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Geology of the Cenozoic Rocks of Ellis County, Oklahoma

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David B. Kitts

ABSTRACT

Except for relatively small areas of Permian redbed outcrops and one of Cretaceous rocks along the Canadian and North Canadian Rivers, Ellis County is underlain by Cenozoic deposits ranging in age from Pliocene to Recent. The early Pliocene Laverne Formation comprises about 115 feet of gravel, sand, silt, clay, and caliche in the northwestern corner of the county. The Ogallala Formation rests upon the Laverne Formation and upon an erosional surface of less than 100 feet of relief cut into the underlying Permian redbeds. It covers approximately 70 percent of the area of the county and consists of up to 300 feet of fine- to medium-grained sands, silts, and clays, notably deficient in gravels. At one place along the Canadian River lithologically distinct beds, previously mapped as Permian, bear a Pliocene vertebrate fauna. Informally called the Packsaddle beds, they are assigned to the Ogallala, although they are stratigraphically lower and resemble the Laverne Formation in depositional characteristics. Overlying the Packsaddle beds is a volcanic ash of probable Pliocene age.

Quaternary rocks consist of terrace deposits (three levels on the Canadian River and two levels on Wolf Creek), dune sands, and alluvium.

INTRODUCTION

This paper presents the most recent results of a continuing study of the Cenozoic geology of western Oklahoma. The area considered in the report includes all of Ellis County, Oklahoma (fig. 1).

The study of the Cenozoic sediments of Ellis County began in the summer of 1955 with a reconnaissance study of the Cenozoic deposits of western Oklahoma. Intensive study in Ellis County began in the summer of 1958 and continued during the summers of 1959 and 1960.

The northern part of Ellis County is drained by the North Canadian River and its tributaries. Although the North Canadian

(Beaver) River* cuts across only the extreme northeast corner of the county, a major tributary of this river, Wolf Creek, flows directly across the northern part of the county from southwest to northeast. Wolf Creek, which, along with its tributaries, drains nearly half the area of Ellis County, joins the North Canadian River just over the county line to the east in Woodward County.

The southern part of Ellis County is drained by the Canadian River, which marks the southern boundary of the county, and its tributaries. The drainage basin of the Canadian (South Canadian) River* is remarkably narrow in Ellis County. In most places less than ten miles separates the river from the Canadian River-Wolf Creek divide. The tributaries of the Canadian are, for the most part, minor, intermittent streams. The major tributaries are Red Bluff Creek in the west and Hackberry Creek in the east.

The topography of Ellis County is quite varied. Along the major streams and rivers resistant sandstone layers within the Ogallala Formation have been exposed to form distinct escarpments bordering the valleys. In some places resistant rock layers within the Ogallala have been isolated by erosion to form the capping rock of small buttes. Away from the major drainage the topographic surface developed upon the underlying Ogallala sediments consists of gently sloping hills of moderate relief. This kind of surface is particularly well developed in the area north of Wolf Creek. Much of the Ogallala is covered with inactive sand dunes. Dunes occur almost anywhere but they are concentrated in an area of more than 100 square miles in the south-central and southeastern parts of the county. Typically these dunes are less than 100 yards long and less than 30 feet high. The topography in the dune-covered areas is extremely complex, and few individual dunes can be distinguished or classified as to type.

In a small area in the north-central part of the county adjacent to the North Canadian River, and over a large area along the Canadian River in the southern part of the county, the Permian

* Through inadvertence, on plate I of this report the North Canadian River is labeled Beaver River and the Canadian River is labeled South Canadian River. "Beaver River" and "South Canadian River" are names of limited local usage, which are nevertheless sanctioned by the Oklahoma Department of Highways for use on road signs in the Ellis County area. However, the better established and preferred names, North Canadian and Canadian, are the ones recognized by the Oklahoma Geological Survey and by the U. S. Board on Geographic Names and are used consistently in the text of this report.

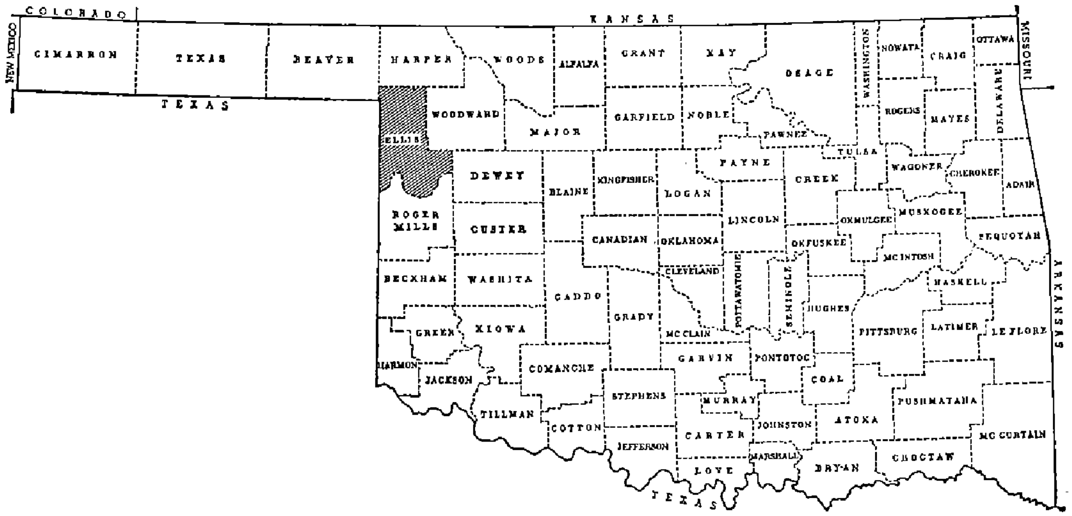

Figure 1. Index map of Oklahoma showing location of Ellis County.

bedrock sandstones and shales are exposed. Soil development and vegetation on the bedrock are limited, and consequently the topographic expression of these sediments is normally rough, typical development being steep-sided canyons and steep-sided, isolated hills.

Acknowledgments

Dwight Taylor analysed several Pleistocene gastropod faunas and Maxim K. Elias identified the Pliocene seeds. William E. Bellis and Charles J. Mankin examined a number of rock samples. Their help is gratefully acknowledged. Charles L. Rowett assisted me during the summer of 1960 and his suggestions have been invaluable. Earl Alley aided me in many ways during the course of my field work.

STRATIGRAPHY

Tertiary Deposits

LAVERNE FORMATION

Beds of the Laverne Formation which are exposed over an area of about 25 square miles in northwestern Ellis County are continuous with Laverne beds in Harper County, Oklahoma, to the north. In addition to exposures in Ellis and Harper Counties, the Laverne Formation crops out in Texas and Beaver Counties, Oklahoma, and in Meade and Seward Counties, Kansas. It is probably present in the subsurface of Haskell, Stevens, and Grant Counties, Kansas.

The name Laverne Formation was first applied by V. V. Waite in an unpublished manuscript which has been lost. Gould and Lonsdale (1926, p. 33) quoted Waite's original description. The type section is presumably somewhere in the vicinity of Laverne, Harper County, Oklahoma.

Schoff, who has thoroughly reviewed the history of the usage of the name Laverne, gave the following description (1956, p. 3).

> The formation consists of sand, gravel, caliche, limestone, silt, and clay, most of which are not readily distinguishable lithologically from other Tertiary beds. Beds are gray, blue gray, tan, yellow, pink, maroon, light green, and white. The distinctive beds in the formation are soft, massive, sandy chalk (or chalky sandstone), hard fossiliferous gray to white limestone, hard carbonaceous limestone, and coaly shale, but all exposures do not include such distinctive beds. No bed or group of beds is sufficiently persistent laterally to serve as a stratigraphic marker within the formation, and no subdivisions of the formation have been proposed.

The Laverne Formation in Harper County has been thoroughly discussed by Myers (1959).

Everyone who has written about the Laverne Formation has remarked that, in contrast to almost all other Cenozoic sediments in the southern High Plains, beds of this formation commonly dip up to 20°. The dip varies in magnitude and direction from place to place. This local structure has apparently resulted from collapse subsequent to solution of cavities within the salt and gypsum beds of the underlying Permian rocks. The collapse occurred before the deposition of most of the Ogallala beds with which the Laverne sediments are associated.

In Ellis County the Laverne Formation is represented by about 115 feet of gravel, sand, silt, clay, and caliche exposed in the northwest corner of the county (measured section 1). The beds show the typical Laverne structure. In the area where the Ellis County Laverne section was measured the beds dip 10° to the south. In Ellis County the Laverne Formation is overlain by sediments of typical Ogallala aspect. In other areas where the Laverne has been described no beds have been observed to be in contact above it. In the Ellis County section the transition from the Laverne to the Ogallala unfortunately occurs in a largely grass-covered interval. There does not appear, however, to be a profound break between the two units. It is interesting to note that in the measured section the beds of Ogallala aspect dip at the same angle and in the same direction as the underlying Laverne beds. It is clear that, in this area at least, solution and slump continued after deposition of "typical Laverne" had ceased.

The Laverne Formation can probably be distinguished from the Ogallala Formation upon the basis of lithology. At the one place where the Ogallala and the Laverne have been observed in contact, that is, in northwestern Ellis County, the unconformity between them, if indeed there is an unconformity, does not appear to be profound. I have used the name Laverne Formation in order to conform to current usage. I believe that in the future we should be reluctant to assign formation names to each separate Pliocene basin fill encountered in the southern High Plains. As a case in point, the "Packsaddle" sediments described later in this report are as different lithologically from "typical Ogallala" as are the Laverne sediments. I have resisted the temptation to apply a new formation name, because I believe that to multiply Pliocene formation names on the High Plains is to increase confusion. The name Ogallala has served and can continue to serve for this complex, coalescing mass of continental sediments exposed in the plains.

A few vertebrate fossils, notably *Nannippus* cf. *N. gratus,* have been recovered from the Laverne Formation in Ellis County. They tend to bear out the view that the Laverne is, for the most part at least, early Pliocene in age.

OGALLALA FORMATION

The Tertiary beds which are exposed in Ellis County are continuous with beds which cover the northeastern part of the Texas Panhandle. It has been customary in recent years to apply the name Ogallala Formation to these beds. The Ogallala Formation was described by Darton (1899) from localities in southwestern Nebraska. M. K. Elias (*in* Stirton, 1936, p. 178) applied the name in a greatly extended sense. He stated:

> In this paper, however, the term Ogallala is applied to the whole thickness of late Tertiary, predominantly arenaceous beds, which overlie the Arikaree of the North Platte valley and are found to range in age from the uppermost Miocene to the Middle and possibly the Upper Pliocene. These beds mantle the High Plains from South Dakota in the north to Texas in the south.

There have been objections to applying the name Ogallala in this greatly extended sense. In recent years a growing tendency has been to include all of these beds in the Ogallala group (Wood and others, 1941), a term which is essentially synonymous with the Ogallala Formation of Elias.

The name Panhandle beds was proposed by Gidley (1903) for the Tertiary sediments younger than the Clarendonian beds in the Texas Panhandle. W. D. Matthew, in an unpublished manuscript quoted in Sellards, Adkins, and Plummer (1932, p. 902), redefined this unit as a formation to include all of the strata of the Staked Plains above the Cretaceous and Triassic formations and below the Recent surface deposits, and consequently to include deposits of Pleistocene age in this area. The name was used in this sense by Sellards, Adkins, and Plummer. Neither the name Panhandle beds nor the name Panhandle formation is in current use.

Reed and Longnecker (1932) applied the name Hemphill beds to the "lower Pliocene" of Hemphill County, Texas, which borders Ellis County on the west. Wood and others (1941) suggested that these beds might be definable as a member of the Ogallala.

Lugn, in his reclassification of the Ogallala of Nebraska (1938, 1939), gave the unit group status and recognized four formations: in descending order, Kimball, Sidney, Ash Hollow, and Valentine. The State Geological Survey of Kansas has classed the Ogallala as a formation and applied the Nebraska formation names, Kimball (including Sidney), Ash Hollow, and Valentine, to its members (Moore, Frye, and Jewett, 1944). Frye, Leonard, and Swineford (1956) used this classification in their paper on the Ogallala of northern Kansas. In connection with their work on the Ogallala of the Texas Panhandle, Frye and Leonard (1957b, p. 17) stated:

> . . . we here class the Ogallala of the area under study in Texas as of formational rank but judge the subdivisions Valentine, Ash Hollow, and Kimball to have insufficient regional lithologic distinctiveness to merit their recognition as members and therefore we treat them as floral zones.

The Ogallala sediments in Ellis County rest unconformably upon the formations of Permian age, except in the northwest corner of the county where the Ogallala Formation is underlain by the Laverne Formation of early Pliocene age. In few places is the contact between the Ogallala and the beds which underlie it clearly exposed. Almost everywhere sands eroded from the Ogallala have been deposited over the contact. The contact as mapped is probably accurate within a few hundred feet laterally.

In the northeastern and southeastern parts of the county, where the Permian-Ogallala contact can best be seen, relief along a few hundred feet of contact does not exceed a few tens of feet. Although vertical control was rather poor, we were able to determine that the Permian-Ogallala contact occurred at an elevation close to 2,200 feet

Figure 2. Tributary canyon of Wolf Creek in sec. 4, T. 21 N., R. 25 W., showing upper 150 feet of Ogallala Formation.

except along the Canadian River in T. 16 N., Rs. 23, 24 W., where the unconformity is about 100 feet lower than this. An elevation of 2,200 feet is close to the elevation of the Permian-Ogallala contact in Roger Mills County, which lies just to the south of Ellis County. Frye and Leonard (1957a) have suggested that the relief of the sub-Ogallala surface underlying the southern High Plains did not exceed 250 feet. Within the area under discussion the relief on the sub-Ogallala surface was probably less than 100 feet.

The regional dip of the Permian bedrock in central-western Oklahoma is to the southeast at less than 1 degree. This gentle tilting almost certainly occurred before the deposition of the Ogallala sediments. With two local exceptions, which will be mentioned below, the beds within the Ogallala Formation are apparently horizontal. The lack of extensive exposures and distinctive beds of wide areal extent make it possible, however, that minor structural features within the Ogallala could go undetected.

The Ogallala Formation is by far the most widely distributed stratigraphic unit in Ellis County. It is exposed over the entire county except in the valleys of the North Canadian River, the Canadian River, and Wolf Creek, in which areas it has been removed by erosion. It directly underlies about 70 percent of the area of Ellis County.

The thickest measured section of unquestionable Ogallala is 175 feet in S½ sec. 6, T. 22 N., R. 23 W., where the base is not exposed (measured section 4). If it is assumed that the Permian-Ogallala contact occurs at an elevation close to 2,200 feet over the entire county, then the thickness of the Ogallala section along the western border of the county must approach 300 feet where the elevation of the Ogallala surface is above 2,500 feet. From the western border of the county the Ogallala Formation thins eastward; in southeastern Ellis County it is only a few tens of feet thick. In the northeastern part of the county, however, it is probably nearly 200 feet thick. The eastward thinning may be in part primary. It is clear, however, that a great quantity of Ogallala material has been removed by erosion.

Ogallala sediments in Ellis County consist of fine- to medium-grained sands, silts, and clays. Gravels are relatively sparse. The color is typically white, light gray, buff, brown, and a characteristic light pink or "peach." Cementation by calcium carbonate is common, but

Figure 3. Road cut on east side of U. S. Highway 283 in sec. 4, T. 21 N., R. 25 W., showing friable, calcium carbonate-cemented sandstones in upper part of Ogallala Formation.

generally it is weak and discontinuous. The degree of cementation is generally greater in the upper 100 feet of the Ogallala section than in the lower part.

The above characterization of the lithology of the Ogallala Formation is valid for hundreds of square miles of Ogallala outcrop in western Oklahoma. Locally, however, the lithology may depart markedly from this general description. Along the Canadian River in T. 16 N., Rs. 23, 24 W., are exposures of beds of quite distinctive lithology which I informally call the Packsaddle beds (beds 2-20, measured section 6). These beds consist of about 75 feet of thinly interbedded, fine-grained sandstones, siltstones, and clays, which range from bright red to reddish brown, overlain by about 30 feet of massive, light-gray and tan sands and silts and a layer of volcanic ash 16 feet thick. Above the volcanic ash is a layer of sand, silt, and gravel. These beds are shown as Permian on the state map and I had assumed that they were Permian. During the summer of 1960 E. C. Olson and I prospected these beds for Permian vertebrates and found, much to our surprise, camel and horse bones in abundance. I had previously mapped beds of essentially identical character in secs. 25, 26, 35, 36, T. 17 N., R. 25 W., Roger Mills County, as Permian (Kitts, 1959). The unconformity between these Packsaddle beds and the underlying formation occurs at an elevation of about 2,100 feet, or more than 100 feet lower than the contact between the Permian and the nearly typical Ogallala. Apparently the Packsaddle sediments represent a basin or valley fill deposited before the deposition of the surrounding beds of typical Ogallala aspect. In this way they are like the Laverne sediments in the northern part of the county.

The uppermost part of the Packsaddle section almost certainly consists of Canadian River terrace sediments of Pleistocene age. A question arises as to whether volcanic ash is associated with the Pleistocene sediments above or with the Pliocene sediments below. No direct evidence bears upon this question. It should be noted, however, that this particular ash is invariably associated with beds of Packsaddle character, in Roger Mills County as well as in Ellis County. Ada Swineford, who has examined samples of the ash, has stated that, because of the weathered condition of the glass, it is impossible to measure the index of refraction. She has found that the shards are characteristically rather flat and that some of them are thick. Bubble junctures are uncommon and mostly straight. Regarding possible similarities to other ashes she stated (personal communication): "The features are definitely not characteristic of the Pleistocene Pearlette ash, and I am not able to make any definite correlations with Ogallala ash falls." Upon the basis of this admittedly scanty evidence, I am inclined to the opinion that the ash in the Packsaddle section is Pliocene in age.

The Packsaddle beds have yielded abundant fossil mammal material. The specimens are so fragmentary and poorly preserved that they are of little use in determining the age of the sediments. The bulk of the material belongs to a medium-sized camel. The nature of the material makes it impossible to make a generic, let alone a specific, determination. The only specimen that gives any clue as to the age of these beds, beyond the fact that they are Cenozoic, is an equid jaw fragment containing two cheek teeth. This specimen may be assigned to *Nannippus* with confidence. It, furthermore, resembles the *Nannippus* material from the nearby Durham local fauna so closely that I am willing to suggest a correlation between the Packsaddle beds and the Durham beds upon this basis. The Durham local fauna was judged to be middle Clarendonian in age largely upon the basis of the *Nannippus* material which was tentatively assigned to *Nannippus gratus* (Kitts and Black, 1959).

Fossils have been recovered from the Ogallala Formation in Ellis County in sufficient abundance to allow rather definite conclusions about the age of this formation.

The Arnett local fauna from western Ellis County (NE¼ sec. 15, T. 19 N., R. 26 W.) was obtained from a layer of sand about 60 feet above the Permian-Ogallala contact. The assemblage consists of *Osteoborus validus, Aelurodon* cf. *A. mortifer, Albanosmilus*? sp., *Serridentinus* sp., *Aphelops* sp., *Neohipparion occidentale,* and *Prosthennops* sp. I concluded (Kitts, 1957) that this local fauna was of late Clarendonian or early Hemphillian age.

Fossil seeds have been collected over a wide stratigraphic and areal range in Ellis County. *Biorbia fossilia,* indicative of middle Pliocene age, is found from near the bottom to near the top of the Ogallala section in Ellis County. Other species recovered from the Ogallala in Ellis County include *Berriochloa amphoralis, B.* cf. *B. maxima,* and *B. conica.* All these species are indicative of middle Pliocene age. The fossil fauna and flora referred to by Stovall and Strain (1936) from a locality 2 miles south of Chaney, Ellis County, is almost certainly Hemphillian in age.

The evidence strongly suggests that the greater part of the Ogallala Formation in Ellis County is middle Pliocene in age. Early Pliocene sediments are present in the Packsaddle section and probably elsewhere in the lowermost part of the "typical" Ogallala. No fossil evidence is known for the presence of beds of late Pliocene age. In the west-central part of the county, however, close to the Texas border a dense, pisolitic limestone is exposed in road cuts and quarries. This limestone is lithologically indistinguishable from the cap rock which marks the top of the Ogallala section over much of the High Plains.

Quaternary Deposits

CANADIAN RIVER TERRACE DEPOSITS

High-terrace deposits.—The Canadian River terrace system is discussed in my paper on the Cenozoic geology of Roger Mills County (Kitts, 1959). The differences between these deposits in Roger Mills County and in Ellis County are minor.

Figure 4. Canadian River high-terrace deposits resting upon resistant Permian sandstone in sec. 14, T. 18 N., R. 25 W.

The high-terrace deposits are extensively preserved in the southwest corner of Ellis County, where they cover about 40 square miles. In general the contact between the high-terrace deposits and the underlying Permian beds is well exposed. The unconformity occurs at an elevation about 150 feet above the flood plain of the river. The deposits are up to 70 feet thick and are predominantly rather coarse grained, consisting for the most part of coarse-grained sands and gravels, typically cross-bedded. Locally, however, silts and even clays are present. The terrace surface occurs at an elevation of about 220 feet above the flood plain. Almost everywhere the surface is obscured either by erosion or the deposition of wind-blown sand.

The most difficult field problem presented by the high-terrace deposits is that of distinguishing them from the Ogallala sediments with which they are associated laterally. So generally similar are the lithologies of the Ogallala Formation and the high-terrace deposits that it would be difficult to recognize a contact between these two units even if it were exposed. Although it is far from obvious, there appears to be a fairly persistent topographic break between the high-terrace surface and the Ogallala surface. It is this break that has been mapped as the contact between the two units.

The deposits mapped as high terrace near the eastern border of the county are associated with Turkey Creek, a major tributary of the Canadian River. They occur at the same elevation as the Canadian high-terrace deposits and no doubt were formerly continuous with them.

Intermediate-terrace deposits.—The intermediate-terrace deposits of the Canadian River are poorly preserved in Ellis County. They remain as isolated remnants covering, with one or two exceptions, areas of less than a square mile. They contrast markedly with the Permian beds and Packsaddle beds with which they are associated and are consequently quite easy to map.

The unconformity which separates the intermediate-terrace deposits from the underlying beds is quite regular and occurs within a few feet, one way or the other, of an elevation 45 feet above the present flood plain of the river. In several places the intermediate-terrace surface is well preserved, and it regularly occurs at an elevation 90 feet above the present flood plain of the river.

The intermediate-terrace deposits consist of gravels, sands, and clays. A typical section consists of a basal coarse-grained sand, quartzite pebble, cobble conglomerate; an intermediate zone of cross-bedded, medium- to coarse-grained sand; and an upper zone of blue-gray clay and silt. In some places the intermediate-terrace deposits consist of sand and silt throughout their thickness.

Low-terrace deposits.—Like the intermediate-terrace deposits, the low-terrace deposits are discontinuously distributed along the north side of the Canadian River in Ellis County. The deposits lie upon an erosional surface on Permian bedrock which ranges in elevation between some level below the present flood plain and 15 feet above the present flood plain of the river. As much as 20 feet of relief occurs along the erosional surface within several hundred feet of the exposed contact. The bedrock surface apparently rises abruptly along the edge of the terrace away from the river.

The depositional terrace surface occurs at an elevation of 50 feet above the flood plain, and consequently the deposits range in thickness from 30 feet to more than 50 feet where the terrace surface is preserved. The low-terrace surface is in most places a little higher than the contact between the intermediate erosional and depositional terraces.

Good exposures of low-terrace deposits are not numerous, but on the whole the sediments are apparently distinctly finer grained than are the higher terrace sediments. Coarse sands are sparse and the few gravel deposits which have been observed are confined to a position high in the section and consist of sand containing a few quartzite pebbles and small cobbles.

WOLF CREEK TERRACE DEPOSITS

Mapping of the terrace deposits along Wolf Creek in central Ellis County entailed a number of difficult problems, the most important of which are listed below.

1. Because of erosion and deposition the contact between the terrace deposits and the underlying sediments can be observed in few places.
2. The terrace deposits are discontinuously preserved.
3. The terrace surface is obscured because material has been eroded from it and deposited upon it. In many areas sand dunes cover the terrace deposits.
4. The lithology of the terrace deposits is strikingly like that of the Ogallala beds with which they are associated.

Despite these difficulties I attempted to map the Wolf Creek terraces in detail. It must be borne in mind, however, that the terrace map is much more nearly a geomorphic map than a geologic map. The usual procedure involves an attempt to identify the terrace sur-

Figure 5. Eroded surface of Wolf Creek high- and low-terrace deposits with Ogallala sandstones in background in sec. 10, T. 21 N., R. 25 W.

faces and to proceed upon the basis of this to make inferences concerning the thickness and distribution of the deposits.

Along the north side of Wolf Creek valley between the Texas border and U. S. Highway 283, a distance of about 6.5 miles, two terrace surfaces are clearly evident. The lower of these surfaces occurs at an elevation 50 feet above the flood plain, whereas the higher occurs at an elevation 85 feet above the flood plain. This area was critical for our understanding of the terrace deposits along Wolf Creek, because, although in other areas the terrace deposits are almost everywhere present, they are difficult to map owing to the effects of erosion and deposition.

The break between the flood plain and the low-terrace surface is in most places pronounced. The flood plain is level in few places; typically it rises about 8 feet from the channel to the low-terrace break. The break is generally characterized by a rise of about 30 feet within a few yards or tens of yards, succeeded by a rise of about 15 or 20 feet across the low-terrace deposits. Thus, almost everywhere, the surface of the low-terrace deposits has been lowered by erosion adjacent to the flood plain and raised by deposition adjacent to the high-terrace deposits. The high-terrace surface has been consequently lowered by erosion close to its contact with the low-terrace deposits and for this reason there is normally little difference in elevation between the surfaces of the two terrace deposits. However, almost everywhere a distinct topographic break occurs between the low-terrace surface and the high-terrace surface, although it may amount to only a few feet of relief.

In the areas farthest from the channel the high-terrace surface has been covered by material eroded from the Ogallala hills which form the valley walls.

The Wolf Creek terrace deposits are well preserved at a few places. We were able to measure one good section of each of the terrace deposits, both in the same area north of Shattuck where a tributary of Wolf Creek has incised deeply through the terrace deposits (measured sections 7, 8). It is my distinct impression that the lithology of these terrace deposits varies markedly from place to place and that the lithology recorded in the measured sections is in no way typical. In general fine-grained sediments (that is, fine-grained sands, silts, and clays) seem to predominate in both the low-terrace deposits and the high-terrace deposits.

FAUNAS FROM THE TERRACE DEPOSITS IN ELLIS COUNTY

Faunas from each of the Canadian River terrace deposits are described in my report on Roger Mills County (Kitts, 1959). In a forthcoming paper by D. W. Taylor and me the question of the age of various western Oklahoma mollusk faunas will be reviewed.

Below is a report by Taylor on one assemblage from Wolf Creek low-terrace deposits and one assemblage from the Canadian River high-terrace deposits.

> In these lists locally extinct species are marked by an asterisk. They give both assemblages a Pleistocene aspect, more marked at locality 23458 by the occurrence of the species *Pupilla blandi* Morse. By the criteria used in southwestern Kansas neither assemblage is necessarily of glacial age, although that from locality 23458 may well be.
>
> U. S. Geological Survey Cenozoic locality 23457 (G-1-60). Ellis County, Oklahoma. SE cor. sec. 8, T. 21 N., R. 24 W. Low-terrace deposits along Wolf Creek. Shells from gray clay about 8 feet above present flood plain.
>
> Fresh-water snails:
> - *_Lymnaea caperata_ Say
> - *_Lymnaea reflexa_ Say?
> - _Gyraulus parvus_ (Say)
> - _Helisoma trivolvis_ (Say)
> - *_Promenetus exacuous_ (Say)
> - _Physa anatina_ Lea
> - *_Physa gyrina_ Say
>
> Land snails:
> - cf. _Succinea_
> - _Oxyloma_
> - _Pupoides albilabris_ (Adams)
> - _Gastrocopta cristata_ (Pilsbry and Vanatta)
> - _Vertigo ovata_ Say
> - _Hawaiia minuscula_ (Binney)
>
> U. S. Geological Survey Cenozoic locality 23458 (G-2-60). Ellis County, Oklahoma. Road cuts along line between sec. 36, T. 18 N., R. 26 W., and sec. 31, T. 18 N., R. 25 W. High-terrace deposits along Canadian River. Shells from gray clay about 15 feet below high-terrace surface and about 65 feet above base of high-terrace deposits. High-terrace surface is 200 feet above river.
>
> Fresh-water clams:
> - _Pisidium casertanum_ (Poli)
> - *_Pisidium obtusale_ (Lamarck)
>
> Fresh-water snails:
> - *_Lymnaea caperata_ Say
> - *_Lymnaea elodes_ Say?

Fossaria dalli (Baker)
Fossaria obrussa (Say)
**Gyraulus circumstriatus* (Tryon)
Gyraulus parvus (Say)
**Promenetus umbilicatellus* (Cockerell)
Physa
**Aplexa hypnorum* (Linnaeus)

Land snails:
cf. *Succines*
Oxyloma
Strobilops
Gastrocopta armifera (Say)
Gastrocopta tappaniana (Adams)
**Pupilla blandi* Morse
Vertigo ovata Say
Vertigo milium (Gould)
**Vallonia gracilicosta* Reinhardt
**Discus cronkhitei* (Newcomb)
Euconulus fulvus (Müller)
Hawaiia minuscula (Binney)
Stenotrema leai (Binney)

DUNE DEPOSITS

Dune deposits are widespread in Ellis County. Although isolated dunes may be found in almost any topographic setting, they are most common near major streams, particularly on the north and east sides of these streams. Most of the dunes are inactive, but dune formation and migration is not uncommon along the north side of the Canadian River, particularly just west of the state line in Texas.

Repeated efforts to isolate distinct episodes of dune formation have failed. Apparently accumulation of wind-blown sand has been going on almost without interruption throughout the Pleistocene and Recent.

GEOLOGIC HISTORY

Ogallala sediments from southern Nebraska southward rest upon Paleozoic and Mesozoic bedrock. Over this area no pre-Pliocene Tertiary sediments have been discovered. In the limited area of Ellis County the relief on the pre-Ogallala surface probably did not exceed 100 feet. It is generally agreed that the Tertiary drainage in the High Plains area trended west to east. It has not been possible to conclude upon the basis of limited exposures the direction of drainage during the Tertiary in the limited area under consideration.

Early in the Pliocene the rivers in the area under consideration began to aggrade. Sedimentation began in the pre-Pliocene valleys. The Laverne Formation in the northwestern part of the county and the Packsaddle sediments of the Ogallala Formation in the southern part of the county represent the remains of valley fills. The evidence strongly supports the view that sedimentation was almost continuous throughout the Pliocene. As the valleys filled, the channel and flood-plain deposits spread to coalesce with deposits from other drainage systems until, late in the Pliocene, topographic irregularities had been obscured by a continuous alluvial plain.

During early Pleistocene time the eastward-flowing rivers of the region began to erode into the alluvial plain. Certainly by Kansan time, and probably earlier, the Canadian River had attained its present general course. This is indicated by the fact that the area of bedrock exposure closely parallels the present course of the river. It is almost certain that the two bends in the river course along the southern border of Ellis County were superposed on an Ogallala surface in late Pliocene or early Pleistocene time. Lateral planation subsequent to downcutting resulted in the formation of a valley which was 10 miles wide in the western part of the county. After this period of erosion the river began to aggrade, and up to 80 feet of gravels, sands, and silts accumulated.

The deepest Pleistocene erosion followed the period of high-terrace deposition. A difference in elevation of up to 180 feet occurs between the high-terrace surface and the erosional surface underlying the intermediate-terrace deposits. A period of extensive lateral erosion followed the downcutting, and a flood plain, which was more than 5 miles wide in the western part of the county, was eroded from the Permian bedrock. During the early part of the depositional period that followed, the channel migrated widely over the flood plain. A gradual decrease in the competence of the river occurred during the period, in which up to 50 feet of sediments accumulated.

After the deposition of the intermediate-terrace deposits, the river again began to lower the level of its channel by erosion, cutting down more than 90 feet in some localities. Subsequent lateral planation by the river was not as extensive as in the previous cycle, and considerable relief remained on the narrow valley floor. Competence of the river was quite low during the early phase of aggradation. Competence may have increased somewhat just before low-terrace deposition was completed.

After the deposition of low-terrace sediments, the river was again rejuvenated and its channel was lowered to an undetermined level below the level of the present flood plain before it again began to aggrade to bring the channel and the flood plain to their present levels.

Sometime late in the Pleistocene, probably not before Illinoian time, Wolf Creek attained its present course. In the western part of its course it has apparently not cut through the Ogallala Formation into the underlying Permian rock, but near its mouth, close to the Ellis-Woodward county line, Permian sediments are exposed in its valley. The terrace sediments along Wolf Creek indicate two cycles of erosion. The earlier one may have been contemporaneous with the low-terrace cycle on the Canadian River.

Throughout the Pleistocene, the channel and flood plain of the Canadian River provided a source of sediments which were deposited widely over the southern part of the county as sand dunes.

During the Pleistocene, erosion along the tributaries of the Canadian River, the North Canadian River, and Wolf Creek reduced the intervening divides.

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APPENDIX

Measured Sections

1. Laverne Formation
W$\frac{1}{2}$ Sec. 17, T. 24 N., R. 25 W.

		Feet
15.	Sands and silts, white to light-pink; contains caliche pebbles, with a 6-inch bed of fine- to medium-grained sandstone about 5 feet from base which contains seeds; partly grass covered	10.5
14.	"Caliche," pale-green to white	10.0
13.	Sandstone, fine- to medium-grained; calcium carbonate cement; white to pink on unweathered surface	4.0
12.	Grass covered; Laverne-Ogallala contact is apparently at top of this bed	5.5
11.	Sandstone, medium- to coarse-grained, light-gray to tan; calcium carbonate cement; strongly cross-bedded	4.0
10.	Grass covered	35.0
9.	Clays and silts, gray; contains small caliche pebbles	24.0
8.	Sandstone, medium-grained; poorly cemented with calcium carbonate; strongly cross-bedded	1.0
7.	Grass covered	4.5
6.	Silts and fine-grained sands; contains caliche and quartzite pebbles; largely grass covered	5.5
5.	Sand, fine- to coarse-grained, light-gray to buff; strongly cross-bedded; largely unindurated, but contains relatively resistant layers	17.5
4.	Clay, bluish-gray	0.3
3.	Sand, fine- to medium-grained, white to light-gray, cross-bedded	6.0
2.	Sand, fine-grained, silty, light-brown	6.5
1.	Sand, fine-grained, yellow to orange; base not exposed	5.5

2. Ogallala Formation
W$\frac{1}{2}$ Sec. 35, T. 19 N., R. 26 W.

		Feet
12.	Sandstone, quartz, fine- to medium-grained, massive, friable; calcium carbonate cement; white on unweathered surface	35.0
11.	Sand, fine-grained, silty, white to light-pink; in beds about 5 feet thick; partly grass covered	32.5
10.	Sandstone, quartz, fine- to medium-grained, friable, light-pink; calcium carbonate cement; poorly exposed	2.0
9.	Silt, tan; in beds about 5 feet thick; partly grass-covered	18.5
8.	Grass covered; quartz pebbles on surface	11.0

		Feet
7.	Sands, fine-grained, and silts, buff and light-gray; contains caliche pebbles in upper 2 feet in beds about 5 feet thick; partly grass covered	16.5
6.	Sand, fine-grained, silty, buff and light-gray; contains two thin (2-inch) weakly cemented beds 3 feet and 4 feet above base	5.5
5.	Sandstone, medium- to coarse-grained, light-gray to buff; weakly cemented with calcium carbonate	0.5
4.	Sand, fine-grained, silty, light-gray and buff, massive	27.0
3.	Sand, fine-grained, silty, buff; with interbedded 1-inch layers of white calcium carbonate	5.5
2.	Clay, silty, dark reddish-brown	3.0
1.	Sand, fine-grained, silty, buff, massive, friable; base not exposed	16.5

3. Ogallala Formation
SE¼ Sec. 16, T. 19 N., R. 26 W.

		Feet
6.	Sandstone, fine- to medium-grained, massive; calcium carbonate cement; unweathered surface is white to pink; prominently exposed in canyon rim in this township	16.0
5.	Sands, silts, caliche pebble conglomerates, generally light-pink; in beds about 6 feet thick; partly grass covered	34.5
4.	Sandstone, fine- to medium-grained; calcium carbonate cement; pink to white on unweathered surface	5.5
3.	Sand, fine- to medium-grained, tan to buff, massive; this bed exposed in northern part of canyon contains fossil vertebrates described by Kitts (1957)	11.0
2.	Sands, silts, caliche pebble conglomerates, generally light-pink	5.5
1.	Grass covered; base not exposed	33.0

4. Ogallala Formation
S½ Sec. 6, T. 22 N., R. 23 W.

		Feet
5.	Sands, silts, and caliche pebble conglomerates, light-gray, white, and pink; in beds 3 to 8 feet thick; mostly grass covered	77.0
4.	Sandstone, fine- to medium-grained, white to pale-pink; moderately resistant; calcium carbonate cement	5.5
3.	Sands, silts, and caliche pebble conglomerates, tan to light-pink; in beds 4 to 7 feet thick; partly grass covered	35.0
2.	Sandstone, fine- to medium-grained, tan to light-pink; calcium carbonate cement; grades laterally into cement-free sand and then into fine- to medium-grained sandstone which is markedly cross-bedded	3.0
1.	Grass and soil covered; base not exposed	55.0

5. Ogallala Formation
Sec. 33, T. 24 N., R. 24 W.

		Feet
16.	Sandstone, fine- to medium-grained, massive, friable; calcium carbonate cement; white to pink on unweathered surface; contains fossil seeds	12.0
15.	Sands, fine-grained, and silts, light-gray and buff; massive; contains large nodular masses of calcium carbonate comprising about 40 percent of the volume of the sediments	34.0
14.	Grass covered	5.5
13.	Sands, silts, and caliche pebble conglomerates, light-gray, white, and pink; mostly grass covered	5.5
12.	Grass covered	5.5
11.	Sands, silts, and caliche pebble conglomerates, light-gray, white, and pink; mostly grass covered	6.5
10.	Grass covered	5.5
9.	Sand, fine- to medium-grained, light-pink; contains caliche pebbles	5.2
8.	Caliche, sandy, white	0.8
7.	Sand, fine- to medium-grained, light-pink; contains caliche pebbles	4.0
6.	Caliche, sandy, white	0.5
5.	Sand, fine- to medium-grained, light-pink to white	11.0
4.	Caliche, sandy, white	0.5
3.	Clay, brown; contains interbedded fine sandy layers 1 or 2 inches thick	2.0
2.	Clay, silty, gray to gray-green; contains spherical masses of dark-brown clay	2.0
1.	Sands, silts, and caliche pebble conglomerates, tan to light-pink; in beds about 4 feet thick; partly grass covered; base not exposed	22.0

6. Ogallala Formation
W½ Sec. 11, T. 16 N., R. 24 W.

		Feet
23.	Sands, silt, and gravel; Canadian River high-terrace deposits	20.0
22.	Volcanic ash, light-gray to white; interbedded with resistant sandstone beds less than 1 inch thick	16.0
21.	Sand and silt, light-gray and tan; locally cemented with calcium carbonate to form resistant ledges	29.5
20.	Grass covered	4.3
19.	Sandstone, fine-grained; in 2- to 3-inch beds	2.0
18.	Shale, red; contains vertebrate fossils	8.3
17.	Sandstone, fine- to coarse-grained, pale-red; ledge former	0.5
16.	Shale, red	5.3
15.	Siltstone, pale-red; ledge former	0.2
14.	Shale, red; contains vertebrate fossils	5.7

		Feet
13.	Siltstone, pale-red; ledge former	0.2
12.	Shale, light-red; with interbedded siltstone	1.7
11.	Sandstone, fine- to medium-grained, dark-red; with small-scale cross-bedding	0.6
10.	Shale, red	3.7
9.	Shale, yellow to greenish-yellow; contains vertebrate fossils	0.5
8.	Shale, red	3.3
7.	Shale, red; contains vertebrate fossils	5.3
6.	Siltstone, light-red, thinly laminated	0.3
5.	Shale, red; contains vertebrate fossils	1.0
4.	Siltstone, light-red, finely laminated; ledge former	0.4
3.	Shale, light-red; partially grass covered	5.3
2.	Grass-covered interval; contains Pliocene-Permian contact	26.0
1.	Gypsum; base not exposed	4.0

7. Wolf Creek High-Terrace Deposits
NE¼ Sec. 9, T. 21 N., R. 25 W.

		Feet
20.	Soil	2.0
19.	Gravel, caliche pebble and cobble; with a few sandstone cobbles; fine- to medium-grained sand matrix	3.0
18.	Sand, fine- to medium-grained, tan, massive	3.5
17.	Clay, sandy, dark-brown; with white calcium carbonate inclusions	0.2
16.	Sand, medium-grained, gray, cross-bedded; with well-developed 2-inch caliche zone at base	2.0
15.	Sand, fine- to medium-grained, dark-gray to black; strongly cross-bedded; with a few quartz pebbles	3.3
14.	Clay, dark-brown	0.2
13.	Sand, medium-grained, tan to orange, evenly bedded	3.0
12.	Clay, dark-brown	0.2
11.	Sand, medium-grained, dark-gray to black	3.0
10.	Sand, fine- to medium-grained, silty, clayey, reddish-brown	0.6
9.	Clay, brown	0.3
8.	Sand, fine-grained, tan, cross-bedded	2.0
7.	Sand, medium- to coarse-grained, tan, cross-bedded	1.5
6.	Sand, fine-grained, silty, tan; with 1-inch layer of gray clay at top	1.0
5.	Sand, fine-grained, tan	1.0
4.	Sand, fine-grained, tan; contains quartzite pebbles	1.1
3.	Sand, medium- to coarse-grained, cross-bedded, tan; contains moderately well-rounded quartz pebbles	4.6
2.	Sand, fine- to medium-grained, tan; with 3-inch layer of dark-brown clay at base	1.3
1.	Sand, fine- to medium-grained, cross-bedded, tan; base not exposed	4.0

8. Wolf Creek Low-Terrace Deposits
SE¼ Sec. 9, T. 21 N., R. 25 W.

		Feet
16.	Grass-covered interval below low-terrace topographic level	20.0
15.	Silts, sands, and caliche pebble conglomerates, cross-bedded; in beds about 1 foot thick	15.5
14.	Sand, fine- to coarse-grained, tan to light-gray; locally indurated to form resistant ledge	0.8
13.	Clay, gray; with calcium carbonate inclusions	0.6
12.	Sand, fine- to medium-grained, tan, evenly bedded	0.3
11.	Clay, gray; with calcium carbonate inclusions	0.5
10.	Sand, fine- to medium-grained, tan, evenly bedded	0.7
9.	Sand, medium-grained, tan, cross-bedded; contains caliche pebbles	1.2
8.	Sand, medium-grained, tan, evenly bedded	1.0
7.	Sand, fine- to medium-grained; strongly cross-bedded; contains quartzite and caliche pebbles	1.0
6.	Sand, medium-grained, brown, massive	3.0
5.	Sand, fine- to medium-grained; finely cross-bedded; contains caliche pebbles	5.5
4.	Clay, silty, tan	0.5
3.	Sand, fine-grained, tan; contains caliche pebbles	1.0
2.	Clay, gray	0.3
1.	Sand, fine-grained, brown; base not exposed	3.0