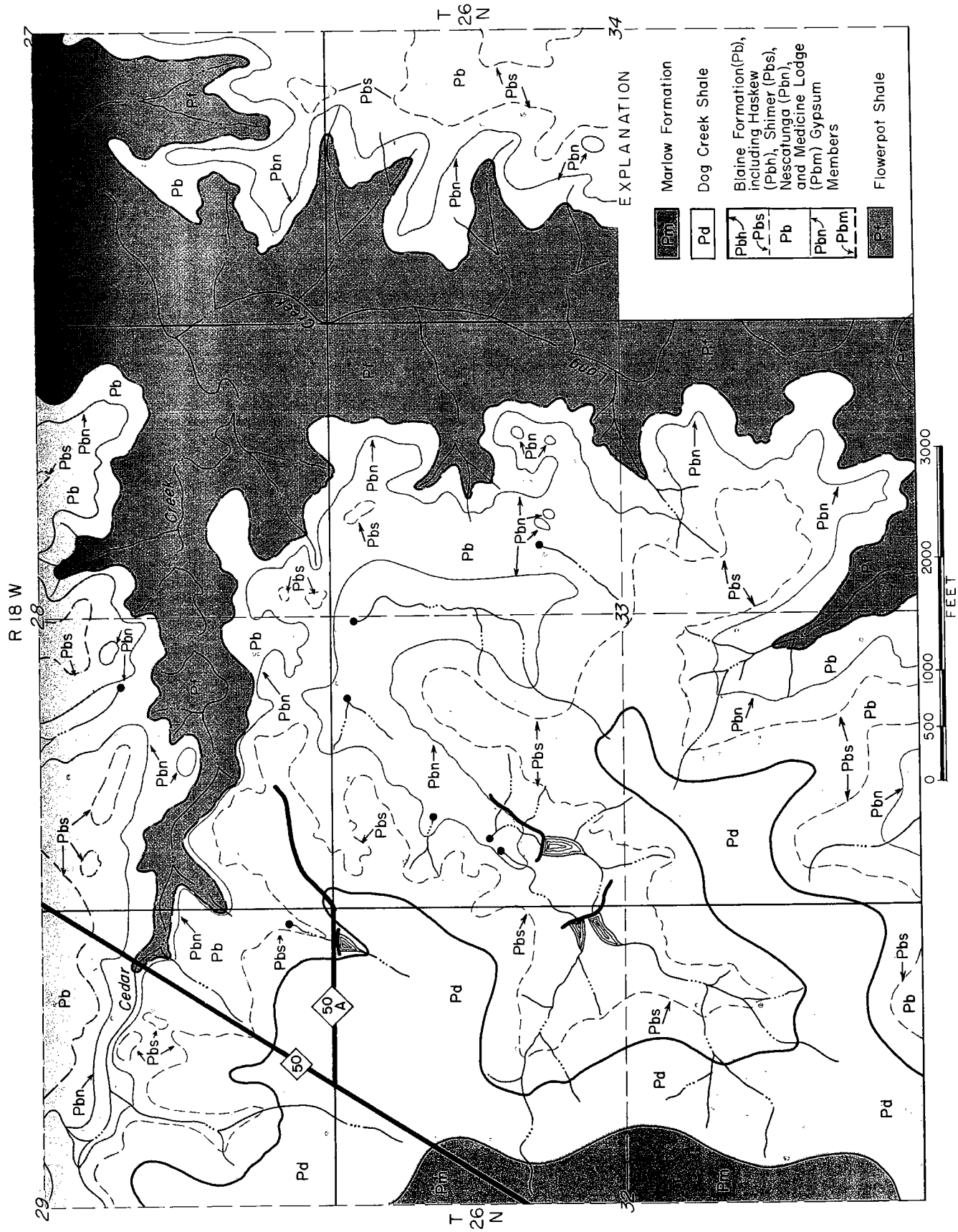


Figure 6. Geologic map of Alabaster Caverns State Park.

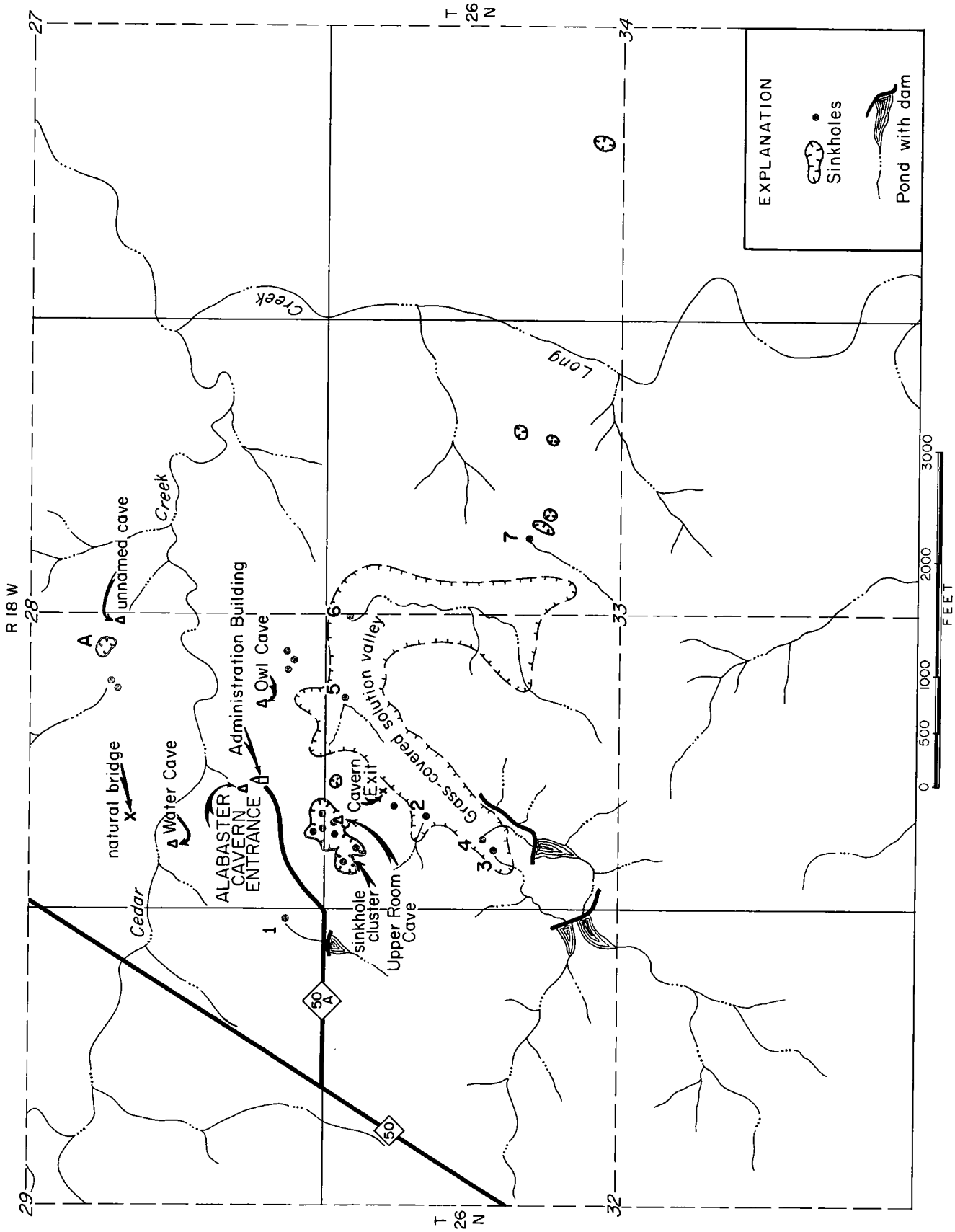


Figure 7. Map of karst features in Alabaster Caverns State Park.

Lodge Gypsum is approximately 25 feet thick, has a 1-foot-thick dolomite at its base, and is overlain by an unnamed shale, 13 feet thick. Resting upon the shale is the Nescatunga Gypsum (named for exposures along Nescatunga Creek in Comanche County, Kansas), which is 13 feet thick. It has a 1-foot-thick dolomite bed at its base and is overlain by 7 feet of unnamed shale. Above the shale is the 13-foot-thick Shimer Gypsum (named for Shimer township in Comanche County, Kansas), with a 2-foot-thick dolomite bed at its base. This gypsum is overlain by 4 feet of shale. At the top of the Blaine Formation is the 4-foot-thick Haskew Gypsum, named for a township in northwestern Woodward County.

The shales of the Blaine are easily eroded and, hence, form escarpments (cliffs); the gypsum layers are resistant and form a series of benches (ledges), and, as a result, the Blaine Formation appears as a series of steps along the sides of valleys. Figure 5 shows the stratigraphic level of Alabaster Cavern in the lower part of the Blaine Formation and illustrates the bench-forming gypsums in the park area. Figure 6 is a geologic map of the Alabaster Caverns State Park area.

Other Permian formations are visible south of the park along State Highway 50. The Dog Creek Shale, overlying the Blaine Formation, is identified by its maroon shales, with a 2-foot-thick, grayish-green shale near the top of the unit. The Marlow Formation, overlying the Dog Creek, consists of approximately 100 feet of fine-grained sandstone and forms a series of low, gently rolling hills. The Doe Creek Limestone fills channels cut into the Marlow. Much of the Doe Creek has been eroded away, but remnants of it form the series of hills east of Alabaster Caverns State Park. The Rush Springs Sandstone rests upon the Marlow and forms a high, steep-sided area west of State Highway 50. The Rush Springs buttes are capped by the Day Creek Dolomite.

The Pliocene Ogallala Formation is the white rock in southwestern Woodward County, and the Antelope Hills, inside the broad loop in the Canadian River in Roger Mills County, are composed of this same rock. The Pleistocene alluvial sand is the broad band north of the North Canadian River that is covered with sand dunes.

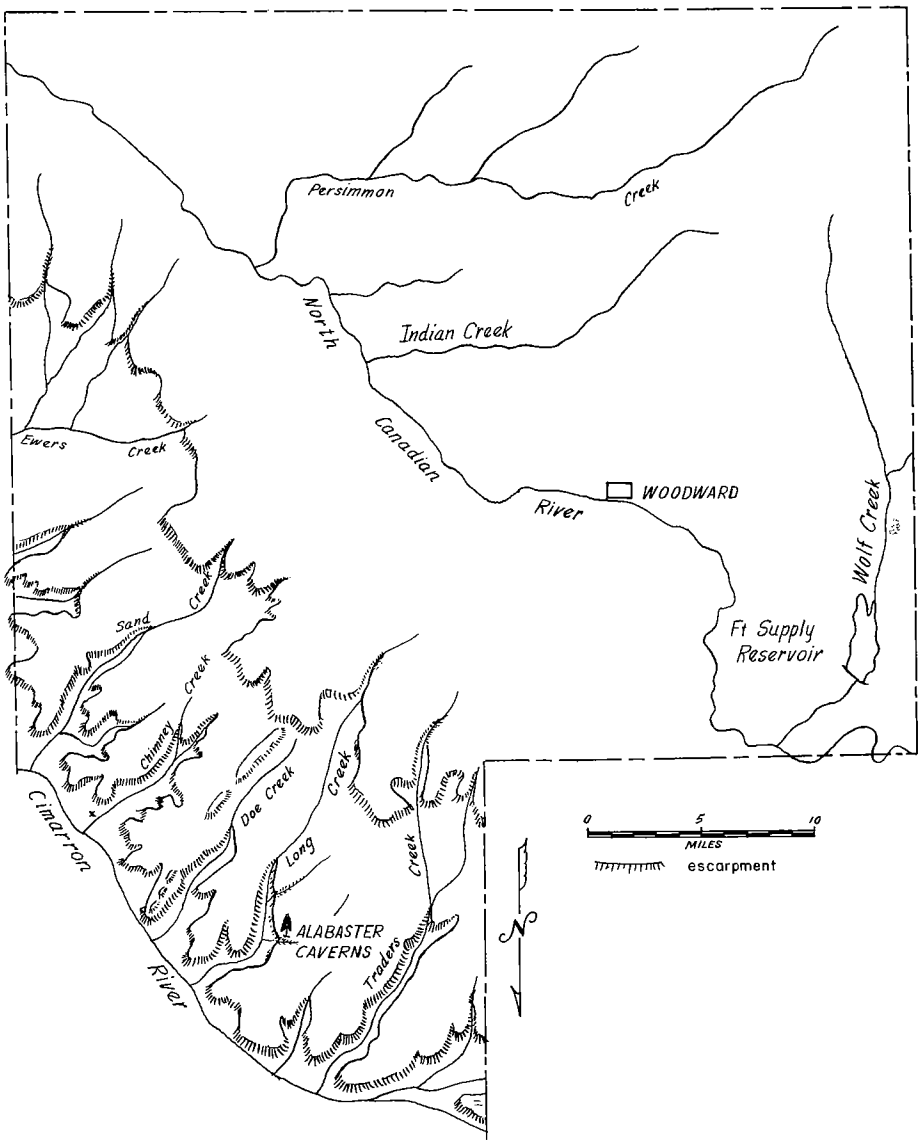


Figure 8. Physiographic diagram of Woodward County showing escarpment features of the area. Note that the map is oriented with north toward the bottom.

PHYSIOGRAPHY

Woodward County is bounded on the northeast by the Cimarron River. Southwest of the river are two northeastward-facing escarpments that parallel its course, the first near the edge of the river flood plain and the second about 10 miles southwest of the first. The first escarpment is formed by the gypsum beds of the Blaine Formation; the second is capped by the Rush Springs Sandstone. The Rush Springs escarpment, which has an average relief of 200 feet, divides the county into two plains, the higher one, above the escarpment, constituting about three-quarters of the county (fig. 8).

The lower plain along the Cimarron River is in the Cimarron Gypsum Hills physiographic province and includes the area of Alabaster Cavern. Most of this area is underlain by the Blaine Formation, but, below the Blaine escarpment, the Flowerpot Shale is also present. The area is highly dissected by northeastward-flowing tributaries of the Cimarron. Most of these tributaries, including Long Creek in Alabaster Caverns State Park, have narrow, steep-sided valleys, owing to the resistant gypsum beds of the Blaine.

The plain southwest of the Rush Springs escarpment includes parts of three physiographic provinces and is traversed from northwest to southeast by the North Canadian River, which is about 400 feet higher than the Cimarron River (fig. 9). The southwest quarter of the plain is in the High Plains province and is underlain by the Ogallala Formation of Pliocene age. Between the High Plains and the Rush Springs escarp-

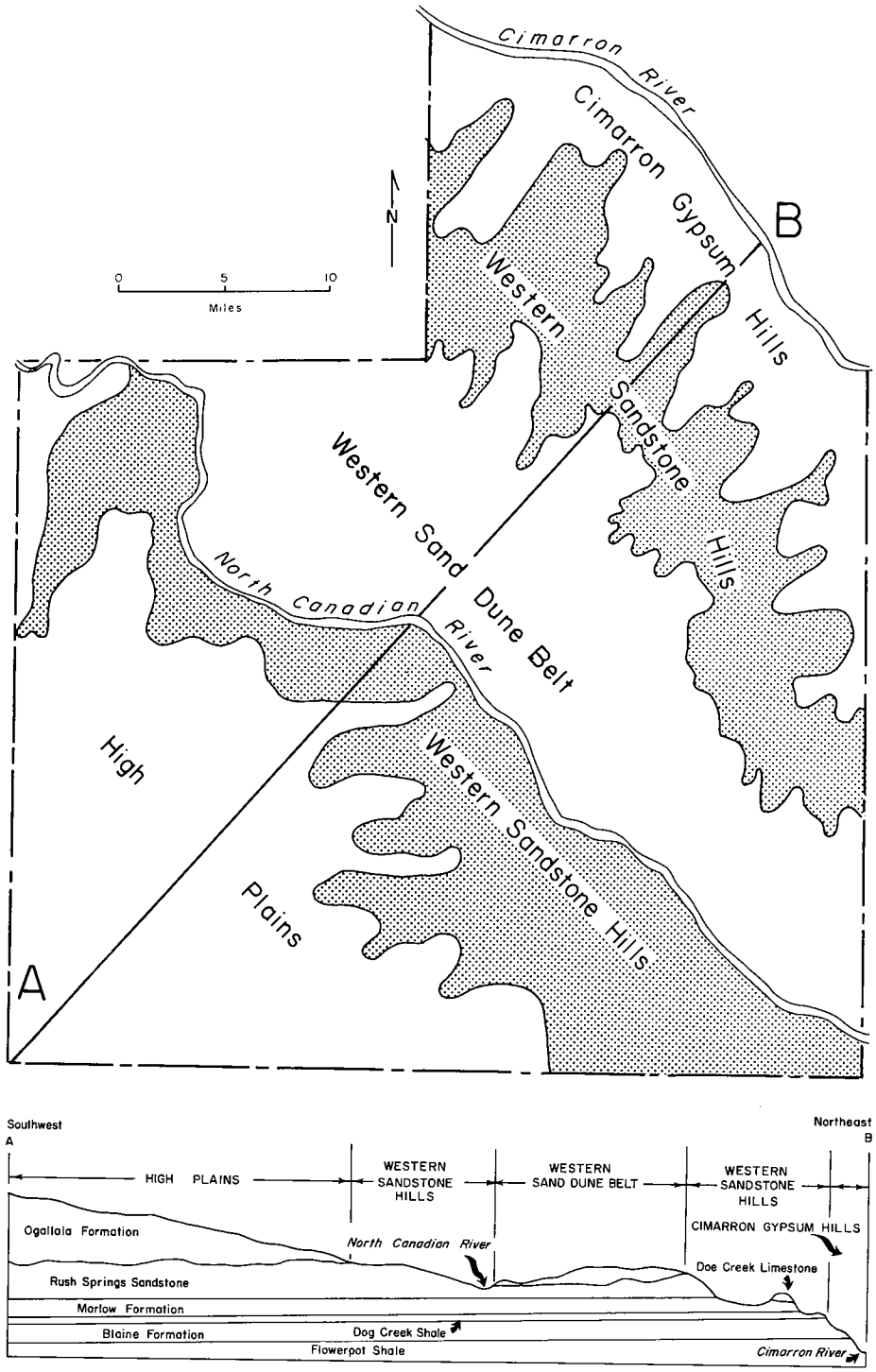


Figure 9. Map and schematic cross section showing physiographic provinces of Woodward County. Cross section follows line A-B on map.

ment, the larger part of the county, the plain is underlain by the Rush Springs Sandstone and isolated outcrops of the Day Creek Dolomite. This area is known as the Western Sandstone Hills physiographic province; it is divided into two parts by a segment of the Western Sand Dune Belts physiographic province on the north side of the North Canadian River. The sand-dune belt in Woodward County is formed on a Pleistocene stream deposit that marks the course of an ancient river.

The lower plain along the Cimarron River is of particular interest because it is the only area in Oklahoma that has well-developed "karst topography." Normally, karst regions develop in limestone terranes, as in the Karst region of Yugoslavia, for which this type of topography is named, but they can develop in areas underlain by gypsum or other easily soluble rock materials. Karst regions are characterized by features that result from the solution of rock, such as sinkholes, solution valleys, natural bridges, and caves. The few streams that form in karst regions are short and intermittent and drain into sinkholes. Thus the drainage is primarily underground, the water moving through subsurface channels to discharge as springs along major entrenched streams.

Four conditions are essential for karst development: (1) a soluble rock, such as limestone, dolomite, rock salt, or gypsum, must be present at or near the surface; (2) the rock should be dense, highly jointed, and preferably thin-bedded; (3) there must be entrenched major valleys below uplands underlain by these rocks; and (4) the area must receive at least a moderate amount of rainfall.

The Blaine Formation, although it contains four gypsum layers, is not ideally suited for karst development because the gypsum layers are interbedded with insoluble shales. However, the Cimarron River and its major tributaries have eroded their channels well below the level of the lowermost gypsum bed and thus provide the required drainage conditions. In Alabaster Caverns State Park, both Long Creek and Cedar Creek have eroded their channels into the Flowerpot Shale below the Blaine Formation, enabling numerous karst features to develop (fig. 7).

Sinkholes develop in two ways. Collapse sinks form when rock below the Earth's surface is dissolved and the overlying material collapses to form the depression. Solution sinks form when solution begins at the surface, normally along joints (fractures in the rock), and the sink becomes wider and deeper as the solution continues. Most of the sinkholes in the park appear to be solution sinks. In most cases, the rim of the sink is in a gypsum layer (either the Shimer or Nescatunga), the floor is in the underlying shale or next lower gypsum bed, and the sides are steep. The sinks range in diameter from 50 to 200 feet and have an average depth of 15 feet. A good example is a sink rimmed in the Nescatunga Gypsum on the north side of Cedar Canyon (sinkhole A,

fig. 7). More abundant than individual sinks are clusters of sinkholes that are a few hundred feet in diameter. These have irregular rims, and the floors are in most cases in the next lower gypsum. One such cluster overlies Alabaster Cavern (fig. 7).

Once a sinkhole forms, it becomes a natural route for the diversion of surface water to the subsurface. In some places the areas drained by such routes are the immediate areas of the sinkholes, but, in other cases, streams draining larger areas flow into sinkholes. As erosion by the stream and underground water continues, an enclosed valley, lower than the level of the surrounding area, is formed. Such a valley is called a solution valley, and an example is the one that includes sinkholes 2, 3, 4, 5, and 6 (fig. 7). The floor of this solution valley is in the Medicine Lodge Gypsum and the rim is in the Nescatunga Gypsum. Four intermittent streams drain into the sinkholes within this valley, two draining areas of more than 1 square mile.

One of the more interesting karst features to be found in the park area is the natural bridge (fig. 10) on the north side of Cedar Creek, northwest of the entrance to Alabaster Cavern. This bridge was formed by stream erosion undercutting a gypsum.

Caves form below the Earth's surface as a result of the removal of soluble rocks. Most caves, such as Carlsbad Caverns in New Mexico and Mammoth Cave in Kentucky, are in limestone, which is easily dissolved by water containing carbon dioxide. However, in Oklahoma and Texas many caves have formed in gypsum and anhydrite. There must be hundreds of hidden caves, because their presence can be discovered only if they are connected to the surface. Some caves have been found when the drilling bit used for drilling oil wells suddenly dropped several feet and the mud used in drilling the hole disappeared. A sinkhole, resulting from the caving in of a portion of the roof, is the most common connection with the ground surface; however, in some cases a downcutting stream will intersect a cave.

The karst region of Woodward County displays one feature that is derived from the chemical nature of gypsum, and hence is unknown in limestone karsts. As noted earlier, calcium sulfate has two forms, anhydrite and gypsum. The two minerals differ chemically only in regard to the presence or absence of water in the sulfate molecule. Anhydrite lacks water (it is anhydrous, hence the name), whereas each molecule of gypsum contains two molecules of water. Much of the Permian gypsum in Oklahoma was originally anhydrite, but, as erosion exposed the anhydrite to weathering, it combined with water to form gypsum. The change from anhydrite to gypsum by the addition of water increases the volume of the rock, and the consequent expansion causes the rock to form igloolike mounds (see discussion on page 7 and fig. 3). These mounds are as much as 3 or 4 feet in diameter and 1 foot high and are usually hollow, affording shelter for snakes and small animals.

This expansion can also be seen in the dome section of Alabaster Cavern, where the gypsum appears to be peeling away from the underlying rock along the sides of the cave (fig. 18).

Figure 10. Natural Bridge in Cedar Canyon, Alabaster Caverns State Park. (Courtesy of the Oklahoma Industrial Development and Park Department)

ORIGIN OF CAVES

Caves have been a focus of man's curiosity since the beginning of time. Man's first shelter was a cave, and, if we are to believe the pessimists, it may be his last. Among man's first great works of art are the wall paintings in the cave at Lescaux, France, executed by Cro-Magnon man more than 20,000 years ago. The famous Dead Sea Scrolls reposed for centuries in the silent security of caves, which their ancient custodians recognized as suitable repositories for their preservation and eventual recovery.

Yet despite our persistent interest in and long association with caves, their greatest mystery is that of their origin. We know only one thing with certainty—caves are formed by the removal of soluble rock by subsurface water. The detailed mechanics of the process, however, are not agreed upon by people who have studied the problem.

Water that occurs beneath the surface of the ground originates as rainfall. Although much of the rainfall runs off in streams or is returned to the atmosphere through evaporation or through transpiration of plants, a large amount infiltrates into the ground and moves downward, under the influence of gravity, as far as it can go. The water occupies the open spaces, or pores, within the rocks. Figure 11 depicts a clastic rock, composed of irregular grains of various sizes with interja-

cent open spaces that permit the passage or storage of water, resting upon an impermeable rock (*I*) (one so dense that water cannot pass through it). Open spaces may also be in the form of fissures, or cracks, as is the case generally with compact rocks, such as limestone, gypsum, and dolomite. Below a certain level, the pore spaces are completely filled with water. This part of the rock is called the zone of saturation (*S*), and the water contained therein is called phreatic water, or

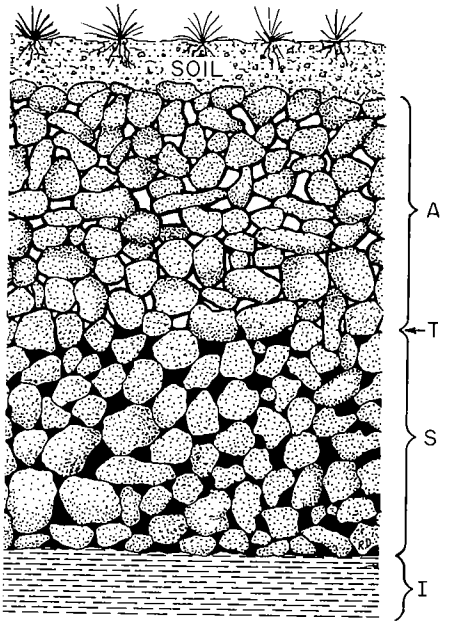


Figure 11. Schematic diagram showing modes of occurrence of water in clastic rock. I is an impermeable rock, such as shale; S is the zone of saturation; A is the zone of aeration; T, the boundary between the two zones, is the water table. The solid black area represents water. As water moves through rocks composed of soluble material, it dissolves the material, thereby enlarging the void spaces.

ground water. Water in this zone moves continuously, at rates so slow that they are measured in feet per year, toward areas where the water table is at lower elevations (fig. 12). Above the zone of saturation is the zone of aeration (*A*), in which the open spaces are occupied mostly by air but also by some water. The water in this zone is referred to as vadose water; it is held in place by adhesion to the walls of the openings or by capillary action in the smaller voids. Movement of vadose water takes place only during periods when water is percolating downward from the surface to the zone of saturation.

The top of the zone of saturation is called the water table (*T*). This surface parallels, in a subdued manner, the topography of the land as shown in figure 12. As indicated by the figure, the depth to the water table is greater on hilltops than in valleys. Ground water moves slowly from the high areas of the water table to the low, but as voids enlarge and coalesce they form conduits through which the water can move more freely and at higher velocities. Where the water table intersects the land surface, the water flows out as a spring or feeds a lake or stream.

All caves about which we have any knowledge are now above the water table (otherwise they would be flooded and inaccessible). However, because they are now above the water table (that is, in the zone of aeration), it is not necessarily true that they have always been there. The water table is not a static surface. Because the water moves away from the place where it enters the zone of saturation (eventually to discharge as a spring or into a perennial body of water), the water table will decline when the amount that infiltrates to it from the surface is insufficient to make up for the amount that has moved away. Conversely, if water is added to the zone of saturation at a rate more rapid than that of its withdrawal, the water table will rise. Other factors, such as movement of the rock, will affect the rise and decline of the water table.

The unanswered question regarding cave formation is whether caves are formed above or below the water table. For years it was accepted that caves were formed above, within the zone of aeration. However, in 1930, William Morris Davis published a paper entitled *Origin of Limestone Caverns,* in which he stated that caves are formed below the water table by phreatic water. His views, with minor differences, were accepted by numerous other scientists. Others supported a vadose-water origin but suggested that cave formation occurred at the water table. However, Clyde A. Malott, in 1938, concluded that caves in Indiana and Kentucky were formed by vadose water above the water table and were subsequently enlarged by the diversion of surface streams into these subsurface routes. I believe that Alabaster Cavern and the other caves of the area owe their origin to vadose water and that they developed in much the same manner as suggested by Malott.

The caves in the Alabaster Caverns State Park area all have features that support the vadose-water origin. Each has one major passageway that resembles a subterranean stream channel and other characteristics indicative of stream erosion. In the recent past, Alabaster Cavern was frequently flooded, a condition that has been eliminated only by the building of dams on the streams that drain into it. Even at the present time, side openings in Alabaster Cavern are being formed or enlarged by the stream that cuts across the cave at several places. The domes, which are formed in part by vertical seepage (itself a vadose-zone phenomenon), also show evidence of abrasion by sediment-laden flowing water. Another feature is the channels that are found in the roof of the collapse section and in the Upper Room.

It can be concluded from the geologic history of the area and from the requirements of cave development that Alabaster Cavern and the other caves of the area did not begin to take form until Late Pleistocene time, by which time the Cimarron River had eroded its bed to a level below the base of the Blaine Formation. While the Cimarron was eroding its channel, sinkholes were developing and much drainage was being diverted to the subsurface. As the water moved downward, it was diverted laterally through openings along bedding planes and other

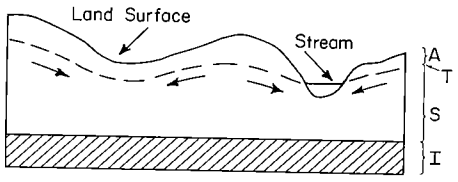
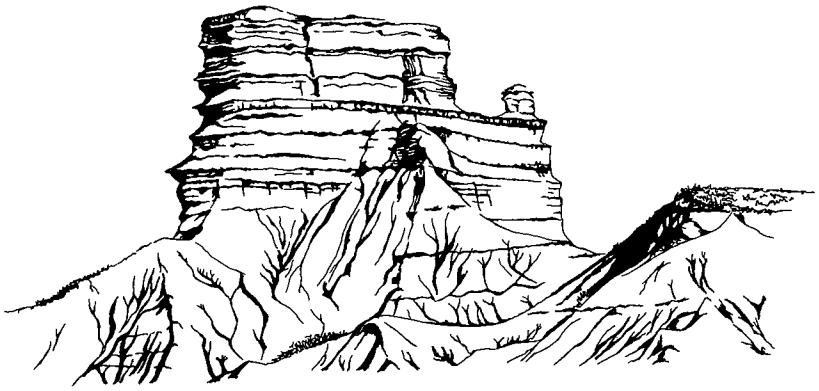


Figure 12. Cross section showing relation of the water table to the topography of the land surface. I is an impermeable rock; S is the zone of saturation; A is the zone of aeration; T is the water table. Arrows indicate the direction of water movement.

zones of weakness. The original openings through which lateral movement took place were microscopic, intertwining channels. As the water dissolved the rocks and enlarged the channels, some channels became the principal routes for ground-water movement, and most of the others were either abandoned or became minor tributaries to the larger channels. The larger channels tended to form a meandering pattern, such as

that displayed by the roof channel in the Upper Room (see figs. 26, 27). As solution continued and the volume of water increased, the channels became larger and less sinuous, such as the channeling in the ceiling of the Encampment Room. Once erosion had cut through the gypsum, it proceeded to excavate large areas in the underlying shale, and, in some places, large blocks of gypsum separated from the ceiling to fall into jumbled masses on the cave floor.

In terms of geologic time, the entire process of cave formation took place in a very brief period. On the comparative time scale shown in figure 2, the Middle Pleistocene began about 1 hour ago, and the caves of this area began to form sometime after that. The process of cave formation has continued without interruption since then and is still active today.



Description of Recreation Areas

Arthur J. Myers and Carol R. Patrick*

ALABASTER CAVERNS STATE PARK

Although the first known exploration of Alabaster Cavern occurred in 1898, the area itself had been homesteaded earlier by Hugh Litton during the 1893 run on the Cherokee Outlet. By 1900 explorers had begun to "document" their investigations, as seen by a name scratched in the cavern's channel section with a 1900 date below. In 1928, Charles Grass bought the land that included the cavern and began to make some limited improvements in the area. Sightseeing was done on a very informal scale at first—picnickers would bring their lanterns and go through the underground rooms at their leisure. A few guided tours were conducted in the 1930's and 1940's, but tourism was not seriously encouraged until the mid-1950's. Mr. Grass wanted to avoid a private commercialization of the cavern, which he feared would ruin its natural beauty, and so he began a campaign to sell the area to the State of Oklahoma, both economically and psychologically. It took several years to build up sufficient interest, but in 1953 he was able to sell the 200 acres of land, including the cavern, to the Oklahoma Planning and Resources Board (now the Oklahoma Industrial Development and Park Department) for $25,000. Since that time, development has progressed markedly, and Alabaster Cavern has been recognized as one of the largest known gypsum caves in the world.

Five known caves comprise Alabaster Caverns State Park: Alabaster Cavern (open to the public), Upper Room Cave, Owl Cave, Water Cave, and an unnamed cave north of Cedar Canyon. The entrances to the caves and sinkholes and the streams that drain into sinkholes are shown in figure 7. Sinkhole 1 probably connects with Water Cave; sinkholes 2, 3, and 4 connect with Alabaster Cavern; and sinkholes 5 and 6 probably connect with Owl Cave.

Alabaster Cavern

The accessible part of Alabaster Cavern is 2,300 feet long and has a maximum width of 60 feet and a maximum height of 50 feet. Although the cave is probably half a mile longer, the opening to this portion, seen near the cavern exit, is small and clogged with boulders. The temperature in the cave ranges from 52° to 58°F. The main cavern area consists of three major sections: a collapse section, a dome section, and a channel section. These sections and their various features are indicated on the map of the cavern in figure 13. Figure 14 is a cross section of the cavern, showing its relationship to the surrounding shale and gypsum formations.

The cavern, with its highest elevation at the exit and its lowest near the entrance, is traversed by a perennial stream, the course of which is shown by a dotted line on figure 13. Much of the stream course is through unmappable side channels that are only a few inches high, but it can be seen intermittently along the main passage. The stream flows the entire length of the main passage only during high water, which

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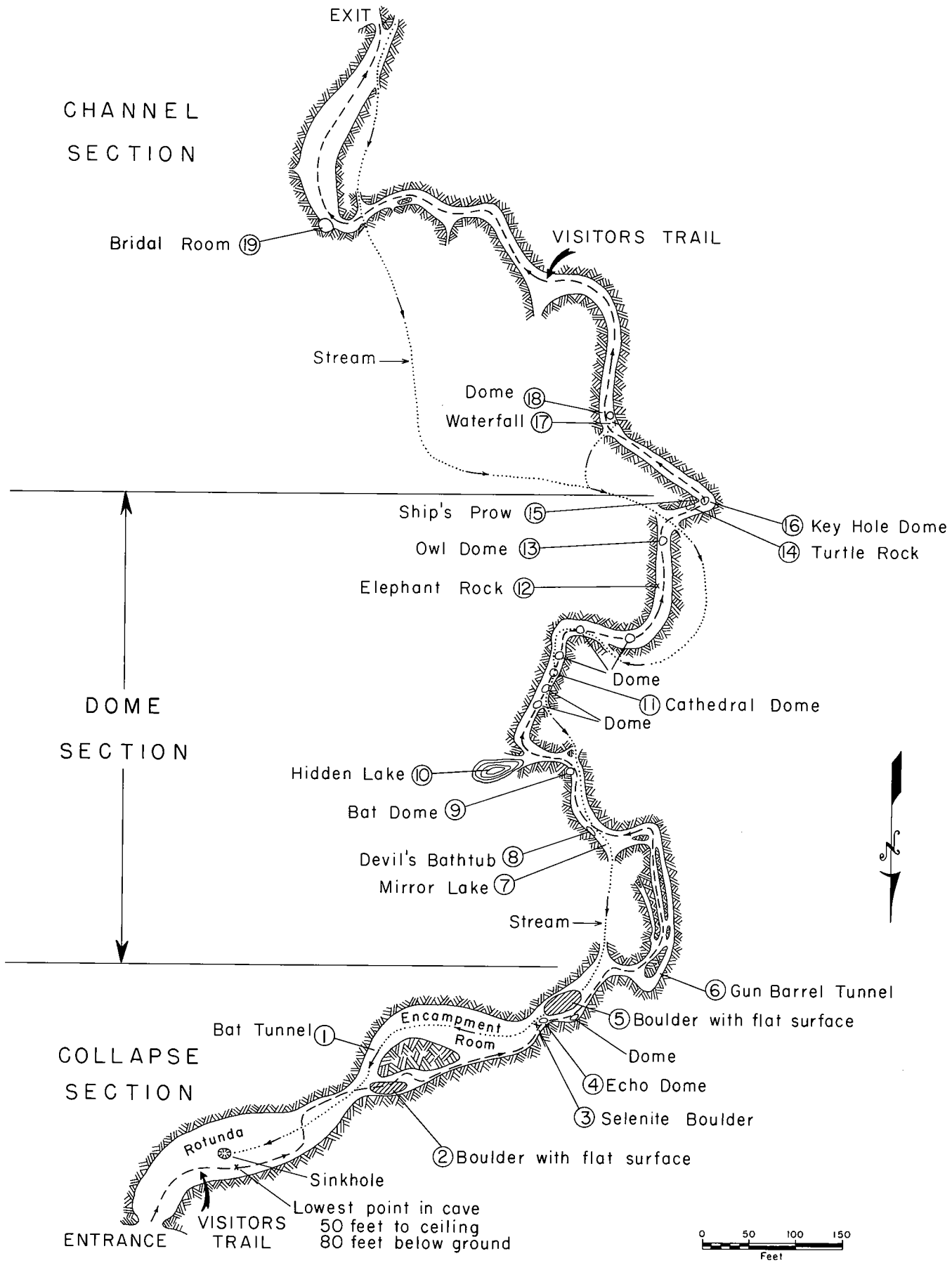


Figure 13. Map of Alabaster Cavern. Note that the map is oriented with north toward the bottom.

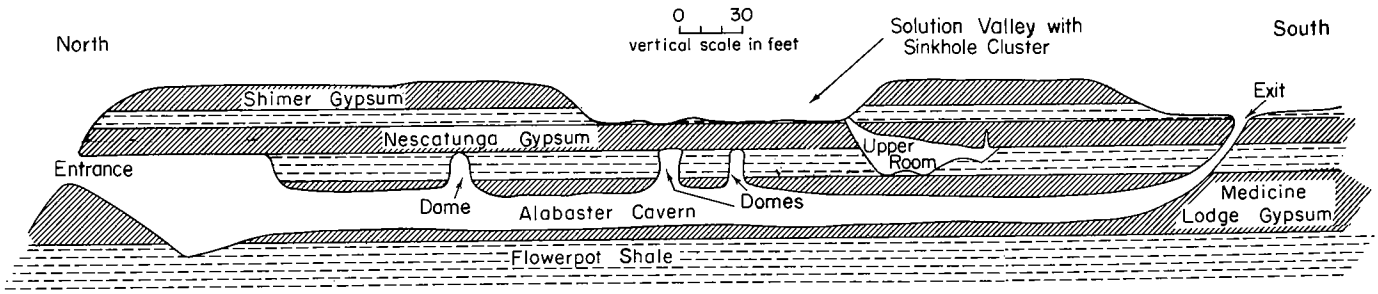


Figure 14. Cross section showing the vertical and stratigraphic relationships between Alabaster Cavern and the Upper Room Cave. Length of the cross section is approximately 2,000 feet. The dashed pattern represents shale layers.

on some occasions has completely filled the cavern. However, dams have been built on the streams that drain into sinkholes 3 and 4, and when the ponds behind the dams become too full, the water is diverted into the stream that drains into sinkhole 5. Because sinkholes 3 and 4 connect with the cavern, the cavern stream normally contains little water.

The cavern entrance, through a large sinkhole in the side of Cedar Canyon, leads into the collapse section, where the floor is a jumble of fallen gypsum, shale, and selenite boulders, the largest of which is 39 feet long, 21 feet wide, and 10 feet thick.

The Rotunda is the first and largest room, and its broad, flat roof is at the base of the Nescatunga Gypsum. Here visitors descend stairs to the lowest point in the cavern (fig. 15). The floor, in the Flowerpot Shale, is approximately 50 feet from the ceiling and 80 feet from the surface. The roof is lower near the far end of the Rotunda and is in the upper part of the Medicine Lodge Gypsum, which forms the roof through most of the remaining portions of the cavern. As the cave narrows, Bat Tunnel, one of the primary roosting areas for the bats, joins the main cave from the left. Here, the bats are undisturbed by visitors and can occasionally be seen hanging from the ceiling. The underground stream of the cavern flows through the tunnel into the Rotunda, disappears into a sinkhole approximately 120 feet from the entrance, and reappears as a spring-fed tributary to Cedar Creek in Cedar Canyon.

From Bat Tunnel the trail leads over one of the larger boulders (fig. 13, no. 2) that has fallen from the roof. The visitor's trail continues through a narrow passage, and in the ceiling can be seen a groove that represents one of the small early channels that were enlarged to form the cavern. This channeling can be traced for 300 to 400 feet through the Encampment Room.

The Encampment Room is shown in figure 16, a photograph taken from the far end of the room with the visitor's trail on the right. To the left is Selenite Boulder, its large size and massive selenite crystals clearly illustrated in figure 17. The largest boulder in the cave lies just beyond Selenite Boulder and is approximately 50 feet long, 20 feet wide, and 8 feet thick. Scattered layers of selenite glitter in the ceiling and along the walls.

Beyond the Selenite Boulder is Echo Dome. The rim of the dome is in the Medicine Lodge Gypsum, and the ceiling, seen through an opening in the dome, is at the base of the Nescatunga Gypsum (the shale between the two gypsums has been removed by flowing water).

A short distance from Echo Dome is another of the larger boulders in the cavern (fig. 13, no. 5). The flat surface is a bedding plane within

Figure 15. View along the trail at the lowest point in the cave. To the left of the two men is a large tilted boulder of gypsum, and fallen gypsum boulders are scattered over the floor. To the upper right of the photograph is a section of wall showing the pattern formed by solution of gypsum. (Courtesy of the Oklahoma Industrial Development and Park Department)

Figure 16. View of the Encampment Room showing the Selenite Boulder and, just above and behind it, the largest boulder in the cave. (Courtesy of the Oklahoma Industrial Development and Park Department)

the Medicine Lodge Gypsum, and ground water flowing in minute channels along this bedding plane loosened the block, causing it to fall. Patterns on the surface of the block can be matched with patterns on the ceiling.

From the Encampment Room the cave narrows into Gun Barrel Tunnel. This round, tubular opening is a good example of the abrasive action of muddy water. The ceiling of the tunnel is so low that at one time people had to crawl through the passage in order to continue a tour of the cavern. Today the visitor can bypass Gun Barrel Tunnel through a man-made opening that permits him to walk upright.

The second major portion of Alabaster Cavern is the dome section, named for the many domes in the ceiling. The section has an average width of 15 to 18 feet and is approximately 10 feet high. Seven of the ceiling concavities are in the Medicine Lodge Gypsum and range from small, concave indentions to rimmed depressions 3 to 4 feet high.

A few domes are present in other parts of the cavern, but there must be some explanation for the large number that appear in this section. When a map of the surface features and a map of the cave are superposed, it becomes obvious that the dome section lies beneath a cluster of sinkholes (fig 7). Rain water concentrates in these sinkholes and is channeled downward through the layers of gypsum and shale. This water action has dissolved out parts of the cavern roof, thus creating the ceiling domes. Erosion has continued upward to the top of the Medicine Lodge Gypsum in four of the domes, and, as mentioned earlier, the shale between the Medicine Lodge Gypsum and the overlying Nescatunga Gypsum was easily removed by the turbulent water. A careful examination of these domes, especially those with ceilings at the base of the Nescatunga Gypsum, shows that the mouths are shaped like old vertical stream channels. The large openings exhibit inner ridges formed by swirling water. The domes with high ceilings are broadest in their upper sections, with the shale sloping toward the openings at the top of the Medicine Lodge Gypsum.

Figure 17. Selenite Boulder. (Courtesy of the Oklahoma Industrial Development and Park Department)

In this section the visitor will see layers of gypsum that seem to be pulling away or peeling from the rock (fig. 18). This is caused as the addition of water to alabaster, an anhydrite ($CaSO_4$), changes the rock to gypsum ($CaSO_4 \cdot 2H_2O$). The additional volume in the rock causes it to expand and pull away from the rock beneath. (See page 7 for more detailed explanation.)

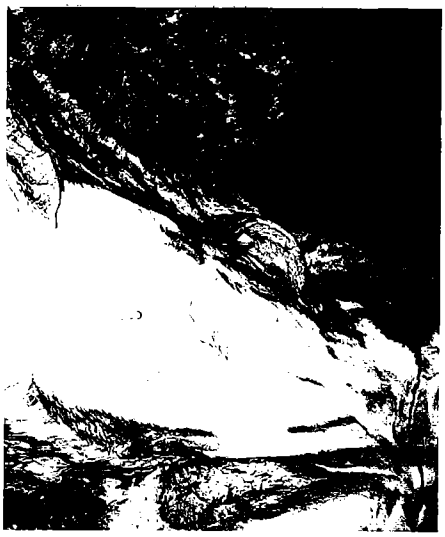


Figure 18. Such "peeling" formations as the one above result from expansion caused by the addition of water to alabaster (an anhydrite). Similar processes also take place outside the cavern, resulting in mounds like the one in figure 3.

Further down the trail to the left in what appears to be a gaping chasm in the floor, lined with jutting bits of gypsum. This optical illusion is actually Mirror Lake, its still waters reflecting the largest group of gypsum stalactites in the cave. Compared to limestone stalactites, these may seem quite small, but, because gypsum is so much more soluble in water than is limestone, smaller and fewer stalactites and stalagmites occur in gypsum caves.

The Devil's Bathtub (fig. 19) lies just beyond the lake. The base of

the tub is a projection of gypsum, and the smooth surface of the tub is the result of abrasive action by muddy water. This area is an early channel that was undercut as water seeped downward and the cave became larger. A lower channel lies below the base projection of the tub.

Near the Devil's Bathtub is Bat Dome. This dome once served as a nursery for young bats, and proof of habitation is quite clear from the concentration of bat guano below. The dome's high ceiling is at the base of the Nescatunga Gypsum.

Figure 19. This side view of the Devil's Bathtub shows the upper channel cutting that forms the tub and the lower channel cutting just below the base.

Beyond Bat Dome is Hidden Lake, which occasionally supplies water to the stream flowing through the cavern. Its dimensions are unknown because the roof is too low to permit exploration.

Figure 20 is a view of the cavern near Cathedral Dome, and figure 21 shows part of the Cathedral Dome rim. The grooves in the rim were probably formed between layers of gypsum. Bedding planes between layers of rock are readily eroded, and, during times of high water, swirling muddy water flowing through the cavern formed these grooves that enhance the beauty of the dome. Like many of the other dome roofs, its high ceiling is at the base of the Nescatunga Gypsum, with a small opening at the top of the Medicine Lodge Gypsum.

Several rocks in the cavern have been given specific names because of their appearances. Elephant Rock is a mass of gypsum shaped like an elephant's head with upturned trunk, Santa Claus Rock is also gypsum, and Mouse Rock is a projection of selenite layers. Other examples of this type of sculpture are Owl Dome and Turtle Rock. Owl Dome has brown stains that were formed by downward seeping water, giving it the appearance of an owl's face. Turtle Rock is a low, smooth mound of gypsum on the cavern floor, and its rounded "shell" and "head" were formed by the abrasive action of muddy water.

Further along the trail is Heart Dome, which, although not a deep indention, has a unique appearance because of its nearly perfect shape.

The last dome in this section of the cavern is Key Hole Dome, also formed in the Medicine Lodge Gypsum, with its ceiling at the base of the Nescatunga Gypsum. The large opening is in the shape of a key (fig. 22), making it one of the more interesting domes in the cavern.

The sharpest turn in the cavern is appropriately called Ship's Prow, and on the outside wall at the turn are what appear to be ripple marks. Close examination reveals that in the center of each ripple is a crack. Because cracked areas are more easily dissolved than others, pseudo (false) ripples have formed. Another old stream channel can be seen in the wall beneath the ripples. Other irregularities in the gypsum, probably caused by turbulent water, appear on the wall beyond Ship's Prow.

The channel section, where the abrasive action of the underground stream is best shown, extends from Ship's Prow to the cavern exit. This area has an oval cross section, with an average width of 15 feet and an average height of 8 feet. The gypsum roof, walls, and floor show the smoothing and polishing effect of the cavern stream (fig. 23).

Further up the trail is the Waterfall. Here, the water is continuously flowing, and it has a "gypy" taste caused by dissolved gypsum, indicating that solution is taking place at a higher elevation and may be forming a new cave.

Probably most, if not all, of the domes are connected to the surface by small openings. However, the only dome that is definitely known to have an opening at the surface is the one designated by the number 18 in figure 13. The opening is large enough for a man to crawl through. In early 1964 an adventurous individual climbed into one of the sinkholes, coming out in this dome, and a ladder had to be used to get him down from his precarious position.

Figure 20. A part of the cavern's dome section near Cathedral Dome. (Courtesy of the Oklahoma Industrial Development and Park Department)

Approximately 200 feet from the end of the cave is the Bridal Room, a circular room with its roof at the base of the Nescatunga Gypsum. It is always several degrees warmer than the rest of the cave, and this is probably the result of warm air rising from the lower parts of the cavern and becoming trapped in this room.

Figure 21. Part of the Cathedral Dome rim showing the grooves near the base cut by swirling water.

The last 200 feet of the cavern, the widest part of the channel section, has a maximum width of 40 feet and contains many gypsum boulders. The cavern has been designated as a fallout shelter, and food suitable for sustaining 3,080 people for two weeks is stored in this area. Just beyond the storage area is the exit to the surface, through another large sinkhole.

During the cavern tour the lights are turned out briefly, giving visitors the experience of total darkness. Animals living in such an environment become blind. Although no blind animals are known to exist in Alabaster Cavern, colorless, eyeless fish and crayfish are present in Kentucky's Mammoth Cave, and blind salamanders are present in caves in the Ozark Mountains.

Figure 22. Keyhole Dome.

A layer of Nescatunga Gypsum lies at the surface of the cavern exit. From here, visitors are transported from the exit to the administration building and pass a ridge of Shimer Gypsum that descends into a solution valley. At the bottom of the valley in the Nescatunga Gypsum is a cluster of sinkholes (fig. 7) that overlies the dome section of the cavern. Beyond the valley, the trail ascends to the level of the Shimer Gypsum, on which the administration building stands.

Figure 23. The cavern's channel section showing the smoothing effect caused by rushing water.

Upper Room Cave

Upper Room Cave, which has formed in the Nescatunga Gypsum and the underlying shale, is entered through an opening approximately 2 feet by 1.5 feet at the top of the Nescatunga (fig. 24). The location of the entrance is shown on figure 7, and figure 25 is a map of the cave. No large openings between the Upper Room and Alabaster Cavern are known, but the two probably are connected.

The entrance room is approximately 75 feet long, ranges in width from 10 to 20 feet, and has a maximum height of approximately 15 feet. The roof is in the Nescatunga Gypsum, and the shale floor is covered by gypsum boulders that have fallen from the roof. The Medicine Lodge Gypsum is exposed at the lowest point in the cave, and a solution sink about 2 feet in diameter, at one time a drainage channel for the Upper Room, penetrates 10 to 15 feet into the floor. Running water at the bottom of the cavity is believed to be one of the water runways in Alabaster Cavern.

Figure 24. Entrance to the Upper Room Cave. Its small size is obvious when compared to the pipe on the left side of the opening.

At the far end of the entrance room are two corridors. The north passage trends in a northerly direction and is entirely within the Nescatunga Gypsum. It is 50 feet long and has an oval cross section that is 7 feet wide and 4 feet high. The floor slopes gently toward the south, into the entrance room. In the ceiling at the end of the passage is a vertical shaft that is 4 feet wide and approximately 15 feet high, the roof of which is probably at the base of the Shimer Gypsum.

The larger south passage averages 12 feet in width, ranges in height from 3 to 12 feet, and is about 185 feet long. The floor is in the shale between the Medicine Lodge and Nescatunga Gypsums, and the roof is in the Nescatunga Gypsum, except for the southernmost 60 feet, which is at the base of the Nescatunga. In the northern section of the south passage the floor is partly covered with fallen gypsum boulders, but the southern section is entirely shale, except for one boulder in the terminus room.

The terminus room is circular and is about 30 feet in diameter, has a funnel-shaped floor, and has a maximum height of 6.5 feet. A dome, with a ceiling probably at the base of the Shimer Gypsum, lies about midway in the south passage.

Upper Room Cave is exceptionally dry. Its floor is covered to a depth of 1 to 2 inches with gypsum powder, indicating that enough water seeps through the rock to weather the massive gypsum but that practically no water flows through the cave. The drainage ways that

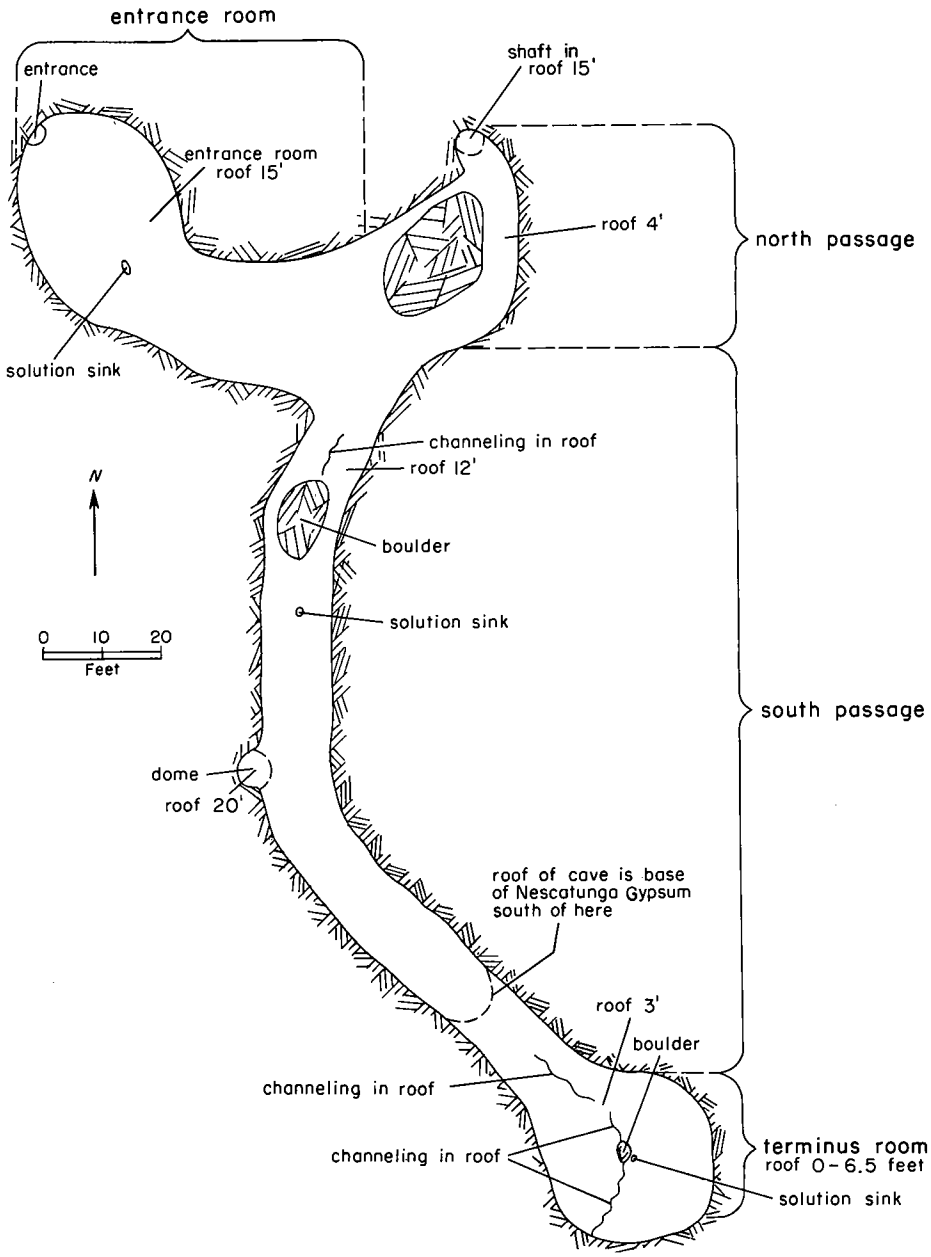


Figure 25. Map of the Upper Room Cave.

formed the cave are, however, still evident. A solution sink in the south passage, about 40 feet from the entrance room, exposes the Medicine Lodge Gypsum and was the drainage for most of the south passage. Water from the northern end of the south passage drained into the solution sink in the entrance room. The terminus room was drained by the sink at the lowest point in the center of the room.

The small, tubular north passage was caused by water flowing through the gypsum, but the larger entrance room and south passage were formed by water cutting through the gypsum and flowing onto the shale. As it meandered across the shale, it undercut the gypsum, which later collapsed. The funnel-shaped terminus room shows the removal of the shale without collapse of the overlying gypsum.

The most interesting feature of Upper Room Cave is the channeling in the roof of the south passage. The channeling, which looks like an inverted entrenched stream channel with numerous meanders (looplike bends in a stream), was formed by vadose water as it percolated through the gypsum. A meandering course developed, and further flowage caused a downward cutting that maintained the same pattern. Figure 26 shows the pattern caused by the channel, and figure 27 is a close view of one of the meanders.

Owl Cave and Water Cave

Owl Cave was formed in the Medicine Lodge Gypsum and consists essentially of one large room. The entrance, which is about 26 feet wide and 10 feet high, is through a sinkhole along Cedar Canyon. The room has a length of 200 feet, a maximum width of 40 feet, and a maximum height of 40 feet. The floor is littered with boulders of gypsum that have fallen from the roof, and the Flowerpot Shale is exposed at the lowest point in the room, approximately 40 feet from the entrance. About 150 feet from the entrance, the cave narrows to 6 feet and is about 5 feet high. The room widens slightly and then descends at a steep slope to another cave, which is too small for exploration.

Figure 26. Entrenched stream channel in ceiling of the Upper Room Cave.

Figure 27. Close-up of one meander in the channel.

Water Cave, the smallest explored cave in the park, is entirely within the Medicine Lodge Gypsum and consists of a tubular opening that is 12 feet wide and 6 feet high. The main room is about 60 feet long; the cave is longer but narrows to only 1 to 1.5 feet high. A concrete retaining wall built in the cave impounds a subterranean pond that is one of the sources of water in the park.

BOILING SPRINGS STATE PARK

Boiling Springs State Park lies in the midst of an 880-acre tract of woodlands and water, 6 miles east of Woodward on the north bank of the North Canadian River (fig. 1). The park derived its name from the many sand springs in the area, which appear to be boiling. This effect is produced by water moving rapidly through the sand and throwing up clouds of "steam" that are actually fine-grained sand. Nearly 300 gallons of water per minute flow from the main spring, and a pavilion, from which visitors can watch the activity, has been built over the spring. The park's 4-acre lake was formed by building a dam on one of the spring-fed streams that flows into the North Canadian River (see illustration on page 5).

Figure 28. A spring-fed pond in Boiling Springs State Park. (Courtesy of the Oklahoma Industrial Development and Park Department)

The aquifer through which the water moves to the springs is the Doe Creek Limestone, the pink rock that can be seen in the park. Some of the limestone has been dissolved, and, as a result, water readily flows through the openings in the rock, causing them to look like a series of minute caves.

The park has a wide variety of trees, many of large size, in marked contrast to most of northwestern Oklahoma, which consists primarily of treeless plains. One of the quiet, shady spots in the park is shown in figure 28. Because of the trees and springs, wildlife abounds, and visitors can see deer and wild turkey as well as the more common animals and birds.

The park is a veritable oasis, especially during the summer, with excellent camping facilities, a 10-unit trailer park, two cabins, and a community building with kitchen and dining facilities available. Picnic tables, shelters, grills, and combination restroom/shower buildings are also present throughout the park.

Figure 29. First Cove at Damsite Right, Fort Supply Reservoir. (Courtesy of the U. S. Army Corps of Engineers)

FORT SUPPLY RESERVOIR

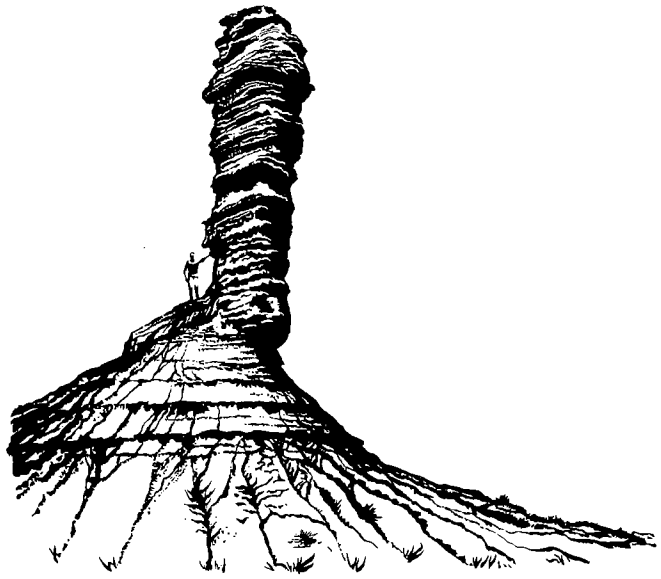
Fort Supply Reservoir (fig. 1) is 14 miles west of Woodward on U. S. Highways 270 and 183. The reservoir was formed when a dam, begun in 1938 and completed in 1942, was built on Wolf Creek. It is a rolled-earth fill embankment that is 11,325 feet long and has a maximum height of 85 feet above the stream bed and a width of 25 feet at the top. The

total volume of earth fill is 5,560,000 cubic yards.

The reservoir, at 2,002 feet above sea level, normally has a surface area of 1,800 acres and a shoreline perimeter of 26 miles. The shoreline is comparatively regular, the most irregular part being along the east side in an area of sand dunes. During flood-control periods, the water surface is at an elevation of 2,028 feet, the surface area is 5,730 acres, and the water extends about 8 miles upstream. The last time that water was at this level was in 1951.

The watershed of Wolf Creek, above the dam, is about 85 miles long and 20 miles wide, covering an area of about 1,494 square miles. Wolf Creek is the first important tributary of the North Canadian River upstream from Oklahoma City.

The reservoir is an important recreation area for northwestern Oklahoma and adjacent parts of Texas and Kansas (fig. 29). Three areas for public use are available: Damsite Right, Damsite Left, and Cottonwood Point. At these areas are bathing beaches, boat-launching ramps, picnic grounds, camp grounds, drinking water, and toilets. Additional services at Damsite Left are boat and motor facilities, bait and tackle supplies, and food and refreshments. Fishing is average for crappie, bass, sand bass, and channel cat. In addition, the Oklahoma Department of Wildlife Conservation has been granted use of 5,500 acres of land surrounding the reservoir for game-management purposes. Quail, deer, and turkey are the main game species, but rabbit, dove, pheasant, furbearers, and predators are also numerous.



History of Woodward County*

A. M. Gibson†

Oklahoma is conspicuous among the states of the nation for a distinctive and colorful past. Some of the better known elements of the Sooner State's heritage, such as the Five Civilized Tribes and their remarkable cultural evolution, have received such wide attention that equally significant and interesting facets that combine to produce Oklahoma's distinctive and unique history are neglected. One of these is the epic of northwestern Oklahoma and, notably, its focus—Woodward County.

The first Europeans to enter this region were Spanish *conquistadores.* Francisco Vásquez de Coronado crossed northwestern Oklahoma in 1541 during his search for that fabled center of wealth, the Gran Quivira. Expedition chroniclers noted the scarcity of timber, the vast expanses of rich grassland, and the migratory people, probably the Plains Apaches, who lived in little portable field tents made of animal skin, subsisted on humpbacked cows (bison), and used large dogs as beasts of burden. Successive Spanish exploring parties roamed Oklahoma's western border in search of the elusive Gran Quivira, the routes regularly crossing Woodward County. These included Juan de Oñate's expedition from the Spanish settlements on the Rio Grande in 1601 and that of Alonzo Baca thirty-three years later.

Spanish explorations gave Spain dominion over this region, but in the late seventeenth century French representatives challenged the Spanish claims. In the 1680's Robert Cavalier, Sieur de La Salle, claimed the vast trans-Mississippi West for France, named it Louisiana, and introduced a plan for tapping its natural bounty. Soon, daring French *coureurs de bois,* the bush rangers, roamed Louisiana, probing as far as the upper tributaries of the Canadian and the Cimarron Rivers in their quest for furs.

Louisiana became United States territory in 1803. Restless American explorers and traders, called "long knives" by the Indians, followed the streams of Louisiana into the Great West. One of the more successful American traders was Thomas James of St. Louis. In 1823 he led a party of trappers up the North Canadian River to the mouth of Wolf Creek in present Woodward County. James established a crude stockade to store his goods and serve as a base for trading among the wandering bands of Indians, while men from his party hunted and

Figure 30. Painting of a buffalo hunt on the plains (Berthrong).

*Illustrations in this section were taken from photographs in the Western History Collections of the Division of Manuscripts, University of Oklahoma Library. The name of the collection is listed in parenthesis after each caption.

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trapped for furs and hides along the creeks and on the plains of northwestern Oklahoma.

Although James made the fantastic profit of ten to one on his exchanges with the Comanches and other tribes of this area and his trappers gathered tons of hides and furs from the North Canadian and its tributaries, the prospects of future commerce in this region were not too bright. A steadily increasing stream of traffic from the American settlements in Missouri bound for Santa Fe, New Mexico, passed through this accustomed range of the wild Plains tribes. Kiowa and Comanche leaders maintained that the Americans frightened away the game, wantonly destroyed buffalo, deer, and antelope herds for a few choice cuts of fresh meat, burned the grass, and were a general nuisance. Local tribes were also apprehensive of another invasion—this from the north. The Cheyennes and Arapahoes, attracted by the abundant game of the region, were gradually drifting south, each year sending larger and better armed hunting and war parties into range of the Kiowas and Comanches (James, 1916, p. 190-227).

Northwestern Oklahoma and the Southern Plains generally became a dark and bloody ground, a dreaded crossing for Santa Fe merchants, and a scalp alley to the immigrants. Kiowa, Comanche, and Apache bands, although covering a wide range in their annual migrations, customarily camped for a time each season in the Wolf Creek and upper North Canadian area, and they resented any intrusion on this choice part of their vast domain. Besides its bounty of wild game—large herds of buffalo, deer, and antelope, flocks of wild turkeys, and bear, rabbit, and other creatures—the grasses of this area, primarily mesquite and buffalo (called short grass by the cattlemen), cured on the ground, were highly nutritious and provided excellent pasture in summer and winter. The protected, heavily timbered canyons made excellent winter quarters. Sand plums, persimmons, and wild grapes grew in profusion. On the Cimarron were saline flats where a season's salt supply could be gathered in a matter of minutes.

Two of the more popular watering places on the plains were at nearby Osage Springs and Boiling Springs, both called "sainted waters" because of the medicinal powers their waters were supposed to possess. Deep-rutted trails near the springs and the great amount of camp debris observed by later pioneer settlers attest to the heavy use of these watering points by wandering Indian bands. A folk tale concerning Boiling Springs, commonly found in the lore of the tribes of the Southern Plains, tells of two braves locked in mortal combat for the charms of a fair maid. As the struggle neared a climax, the combatants fell into the deep spring and drowned. The surging waters of Boiling Springs were explained by the spirits of these warriors continuing the struggle as in life (Univ. Okla., Boiling Springs File).

One of the bloodiest tribal wars on the plains broke out in 1837 between the defending Kiowas, Comanches, and Apaches and the invading Cheyennes and Arapahoes, the prize being the buffalo range of northwestern Oklahoma and the choice habitat on Wolf Creek. According to Kiowa legend, an invading party of 40 Cheyenne warriors was annihilated by a clever ambush

Figure 31. Painting by Charles Schroyer of the Battle of Washita (Berthrong).

during the summer of 1837. The following year a vengeance-bent Cheyenne war party sought out the Kiowas, killed twelve Kiowa women out gathering roots, then charged the Wolf Creek village. To reach it the invaders had to run their horses up a steep, muddy bank. On each charge the Cheyennes slipped to the bottom, giving the Kiowa warriors time to organize a defense. Comanche allies, camped nearby, rushed to assist the Kiowas, and the combined force drove off the invaders. Two years later the Cheyennes and Arapahoes and the Kiowas and Comanches made peace in order to present a united front against the increasing encroachments of pioneer settlements and growing east-west American traffic through their domain (Berthrong, 1963, p. 82-83).

Even though northwestern Oklahoma was the historic range of the wild tribes, the United States government incorporated this area into a vast Indian Territory, established for the purpose of relocating tribes from east of the Mississippi. By a treaty negotiated in 1828, the government assigned all of present northern Oklahoma, except the Panhandle, to the Cherokee Nation. That area, extending from the western borders of Missouri and Arkansas to the 96th meridian, was designated as the Cherokee Nation proper; and a ribbon of land, 60 miles wide and running from the 96th meridian west to the 100th meridian, including present Woodward County, was ceded to the Cherokees and designated as the Cherokee Outlet (incorrectly called the Cherokee Strip) (Kappler, 1904, vol. 2, p. 289).

The Cherokees had abundant land in eastern Indian Territory and, except for occasional hunting expeditions, did not use the Outlet. Following the American Civil War and the rapid development of the American West, there were strong demands that the wild tribes be settled on reservations in western Indian Territory. At the famous Medicine Lodge Council of 1867, leaders of the Kiowas, Comanches, Cheyennes, Arapahoes, and other tribes agreed to accept permanent reservation homes west of the 98th meridian in Indian Territory (Kappler, 1904, vol. 2, p. 977-982).

The failure of these tribes to remain on their assigned reservations, their continued hunting up and down the corridor of western Oklahoma, and their bloody depredations on the settlements of Kansas, Colorado, and Texas brought Woodward County into national history. In 1868 the War Department ordered General Philip Sheridan, commander of United States forces on the frontier, to establish a military post at a point where hostile bands could be watched and intercepted if a thrust into western Kansas was imminent. The stipulations for guiding Sheridan in his choice were that the new post be not more than 100 miles south of the Arkansas, possess natural advantages of a supply depot and operational base, and have environs with ample wood, water, and winter pasture for a large number of horses.

General Alfred Sully selected as a site for the new post the junction of Wolf and Beaver Creeks. During November 1868, the first contingent, consisting of five companies of the Third Infantry under Major John H. Page, left Fort Dodge for the Cherokee Outlet. Page's orders were to construct fortifications and organize his troops as a garrison force. A train of 450 wagons, loaded at Fort Dodge, carried building materials, provisions, weapons and ammunition. General George Armstrong Custer and eleven troops of the Seventh Cavalry served as escort for the supply train and arrived at the Wolf Creek site on November 21, 1868 (Univ. Okla., The Sheridan Papers, Nov. 23, 1868).

Troops from Fort Lyon, Colorado, and Fort Bascom, New Mexico, and the 19th Kansas Cavalry were expected momentarily. This combined force was being gathered for the purpose of making contact with scattered bands of hostile Indians, now reported in winter quarters, and driving them south of the Cimarron and the Canadian. A heavy snowstorm swept onto the Southern Plains; on Oklahoma's western border the snow was reportedly a foot deep; and the Colorado, New Mexico, and Kansas troops were delayed. General Custer, anxious to move against the hostile bands before the warriors learned of this secret winter campaign, led his Seventh Cavalry, complete with band, and three scouts—the colorful California Joe and two Osage trailers—south onto the cold, snow-covered plains of western Oklahoma.

On the morning of November 27, Custer's scouts found a large Indian village in a bend of the upper Washita River. The general invested the settlement, smashed it in a roaring dawn attack, and caught the sleeping Indians so by surprise that only the slightest resistance was possible. The massacre that followed was identified in the official reports as the Battle of the Washita. Cheyenne Chief Black Kettle, who miraculously escaped the Sand Creek Massacre in eastern Colorado in 1864, was slain, as were numerous women and children and 102 Cheyenne warriors. Custer's troopers shot the village herd of 800 Indian ponies; burned every lodge in the encampment; collected a large store of booty, including 247 saddles, 573 buffalo robes, arms, ammunition, and the village meat, meal, and flour supply for winter; and gathered up more than 50 women and children as prisoners (Univ. Okla., The Sheridan Papers, Nov. 29, 1868).

The triumphant Custer and his Seventh Cavalry returned from this first winter campaign in western Indian Territory to find work already underway on the new post. At its peak, Fort Supply (called Camp Supply in its early history), the first permanent American settlement in Woodward County and northwestern Oklahoma, included a military reservation of 40,320 acres. Major Page's men cut logs from the timber along the creeks and in the canyons to erect twenty log buildings. Each structure had a dirt floor, and the logs in the walls were chinked with mud made from native gyps and sand. These crude barracks replaced the tents used for temporary storage and quarters. The post perimeter was enclosed by a log picket wall 10 feet high.

For many years Fort Supply played a key role in bringing peace to the plains. In the early days of Supply's existence, arrogant, fast-riding Indian raiders swooped to the very walls of the post, causing woodcutters and hay crews to run for their lives and spooking the grazing cavalry mounts. A bolstered defensive perimeter, extending from Fort Dodge on the north to Supply to Forts Reno, Cobb, and Sill to the south, gradually brought peace to this savage frontier. Troops from Fort Supply went north to suppress the Indian uprising that followed the disastrous Battle of the Little Big Horn; Fort Supply cavalry searched for the renegade Dull Knife band in 1878; and Supply was given other important assignments, such as supervising the opening of the

Unassigned Lands to the homesteader in 1889 (Carriker, 1964).

In less than five years, those warriors who raided to the very gates of Fort Supply were coming in peace to receive their government rations and annuities. In 1881 a reported 5,000 Indians were camped east of the post, "and in the fork of Wolf and Beaver Creek extended a veritable forest of teepees" (Univ. Okla., Fort Supply File).

Fort Supply cavalrymen and their families, post sutlers or traders, teamsters, laundresses, and general hangers-on made northwestern Oklahoma's first settlement a colorful, lusty community. The abundance of game on the reservation around the post made hunting a pleasure, and the daily bag of buffalo, deer, antelope, turkey, and quail provided a welcome change from beans, sowbelly, hardtack, and, occasionally, tough beef rations. Dances were frequent, a hall being provided by stretching a tarpaulin across the granary floor.

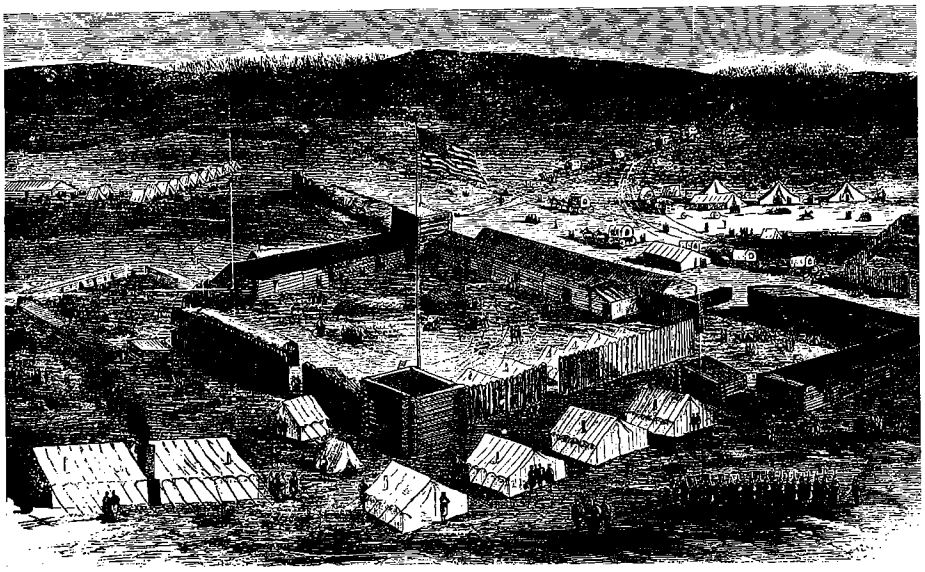


Figure 32. Lithograph of Camp Supply, Indian Territory (Berthrong).

But gambling was by far the most popular pastime. Fort Supply lore tells of Jim Quinlan, a young man from the East, stricken with tuberculosis, who came West seeking the cure. He hired out as a civilian teamster on the run between Fort Dodge and Fort Supply at a wage of $35 per month and government rations. The frugal Quinlan saved his earnings and soon had enough capital to operate the Mexican monte bank that ran full blast in the teamsters' cabin. Soldiers and civilians both patronized Quinlan's operation. "Jim ran a square game and collected his percentage. In a few years it is said he cleaned $60,000. He made a trip back east to buy a fine farm for his parents, then he returned to Fort Supply." He died at 32, one of the earliest civilians buried in Woodward County (Univ. Okla., Fort Supply File).

Fort Supply provided northwestern Oklahoma with its first communications with the outside world. Besides the heavily traveled trail between Fort Dodge and the post on Wolf Creek, a number of trails or rudimentary roads radiated southward from Supply. These included the Fort Supply-Fort Sill road; the Meridian Trail, which coursed from Supply along the 100th meridian across the Red River into Texas, fanning out to connect Wichita Falls, Texas, and other points; the Fort Supply-Fort Elliott Trail, southwestward in the Texas Panhandle near Amarillo; and the link connecting Fort Supply with Fort Reno. A telegraph-line survey was run between Fort Supply and Forts Reno and Sill, but only the Reno line was completed, this occurring in 1884. Squads of soldiers stationed in relays north and south of Supply as heliograph operators could send dispatches from the Cherokee Outlet to Red River or north toward the Arkansas in a matter of minutes on a clear day. Stageline service connected Supply with Dodge City and Wichita, Kansas. Severe winter storms seemed to have little effect on passenger and mail service. During the great blizzard of 1886, a furious storm that swamped the plains from Canada far into Texas, the Dodge City-Fort Supply coach rolled into the post "with the driver sitting on the box frozen to death. The passengers inside knew nothing of the death of the driver until they had alighted" (Univ. Okla., Fort Supply File).

The ranching frontier came to Woodward County and northwestern Oklahoma after military forces from Fort Supply and other posts in western Indian Territory tamed the wild Plains tribes. One of the fastest growing industries in the trans-Mississippi West after the Civil War was the range cattle industry. Beginning in Texas, its rapid expansion opened new frontiers throughout the Great Plains. Indian Territory, the future Oklahoma, played a key role in this development, beginning with the famous northern cattle drives and serving as a great cattle highway. The East Shawnee Trail, West Shawnee Trail, Chisholm Trail, and Dodge City or Western Cattle Trail, which connected Texas ranches with markets at the railheads in the brawling Kansas cow towns, all crossed Oklahoma (Dale, 1923, p. 34-46).

Three of the great cattle trails crossed the Outlet, and market-bound herds were allowed to graze and fatten on the primitive pastures that had until recently sustained the buffalo, antelope, and deer. The Dodge City Trail passed through present Woodward County. In the late 1870's cattlemen began occupying, more or less permanently, certain ranges in the Outlet. The number increased each year, with the result that this 60-mile-wide ribbon of grassland, extending from the Arkansas in the eastern part of the Outlet to the 100th meridian west of Fort Supply, became one of the most famous ranges in the West (Dale, 1920, p. 307-322).

Cherokee Nation officials at Tahlequah soon learned of this appropriation of their lands by cattlemen and sent representatives west with authority to collect grazing fees. At first the annual levy was 25 cents per head; later this was increased to 45 cents. The grazing tax collected from Outlet stockgrowers became such an important source of revenue for the Cherokee government that the treasurer of the Nation came each year to Caldwell, Kansas, established an office, and sent his deputies riding through the

Outlet to collect grazing fees (Univ. Okla., Outlet Grazing File).

Most cattlemen paid the Cherokee grass tax, but some evaded it. There were reports of ranchmen in southern Kansas driving their stock into the Outlet to avoid paying the Kansas property tax, only to move the animals back into Kansas just before the Indian collectors arrived. The honest stockgrowers, to protect themselves and their ranges from the unscrupulous and to better assure their rights in the Outlet, met in 1880 in the border town of Caldwell, Kansas, to form an association. This effort, the predecessor to the fabulous Cherokee Strip Live Stock Association, was loosely organized, and its purpose was primarily to assure that the Cherokees received their due. Fixed dates and places of roundups provided a means of settling disputes and protecting the Outlet ranges against trespass, rustlers, and predators (Rainey, 1933, p. 163-165).

Some Outlet stockmen felt the need for a tighter organization, and so in 1883 representatives met at Caldwell and established the Cherokee Strip Live Stock Association. Incorporated under the laws of Kansas with permanent headquarters at Caldwell, the association agreement, representing more than 100 individuals and corporations owning more than 300,000 head of cattle, set up a three-member board of arbitration. The board provided for registration of brands, tightened control of rustlers and predators, and established methods for assigning Outlet ranges.

At this meeting the stockmen delegates elected a president, a secretary, and a treasurer. These officers, as trustees for the association, negotiated a five-year lease at $100,000 per year with the Cherokee Nation for the exclusive use by Cherokee Strip Live Stock Association members of the 6 million acres of grassland. This lease was renegotiated in 1888 for $200,000. The officers also hired brand inspectors to police the range for rustlers and to inspect and record livestock shipments, adopted roundup schedules and rules, surveyed and mapped the Outlet and assigned particular ranges to members, and set rules for fencing member ranges (Dale, 1920, p. 307-322).

Those stockmen assigned ranges in Woodward County by Cherokee Strip Live Stock Association officials included the New York Cattle Company, the Day Brothers (Gregory and Eldred), the Gorham Company, J. W. Andrews, and the Ward-Byler Company. Each stockman or his manager established a large headquarters dwelling with bunkhouse and corrals at a central location on the assigned range. Scattered over the ranch were line shacks for the riders (Okla. Univ., Cherokee Strip, map).

Watching over the herds of the Woodward County ranches was the colorful cowboy with the high-crowned hat and delightful sense of humor. One old rider who worked for various cattle companies around Fort Supply recalled that typical cowboy gear included a fancy saddle, poncho and bedroll or blanket, coiled lariat, and a pair of leather chaps to protect the rider's legs from the brush. Nearly all his compadres were armed with six-shooters and Winchesters, and around their necks they wore large handkerchiefs that were used as hoods when buffalo gnats and flying ants were active. On Sundays the riders entertained themselves by riding and breaking wild horses. At first these horses ran in herds over western Oklahoma, but, later, ranch remudas were filled by mustangs shipped in from farther west (Harper, 1938, p. 334).

The big events in the range life of Woodward County were the spring and fall roundups. The fall gathering was for the purpose of learning the size of the herd, getting cattle ready for market, and branding animals with the owner's mark. Some of the marketable steers were five or six years old and had great long horns. In those days the cattle were readied for market on the range and were exclusively grass-fed. Stock raisers believed that beef animals had to have age on them before they could carry the flesh necessary for market (Rose, 1951, p. 180; *also in* Univ. Okla., Ranching File).

Figure 33. Branding in the 1890's. The maverick was roped and stretched between two horses before the hot iron was applied (Forbes).

Those animals not held for market were turned loose in late fall to shift for themselves. Before fences became common, herds would drift with winter storms for many miles. In the spring, riders from area ranches at times moved as far south as the Canadian and the Washita in south-central Oklahoma to gather up and drive back to the home ranges the thousands of cattle that had drifted during the winter storms.

Soon after the Cherokee Strip Live Stock Association was organized, members began to fence their ranges. This practice made it easier to control the vast herds grazing in the Outlet. Also, many ranchmen imported well-bred bulls from Missouri to upgrade the range stock. Herd improvement was better assured with enclosures, but barbed wire caused disaster at times, too.

Before the ranges were fenced, cattle could move with the severe winter storms that swept through northwestern Oklahoma from time

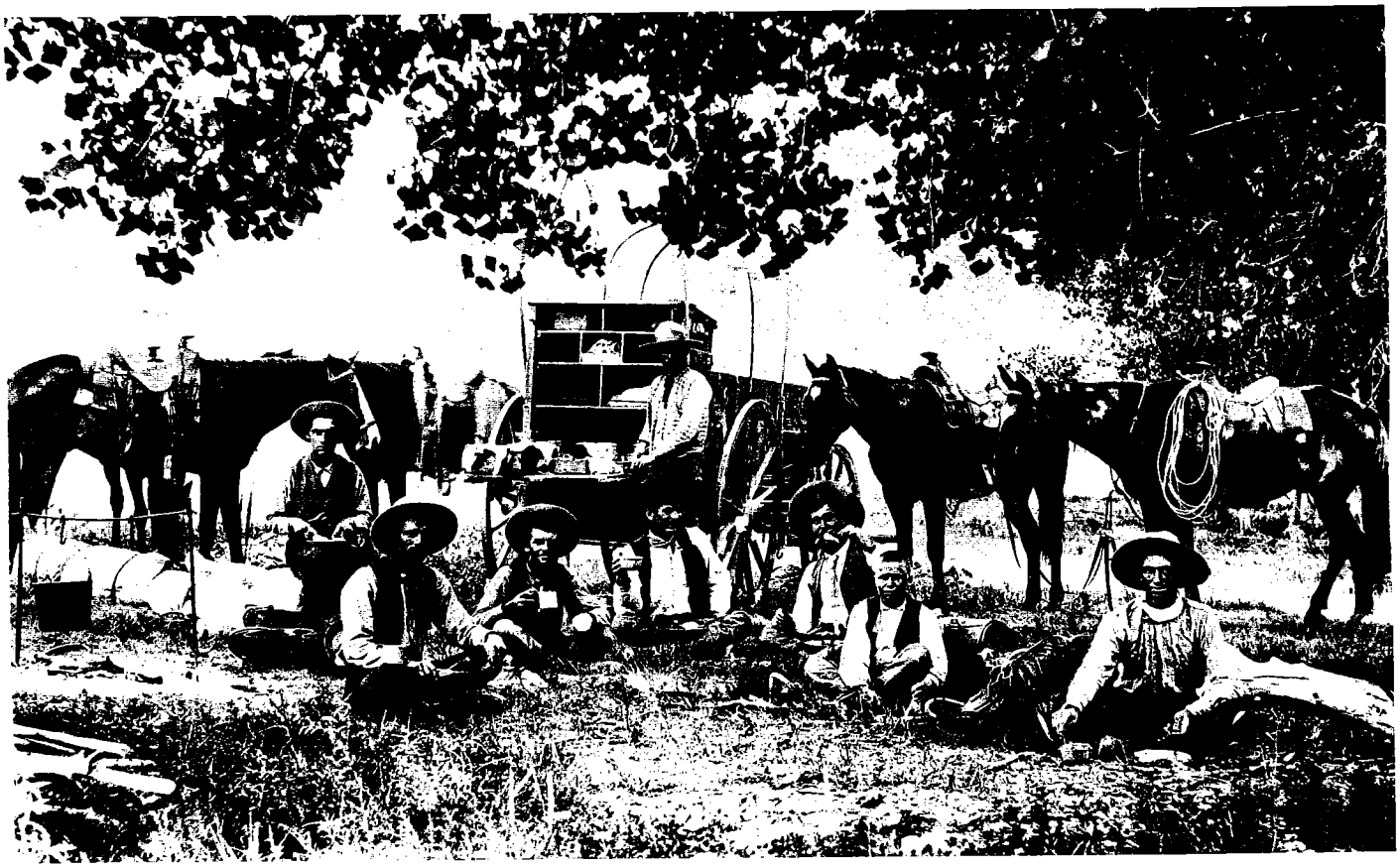


Figure 34. Mealtime at the chuck wagon; note the youngster in the crew, second from the right (Forbes).

to time. Cattle moving ahead of a blizzard generally followed the creek bottoms, the high-cut banks providing excellent windbreaks, and in the bottoms the animals could feed on brush or other vegetation. Herd losses due to storms before barbed wire was used were less than 2 percent. Regardless of the size of a particular ranch, after enclosures became common, cattle drifted into the fence corners, huddled up, and often froze to death. One Cherokee Outlet rider reported that, after the devastating blizzard of 1886 that wiped out ranchers from Canada to Texas, he came upon a herd of cattle in the corner of a pasture. Every animal was standing upright and frozen to death. The herd had drifted into a fence corner and stood knee-deep in snow with heads turned from the storm. First a hard rain mixed with sleet had covered the brutes, and this was followed by a hard-blowing sub-zero wind that froze every animal as it stood, "the solid mass of deep ice still holding them up as though alive." Another Cherokee Outlet cowboy, reporting on the destructive storm, told of wire fences on his ranch, "hung literally full of cow hides, resembling, from a distance, a huge washing on the line" (Rainey, 1933, p. 173-174).

If enclosures and death-dealing blizzards made ranching in northwestern Oklahoma an uncertain business, Cherokee Strip Live Stock Association members had other problems too. Herd losses due to rustlers and wolves had to be considered in each roundup tally. Vigorous brand inspectors effectively controlled the rustlers, and each year association members collected their riders and some professional hunters to carry out an extensive wolf hunt to rid the ranges of the lobo. The association paid a $25 bounty for grown wolf scalps and $10 for each whelp. The most notorious killer on the Woodward County ranges was "old two-toes," a white wolf. The association offered a $100 reward for his hide. He was sought by more than 30 men for four years, but "dogs, poison, and cold lead could not avail his capture. He has killed more cattle than would feed five ordinary families every year and is still on the turf for more." But finally, in 1898, a pack of hounds brought him down. The white killer weighed 200 pounds and measured 6 feet from tip to tip; through the years he had done an estimated $10,000 worth of damage (Univ. Okla., Woodward File).

Cherokee Strip cattlemen had excellent means for marketing their herds. The Dodge City or Western Cattle Trail passed through Woodward County, and in the early days of Outlet ranching, local stock raisers used this famous cattle highway. In the mid-1880's rail connections were established at Kiowa and other Kansas border towns; then in 1887 the Santa Fe Railway was extended southwestward across the Outlet. A station, complete with shipping pens and named for Brinton S. Woodward, a Santa Fe Railway Company director, was constructed on the present site of Woodward (Univ. Okla., Woodward File).

By the 1880's most of the arable, well-watered land in the trans-Mississippi West had been homesteaded, and land-hungry settlers began to cast covetous glances at the Indian Territory. After years of promotion and incessant pressure by Elias C. Boudinot, David L. Payne, William L. Couch, and other Boomer leaders, the United States government, in 1889, began opening various tracts and reservations in the Indian Territory for settlement.

Because there were many more homeseekers than homesteads available and in order that opportunity would be equalized, the government used the novel and dramatic land runs to open these areas. Successively the Unassigned Lands in central Oklahoma, the Sac and Fox Country, and the Cheyenne-Arapahoe Reservation were opened to the homesteaders. These openings only whetted the settler's appetite for more land. Boomer pressure continued, and finally in 1893 even the fabulous Cherokee Outlet became a homesteader's prize (Gibson, 1962, p. 26-31).

Anticipating the opening of the Outlet, President Benjamin Harrison, in February 1890, issued a proclamation ordering all cattlemen to vacate by October. Government negotiators went to work on the Cherokees and finally, in December 1891, got an agreement with them to sell the Outlet to the United States for about $8,000,000. Cherokee Strip Live Stock Association officials directed members to remove their fences, find new ranges for their herds, and set about the business of dissolving the affairs of this huge ranching syndicate. Although the Outlet was generally clear of fences and cattle within the time specified by President Harrison's order, some cattlemen lingered in this ranchman's paradise for several years; observers noted that large herds were still grazing in the Woodward County area as late as the day of the land run in 1893 (Kappler, 1904, vol. 1, p. 489; Richardson, 1909, p. 99).

President Grover Cleveland issued a proclamation on August 19, 1893, fixing 12 noon, Central standard time, Saturday, September 16, as the date of the opening. News of this coming event was published in newspapers throughout the country, and weeks before the opening, crowds from most states of the Union began gathering on the borders of the Cherokee Outlet, ready for the homestead race. In preparation for the opening, Hoke Smith, secretary of the interior, established seven counties across the Outlet; each received a letter designation. The westernmost region, which became Woodward County, was designated N County—an area containing all the land in the Outlet from the western edge of range 16 to the 100th meridian. This county remained undivided until statehood in 1907, when it was partitioned into present Woodward, Harper, the western part of Woods, and the northern part of Ellis Counties. Secretary Smith reserved sections 16 and 36 in each Outlet township for the use of public schools, sections 13 and 33 for the support of higher education and public buildings, and 320 acres in each county for a county seat (*United States Statutes at Large,* vol. 27, p. 64; *also in* Richardson, 1909, p. 407).

Smith also sought to check Soonerism. Sooners were those "cheats" who slipped in ahead of time and selected choice locations. To be eligible to participate in the run, homeseekers were required to register at one of the nine government booths scattered around the Outlet. The registration form included an oath that they had not entered the lands covered by the proclamation prior to noon, September 16, 1893. The booths were opened early on the morning of September 11. Hot, dry weather scorched the land and the homeseekers. Water was scarce and much in demand, selling for 10 to 25 cents a cup. Prospective settlers who camped near dry stream beds dug into the sand and drank from the little pools that seeped to the surface (Univ. Okla., Woodward File).

The greatest number of people at any booth was near Arkansas City, Kansas, where 30,000 registered; 15,000 showed up at Caldwell, Kansas, 10,000 at Hunnewell, and 10,000 at Kiowa, with lesser numbers south of the Outlet. Land offices for registering claims were established at Alva, Enid, Perry, and Woodward. Between 100,000 and 150,000 people participated in the Cherokee Outlet race, making it the greatest land run in history (Rainey, 1933, p. 273-275).

An estimated 5,000 homeseekers rushed into County N on September 16, but not much of the land was claimed. Many believed the region was too dry for farming, thus, ranchmen were able to hold on in Woodward County. To control large range areas, many cattlemen had their cowboys file on claims containing streams; by owning the water, they controlled the peripheral grassland (Univ. Okla., Woodward File).

Even as late as 1901, several large ranches were operating in Woodward County. The Kilgore Ranch sprawled over 10 sections; Eddleman Ranch interests controlled 40 sections, and the Chain C Ranch was estimated to hold a series of ranges 25 miles across. Most of this stock range was public land, each rancher being permitted to own only 160 acres plus any quarter sections his cowboys might have filed on for him, and a considerable amount of government land in Woodward County was still open to homestead entry. Many pioneers abandoned their claims, either intimidated by unfriendly cattlemen or forced out by the drouth. One settler recalled that "homesteaders were about as welcome as sheepmen in cow country." In 1894, a few months after the run, the county population was 2,241; until 1898 there was a sustained decrease in population (Rose, 1951, p. 184-185).

Besides unfriendly rancher neighbors, drouth, severe winters, and the general problems of adjustment to a new frontier environment, the settler had the additional burden of paying for his land. The free-land clause of the Homestead Act did not apply to the Cherokee Outlet, since the government, in order to open this area to settlement, had to pay $8,000,000 to the Cherokee Nation. It was expected that the homesteader would reimburse the government for this outlay by paying for his land. Thus, the Cherokee Outlet was divided into three sections. In the eastern third, land was priced at $2.50 an acre; in the central district, homesteaders were to pay $1.50 an acre; and in northwestern Oklahoma, the price was $1.00 an acre. The money could be paid by the installments. The settler also had to pay a filing fee of about $15. He was required to reside on his quarter section for five years, cultivate the land, and make certain improvements before final title was issued to him by the government. Cherokee Outlet settlers organized the Free Homes movement for the purpose of agitating in Congress for the repeal of the payment clause, and in 1900 the so-called Free Homes Bill was passed and signed into law (*United States Statutes at Large,* vol. 31, p. 179; *also in* Rainey, 1933, p. 336).

The hardy ones remained and through their energy and tenacity were able, gradually, to convert northwestern Oklahoma from a howling wilderness to a thriving agricultural region. Most of the early settlers were poor. Cash crops were eventually adapted to this erratic Great Plains environment, but, in those harsh early days, survival was a clear and constant question. Lack-

ing money, the homesteaders bartered butter and eggs for salt, sugar, and coffee. It was common to trade a horse or cow for a year's supply of flour. The men gathered buffalo bones on the prairie and sold them to Dodge City buyers at $7 to $9 a ton. These bones were shipped East and ground into fertilizer. Some settlers cut cedar posts and sold them to ranchers at 2 cents each. During those lean years after the crops were in, fathers and sons followed the wheat harvest in Kansas to earn enough to carry their families through the winter and improve their frontier farms. Harvest wages ran $1.50 a day or $3.00 for man and team (Rose, 1951, p. 195; Univ. Okla., Woodward File).

Many of these settlers were from the East, and drastic adjustment, not only in personal habits but also in farming techniques, was required of them. The soil was carpeted with deep-rooted, thick buffalo sod, and special tools were needed to cut this cover and open fields for planting. The sod plow, already in use on the northern plains, accomplished this satisfactorily. Two types were widely used—the Jack Rabbit and the Nebraska. Both worked on the same principle and were pulled by a two-horse team, but the Nebraska plow was shorter and lighter than the Jack Rabbit. Instead of a moldboard, commonly found on regular turning plows, the sod plow had steel rods set 4 inches apart and curved like a moldboard. The tough sod was cut vertically and horizontally into shallow furrows by a knife set near the point of the plow. The rods turned the sod bottom-side-up in long ribbons or slablike layers, sometimes the length of the field (Rainey, 1933, p. 332).

Pioneer dwellings were adapted from the resources of this new land. Immediately after the run, homesteaders used tents or canvas-covered wagon boxes for temporary shelter. If there was a timbered canyon on his claim, the homesteader cut logs and constructed a crude cabin to house his family. However, because most of the county was grassland, those settlers without timber for cabins set up housekeeping in soddies, dugouts, half-dugouts, and sod fronts in banks of low-lying hills, the soddy or sod house being the most widely used type of dwelling in northwestern Oklahoma.

The dimensions of this pioneer dwelling were generally 12 feet wide and 16 feet long. If the settler's family was too large to be accommodated by one sod house, he simply erected a second one nearby. Experience on the plains had shown that building a sod structure any larger would prevent the walls from settling straight up and down, thus causing them to fall either in or out. The sod-house roof, framed with poles, was usually slightly rounded or "car-shaped"—like the roof of a freight car. The roof frame was covered with tar paper; a rim of sod was laid around the outer edge; and the entire surface was covered with 6 inches of soil to hold the tar paper down. Homesteaders asserted that this type of roof shed the water very well. A few Woodward County sod houses had pitched roofs with cedar shingles. When laying a sod wall, the pioneer builder took ribbons of thick buffalo sod, cut about 4 inches thick by his Jack Rabbit plow, and, with a spade, cut blocks 2½ feet long. The sod blocks were laid in overlapping joints, like brick, the grass side down. It was believed that sod walls about 2 feet thick kept the interior cool in summer and warm in winter (Rose, 1951, p. 183).

During those hardscrabble days, Woodward County homesteaders were pressed even to find sufficient fuel for heating their crude dwellings and for cooking fires. Wood on most claims was scarce, and the pioneers relied primarily on cow chips. The women found that a bucket of dry cow dung, kindled by dried grass tapers, made a good bed of cooking coals. Through heavy use, this fuel became scarce across northwestern Oklahoma, and homesteader families placed sideboards on their wagons and went across the 100th meridian to the great cattle ranges of Texas on cow chip-gathering expeditions. Each family member would take a washtub, tie a short rope to one handle, and drag it across the range. When full, the tub was emptied into the wagon. One settler recalled that his family stacked a winter fuel pile 50 feet long, 12 feet wide, and 8 feet high in their dooryard (Rose, 1951, p. 197).

Figure 35. This sod house, built into the side of a ravine, holds the owner's small treasures in the midst of hardship (Forbes).

Woodward County homesteader's fare was simple and reflected well the resourcefulness of the people. Game was abundant. In 1894 one settler killed a wagonload of turkeys in an hour at Boiling Springs. Another reported that, after a severe snow storm, he went along the creeks near his claim gathering prairie chickens and quail into a grain sack. Coveys of these birds had frozen during the cold. He thawed and dressed them and fed his family through a lean period (Rose, 1951, p. 197).

A popular native fruit was the sandplum, which made excellent pies and jellies and was of great value

to the settlers. When a household ran out of canning jars, the remaining plums were cooked into a batter, spread on cloths made from flour sacks, dried in sheets, then removed from the cloths, and rolled up and put away for winter. During hard times, pioneer families even subsisted on boiled kaffir corn (grain sorghum), and it "became a polite art that first winter to . . . gracefully and quietly spit the hulls out while at the table" (Harper, 1938, p. 330-331; Rose, 1951, p. 197).

Most settlers had a milk cow and were able to milk several additional animals because of a curious custom that developed in Woodward County. Ranchers allowed homesteaders to milk all the cattle they could drive up from the open range. When the ranch crews branded calves in the spring, cowboys made the rounds of the homesteads branding the calves of the cows bearing their employer's mark. Cattlemen did not object, because the settlers took good care of both the range cows and their calves (Harper, 1938, p. 330).

One of the early concerns of Woodward County settlers was the establishment of schools and churches. In the absence of territorial support for early-day education, they built their schools through public subscription. The men donated their labor for hauling material and erecting the buildings. Some of these pioneer schoolhouses were made of sod; others were constructed with split cedar posts placed in picket walls (vertical rather than horizontal as was customary in constructing log buildings).

The only textbooks were those books that the parents had brought from the East. One early-day student remembered that "spelling, ciphering and geography matched with an occasional 'speaking' relieved the monotony of the regular school life." The students at one school carried drinking water from a spring situated a quarter of a mile from the schoolhouse. It was a treat to get to go for water. "Two privies were located on the back of the school yard, and you held up two fingers in a V shape to get permission to leave the room." During pioneer days in Woodward County, school ran for only three months of twenty days each, and teachers received about $25 a month. "One teacher was given a cow . . . as a consideration for teaching a fourth month" (Harper, 1938, p. 333; Univ. Okla., Woodward File).

At first there were no church buildings in Woodward County, but the settlers still worshipped, meeting in the schoolhouse or in homes whenever a circuit rider came through the country. One pioneer wrote, "Everyone went to these meetings (revivals) as they were outstanding events, regardless of the denomination of the preacher. We had what was called free or shouting Methodists, regular Methodists, Baptists, and Christian preachers, who received little pay and stayed with the neighbors" (Harper, 1938, p. 333; Univ. Okla., Woodward File).

Although Woodward County was thoroughly a rural community during territorial days, towns developed at strategic locations as trade centers. Venus and Ivanhoe (quite a rough border town during ranching days) probably had the most picturesque names, but the oldest settled community in northwestern Oklahoma was Fort Supply. This frontier post was abandoned by the United States Army in 1894. In 1900, W. E. Halsell, a rancher, purchased all but 1,760 acres of the military reservation. The following year, P. H. Fitzgerald, a promoter from Indiana, bought the tract from Halsell, laid out a town named Fitzgerald two miles southwest of the old fort, and attempted to relocate a colony of easterners there. This enterprise failed, and, in 1902, James P. Gandy, Fort Supply custodian, purchased 80 acres of the Fitzgerald tract and made plans for a new town 1 mile west of the fort. Gandy moved the buildings from Fitzgerald to the new town of Supply. In 1903 the territorial legislature accepted, as a gift from the United States government, the old post and military reservation and converted the property into a mental institution (Univ. Okla., Fort Supply File).

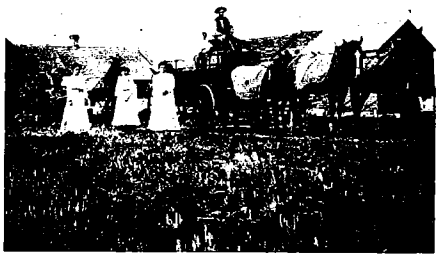


Figure 36. Hauling water to Woodward (Woodward Co.).

Other leading towns included Mutual, a homesteader town on Persimmon Flats, organized in 1899; Mooreland, near the center of the county, founded in 1901, and famous for the visits of Carrie Nation, whose hatchet and sharp tongue condemned local users of liquor and tobacco; and Curtis, on the Santa Fe line and Woodward's rival in population with 400 people. Tangier, first known as Opal, was 9 miles west of Woodward and was a leading shipping point for Fort Supply. Military goods for the post came to Tangier, from where they were wagon-hauled 15 miles north to the post. At its peak, this town had a population of 400; its livery stables handled more than 120 teams for the Fort Supply run and other points (Univ. Okla., Woodward County Towns File).

Figure 37. H. J. Heaton's variety store in Mutual about 1908 (Woodward Co.).

Figure 38. The main street at Curtis, Oklahoma Territory, looking eastward, 1902 (Woodward Co.).

Woodward, founded in 1887 as a cow town on the Santa Fe Railway, had the jump on other communities because it was established before the run, a government land office was situated there, and it became a county seat. But above all else, Woodward in the early days was a rough, rowdy cow town. The first town ordinance admonished its 500 citizens—"If you must shoot, shoot straight up" (Univ. Okla., Woodward File).

An early visitor to Woodward recalled that "the crooked old main street was lined on both sides with mostly old frame buildings, and we got our first sight of a real western frontier cow town. Woodward in those days, while on a little 'milder scale,' was about like Dodge City. It was quite a shipping point for range cattle of those days, and it was naturally full of cowboys. The hitchracks were lined with saddle horses.

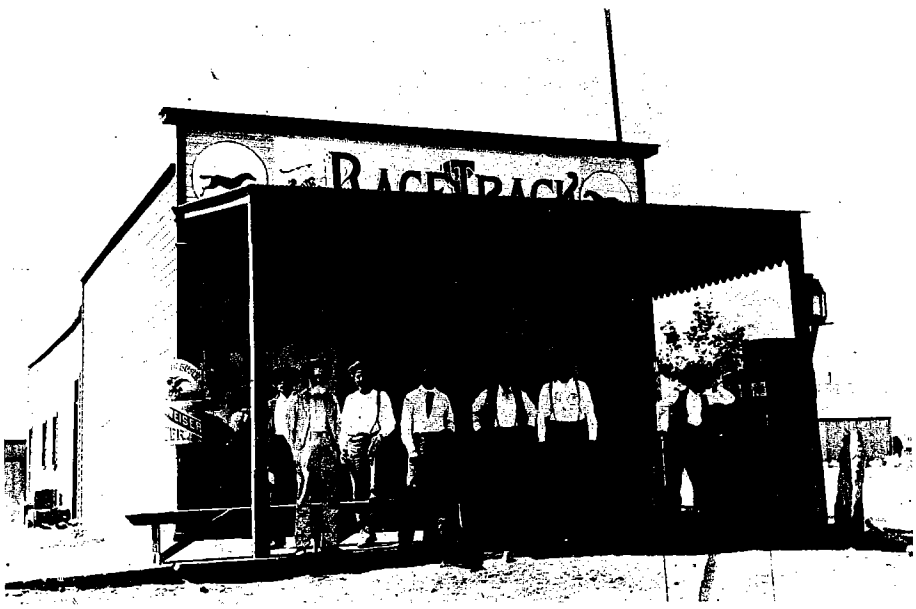


Figure 39. One of the 13 saloons in Woodward about 1900, this one on Main and 10th (Woodward Co.).

Temple Houston's Defense of Minnie Stacy

Gentlemen, you have heard with what cold cruelty the prosecution referred to the sins of this woman, as if her condition was her own preference. The evidence has painted you a picture of her life and surroundings. Do you think that they were of her own choosing? Do you think that she willingly embraced a life so revolting and horrible? Ah, no, gentlemen, one of our own sex was the author of her ruin, more to blame than she; then let us judge her gently. What would be more pathetic than the spectacle she presents? An immortal soul in ruins. Where the star of purity once glittered on her girlish brow, burning shame has set its seal forever. And only a moment ago they reproached her for the depths to which she had sunk, the company she kept, the life she led. Now, what else is left her? Where can she go and her sin not pursue her? Gentlemen, the very promises of God are denied her by man. He said: "Come unto me all ye that labor and are heavy laden and I will give you rest." She indeed has labored and is heavy laden, but if at this instant she were to kneel down before us all and confess her Redeemer and beseech His tender mercies, where is the church that would receive her? And if they received her, when she passed the portals to worship and to claim her rest, scorn and mockery would greet her and those she met would gather around them their skirts the more closely to avoid the pollution of her touch. Would you tell me a single employment where she could realize: "Give us this day our daily bread?" Her own sex would shrink from her as they would from pestilence. Society has reared its resistless walls against her, and only in the friendly shelter of the grave can the betrayed and broken heart ever find the Redeemer's promised rest. They told you of her assumed names as fleeting as the shadows on the walls; of her sins, her habits; but they never told you of her sorrows; and who shall tell what her heart, sinful though it may be, now feels? When the remembered voices of mother and sisters, whom she must see no more on earth, fall again like music on her erring soul, she cannot return—no, not in this life, for the seducer has destroyed her soul. You know the story of the prodigal son. He was one of us, like her destroyer. But for the prodigal daughter there is no return. Were she, with her wasted form and bleeding feet, to drag herself back to her girlhood home, she, the fallen and the lost, what would her welcome be? Oh, consider this when you come to decide her cause, for she is before us and we must judge her. They sneer and scorn at her. We should respect her grief, and I tell you that there reigns over her penitent and chastened spirit a desolation that none, no—none but the Searcher of all hearts can ever know. None of us are utterly evil; and remember that when the saffron scourge swept over the city of Memphis in 1878, a courtesan there opened wide the door of her gilded palace to admit the sufferers, and when the scythe of the reaper swung fast and pitiless was angelic in her ministerings. Death called her in the midst of her mercies and she went to join those whom she tried to save. She, like those the Lord forgave, was a sinner; and yet I believe that in the day of reckoning her judgement will be lighter than those who prosecute and seek to drive off the earth such poor unfortunates as she whom you are to judge. They wish to fine this woman and make her leave. They wish to wring from her the wages of her shame, the price of this meditated injustice; to take from her the little money she might have—and God knows, gentlemen, it came hard enough. The old Jewish law told you that the price of a dog, nor the hire of such as she should come within the house of the Lord. And I say unto you that our justice, fitly symbolized by woman's form, does not ask that you add aught to the woes of this unhappy one who only asks at your hands the pitiful privilege of being left alone. The Master, while on earth, while He spake the wrath and rebuke to the kings and rulers, never reproached one of these. One he forgave; another He acquitted. You remember both. And now, looking upon this friendless outcast—, if any of us can say unto her, "I am holier than thou," in the respect which she is charged with sinning, who is he? The Jews who brought the woman before the Savior have been held up to execration of the world for two thousand years. I always respected them. A man who yields to the reproaches of his conscience as they did has the element of good in him, but the modern hypocrite has no such compunctions. If the prosecutors of this woman whom you are trying had brought her before the Savior they would have accepted His challenge and each one gathered a rock and stoned her in the twinkling of an eye. No, gentlemen, do you as your Master did twice under the same circumstances that surround you. Tell her to "go in peace."

(Rainey, 1933, p. 498-500)

A few buggies and wagons could be seen, and occasionally a covered homeseeker's wagon" (Rose, 1951, p. 179).

The focus of winding Main Street, with its false-fronted buildings and board sidewalks, was the Cattle King Hotel. Only one brick building was in the town as late as 1901. Water was scarce, and businessmen and householders used the barrel system. For 25 cents a townsman could have his barrel, kept on the porch, filled each day from a horse-drawn tank wagon. Restaurants, dry goods and general stores, the Sing Lee Laundry (the proprietor conspicuous with his queue), two banks, and 23 saloons completed the town's leading business establishments. Oklahoma Territory was "wet" until statehood in 1907, and Woodward claimed some of the leading resorts, complete with mahogany and walnut bars, lewd paintings, and lady faro dealers, in the West (Univ. Okla., Woodward File).

Such a prosperous trade center and cattle town could be expected to receive the attention of the several outlaw gangs that roamed the frontier like predatory wolf packs. On March 14, 1894, the famous Bill Doolin gang held up the Woodward railroad station, and the loot included a safe stuffed with currency for the Fort Supply payroll (Litton, 1957, p. 440).

But Woodward had its culture, too. Besides the beginnings of a public library, the town sported an opera house. There, traveling companies presented variety and dramatic productions, including those of Shakespeare. In later years Woodward was on the Redpath-Horner Company circuit for chautauqua and lyceum programs (Univ. Okla., Woodward File).

As a frontier community, Woodward was famous for the colorful characters it attracted; none was more intriguing than Temple Houston, son of Sam Houston, hero of the Texas Republic. Temple Houston came to Woodward in the early days to practice law, and he gained immortality in the western legal fraternity for his famous courtroom

Figure. 40. Young Temple Houston while a member of the Texas state senate in 1885 (Rose).

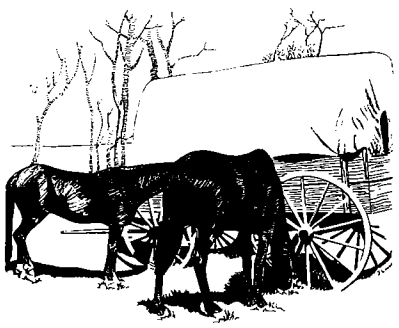
speech delivered in defense of Woodward's most notorious harlot. A civic-improvement campaign caught Minnie Stacy "dead to rights," and she seemed headed for banishment from Woodward or possibly for a hitch in territorial prison. Young Houston ignored public scorn in order to defend her. His magnificent appeal (see box on opposite page) for this fallen woman converted the jury from stern conviction to sympathetic acquittal.

By 1901, northwestern Oklahoma was in the midst of another land rush. The public-domain claims that were either abandoned by the faint-hearted in 1893 or completely avoided by homeseekers, and thus left to the cattlemen as open range, were being filed on. By 1903, all the homesteads in Woodward County had been taken. Two things brought this about. First in 1901, the Kiowa, Comanche, Wichita, Caddo, and Apache reservations were opened to the homesteader by the land-lottery method. Thousands of homeseekers came to Oklahoma Territory from all over the nation to register for claims. Many hundreds of the disappointed went north into Woodward County and filed on public land there. The other factor influencing the rapid development of northwestern Oklahoma was the Free Homes Bill, passed in 1900; thereafter, the land was free.

Of great importance in the rapid development of Woodward County at the turn of the century was the finding of cash crops. The homesteaders made their peace with the cattlemen, who in turn purchased large quantities of kaffir corn and other grains from their farmer neighbors for winter livestock feed. Many homesteaders also became small ranchmen of sorts by developing modest herds of their own.

Strains of seed wheat adapted to the northwestern Oklahoma environment were introduced, and this grain became the long-range money crop. Certain bonanza crops were found too, such as castor beans and broomcorn. In 1902, Woodward County alone produced more than 5,000 acres of broomcorn. This produce sold for $75 a ton, and it was not uncommon for a farmer to sell his crop at harvest time for enough to pay all debts, build a new home and barns, and purchase much needed machinery (Univ. Okla., Woodward File).

When statehood came in 1907, Woodward County had a population of 14,595; the town of Woodward had 3,849 residents. Since then the region, with Woodward as its hub, has moved in a sustained pattern of growth and progress (*Directory of the State of Oklahoma for 1953*, p. 228).



Bats of Alabaster Caverns State Park

Bryan P. Glass*

Eight species of bats occur in the Alabaster Cavern park area. Two of these, the red bat (*Lasiurus borealis*) and the hoary bat (*L. cinereus*) are migrant tree-dwelling species that may be seen from time to time in the trees within Cedar Canyon. The former is fairly abundant and probably lives in the canyon every summer. The latter is quite rare and probably occupies the canyon only occasionally during the warmer part of the year.

The remaining species are cave dwellers. One is a migrant; the others are resident throughout the year.

1. Cave Myotis (*Myotis velifer*). This is the commonest species in Alabaster Cavern and is usually referred to as "little brown bat," a name which is more properly applied to a different species not occurring in western Oklahoma. *Myotis velifer* lives in the cave throughout the year. Great masses of these bats usually hibernate in the main tunnel near the cavern entrance, where they are easily seen by visitors. They rear their young in the cave, and the females form a maternity colony that is a dense aggregation of bats in a restricted location. Formerly, one of these aggregations occupied Bat Dome (see fig. 13 on page 17), but in recent years the females have used an inaccessible part of the cave, presumably where there is less disturbance.

The number of individuals of this species in Alabaster Cavern cannot be stated precisely, but it is at least 4,000 and may be several times that number.

2. Big Brown Bat (*Eptesicus fuscus*). This species occupies the cave throughout the year but is much less numerous than the Cave Myotis. It is solitary except when the females aggregate to form maternity colonies. The females often leave the cave and occupy buildings at this time, but males are in the cave throughout the year.

Eptesicus fuscus likes to sleep in narrow crevices where both its belly and back are touching the rock. Often its roosts are in places where the cave is not even fully dark. The Rotunda (see fig. 13 on page 17) at the entrance to the cavern usually harbors a number of these bats, and the best place to see them is in overhead crevices just inside the entrance.

Figure 41. Clusters of cave bats hanging from the cavern ceiling. (Courtesy of the Oklahoma Industrial Development and Park Department)

3. Big-Eared Bat (*Plecotus townsendi*). Like the big brown bat, this species occupies the cavern throughout the year and is solitary except for maternity aggregations. It is a small species, but its huge ears (more than an inch in length) and its long fluffy fur make it appear larger. When the bat is asleep, the ears are curled backward and downward on the sides of the head.

Maternity aggregations of the big-eared bat resort to caves, rather than buildings, but do not seem to be partial to one location as does the Cave Myotis. They seem to be particularly susceptible to drying out and are therefore usually found in cool, damp parts of the cavern. They hibernate singly and often are found covered with droplets of condensed moisture.

4. Pallid Bat (*Antrozous pallidus*). This species was first reported from Oklahoma (east of Cimarron County) to be in Alabaster Cavern. It is a large bat with big ears, and its body is pale brown above and white underneath.

This species secretes itself in open crevices in cliffs during the day but resorts to caves for temporary roosting places at night, between intervals of feeding. It has been detected only entering or leaving the cavern

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after dark, never sleeping during the day.

The pallid bat hibernates in caves, forming aggregations in narrow overhead cracks. It probably hibernates in Alabaster Cavern, as it is known to do in adjoining parts of Kansas, but no hibernating colony has been found in Oklahoma.

5. EASTERN PIPISTRELLE (*Pipistrellus subflavus*). This species has been seen only once in Alabaster Cavern, where it was hibernating. It was in the lower part of the cavern, where the air is very damp. Nothing is known of its summer habits in the Great Plains. The species is nowhere common in western Oklahoma, the few specimens known having all been taken from damp caves or tunnels. In the eastern United States, the species is common. It hibernates singly in caves during the winter but moves out and lives in trees during the summer. When hibernating, like *Plecotus townsendi,* it seems to be partial to humid places where moisture condenses on its fur. Its distribution in western Oklahoma is probably limited by the availability of suitably damp hibernating sites.

6. MEXICAN FREE-TAILED BAT (*Tadarida brasiliensis mexicana*). This bat belongs to a family that is peculiar in that half of the tail projects beyond the free border of the tail membrane. It is a nonhibernating species that migrates northward from the American tropics in spring to rear its young in temperate latitudes and returns to the tropics in the fall. It is present in western Oklahoma only from April to October.

The free-tailed bat is mainly aggregated into maternity colonies during summer and is famous in Oklahoma for the spectacular size attained by these groups, which comprise millions of bats. They require large caves with high ceilings because of the structure of their wings, which necessitates a drop in order to attain flying speed. A large colony of these bats formerly occupied the front room of Alabaster Cavern, but disturbance, principally the installation of lights, has caused them to abandon it. The dispersal of the bats was a necessary preliminary to opening the cavern to the public because the heat generated by their bodies, as well as the odor of the guano accumulated on the floor, made the atmosphere in the room quite stifling.

Now the species uses the cavern only briefly during the spring and fall migration periods, when groups of several thousand bats may use the cavern for a day or two at a time. However, individuals fly in and out of the cave every night and presumably roost there briefly between feeding flights.

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