THE UNIVERSITY OF TEXAS BULLETIN
No. 3224: June 22, 1932

THE GEOLOGY OF WISE COUNTY, TEXAS

By

GAYLE SCOTT AND J. M. ARMSTRONG

Bureau of Economic Geology
E. H. Sellards, Director

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With Compliments from
J. M. Armstrong

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

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THE GEOLOGY OF WISE COUNTY, TEXAS

BY

GAYLE SCOTT AND J. M. ARMSTRONG

INTRODUCTION

Wise County is one of the second tier of counties in the north-central part of the state. It lies between the ninety-seventh and ninety-eighth meridians, and is cut by the thirty-third parallel. The area included is almost square, measuring approximately 32 miles from east to west, and about 25 miles from north to south. Thus it contains an area of some 800 square miles.

The county is traversed from south to north, in a slightly northwest direction. by the main lines of the Fort Worth and Denver and the Chicago, Rock Island and Texas railroads. A branch line of the latter also runs from Bridgeport to Graham in Young County.

The public roads have been improved greatly in recent years. Besides a number of improved county roads, the area is traversed by state highways 81, 39, and 34.

Wise County was originally under the jurisdiction of Denton and Cooke counties. The separate county was organized in 1856 under the leadership of Colonel Absalom Bishop, a pioneer citizen, and was named by him for Governor Henry A. Wise of Virginia. The position with respect to neighboring counties is shown in figure 1.

Decatur, the county seat, was known in early days as Taylorsville. It stands on the highest point in the county (1111 feet), and is not far from the geographical center. Colonel Bishop, having selected the townsite, first named it for General Zachary Taylor. It is said that Bishop, whose political faith was radically democratic, had the name changed to Decatur (after an early revolutionary commodore of that name) when Taylor became a Whig.[1]

Decatur, the county seat, has a population of 2000. In addition to the public schools, Decatur Baptist College, a junior college, is located there.

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[1]Historical data presented here were taken from the comprehensive and excellently written and illustrated Pioneer History of Wise County, by Cliff D. Cates, Decatur, 471 pp. 1907.

Issued September, 1932.

Other towns of importance are Rhome, first known as Prairie Point, on the Fort Worth and Denver Railroad near the southeast corner of the county; Alvord on the same road in the northern part; and Newark, Boyd, Paradise, Bridgeport, Chico, and Park Springs from southeast to northwest along the Chicago, Rock Island and Texas Railroad. Bridgeport is the largest town in the county, with a population of 2500. Slidel and Greenwood are in the extreme northeastern part; Keeter, Booneville, and Cottondale are in the southern part near the Parker County line; and Crafton is in the western part.

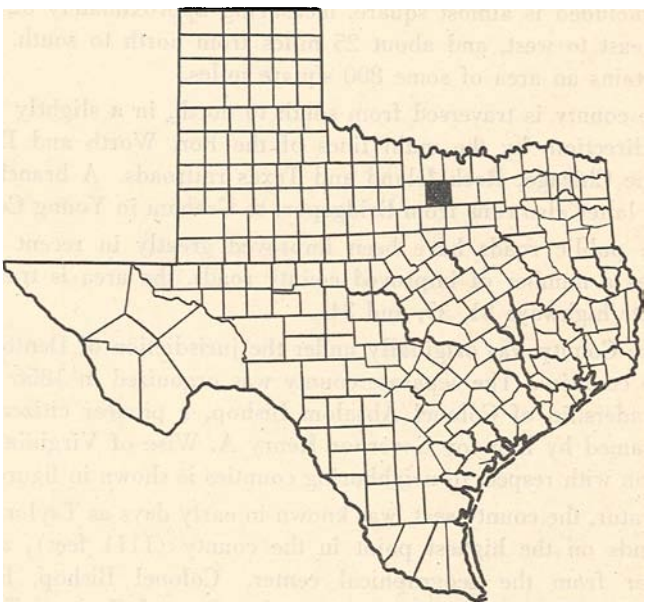

Fig. 1. Map of Texas indicating the position of Wise County.

The region has considerable possibilities from an economic point of view, but its resources have not been fully developed. The human activities are mainly agricultural, and the nature of these pursuits is largely dependent on the geology and physiography. Coal was mined for years near Bridgeport; but the mines were recently closed.

The Pennsylvanian area in the western part offers possibilities for the development of sources of oil, and these are being carefully

investigated at the present time by certain of the oil companies. Also, there are possibilities of oil in the Pennsylvanian of the eastern part, although structure in these beds is concealed by the unconformably overlying Cretaceous beds.

Water wells bear a direct relationship to the geology. Opportunities for Portland cement plants and industries utilizing crushed rock, gravel, brick, lime and other raw materials are considerable. In fact, some of these resources are at present being exploited. They will be considered in a later chapter of this report.

Large areas in the valleys of the major streams are subject to periodic floods; and flood control measures are at present receiving attention. It is hoped that the large Lake Bridgeport will prevent floods in the valley of the West Fork of the Trinity River below the dam.

Accompanying this bulletin is the first detailed geologic map of the county to be published. The Pennsylvanian area in the western part was mapped by Harvard Giddings and O. M. Hudson, geologists of the Prairie Oil and Gas Company, under the direction of J. M. Armstrong. The Comanchean was mapped by Gayle Scott and assistants.

No topographic map of Wise County exists, but the topography of a section along the Trinity River in the southeastern part has recently been mapped in detail. This sheet may be bought for fifteen cents from the United States Geological Survey, Washington, D. C. Except in this area, precise level measurements are limited to the vicinity of the new artificial lake six miles west of Bridgeport, and to railroad levels.

The map used in plotting the geology was compiled by the Texas State Bureau of Economic Geology from maps already mentioned and from abstract records. A number of roads and other features have been added by the writers, as the geological formations were traced.

Previous to this report some geological study was made of the county, and some of the data obtained has been published. The Comanchean area is included in the great work of R. T. Hill.[2] This large report on all of the North Texas counties is accompanied by a map, but unfortunately the report is out of print. Comanchean

[2]Hill, R. T., The Geology of the Black and Grand Prairies of Texas etc. United States Geol. Surv. 21st Ann. Report, Pt. 7, 1900.

regions similar to that of Wise County have been treated, and the formations and their fossils have been described in considerable detail in reports on Tarrant, Denton, Cooke, and Parker counties.[3] Other publications of interest to those studying the Comanchean of north Texas are the University of Texas Bulletins 1945, 2838 and 3232.

The Pennsylvanian rocks in the county have been studied by a number of geologists because of the economic interests involved, but little has been written about them. The first published matter relative to the Pennsylvanian area was by W. F. Cummins,[4] who visited it and described the coal seam that is now mined at Bridgeport.

In 1917 the late Dr. Emil Böse published a small paper[5] in which he described the formations and gave facts relative to the geological features of the region. In 1921 Plummer and Moore[6] published a paper, already classic, on the Pennsylvanian area of north-central Texas, and included the rocks of this age exposed in the western part of Wise County. Plummer at present has a paper in preparation on the geology of Palo Pinto County. In that county the rocks exposed are similar to those occurring in western Wise County.

Temperature and rainfall records for any considerable time are lacking, but the proximity of Fort Worth should enable those interested to apply the data of that city to the area under discussion.

ACKNOWLEDGMENTS

The writers wish to express appreciation to the citizens of Wise County for their coöperation in the preparation of this report. J. H. Cates, Cliff Cates, Sam Renshaw, and W. C. Blythe, all of Decatur, aided greatly in locating survey lines, in locating points of historic interest, and otherwise. Especial thanks are due to the long time

[3]Winton, W. M., and Adkins, W. S., The geology of Tarrant County, Univ. Texas Bull. 1931, 1919.

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[4]Cummins, W. F., Report on the geology of Northwestern Texas, Geol. Surv. Texas, 2nd Ann. Report, 1891.

[5]Böse, Emil, Geological conditions about Bridgeport and Chico, Wise County, Texas, with special reference to the possible occurrence of oil, Univ. Texas Bull. 1758, 1917.

[6]Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations of north-central Texas, Univ. Texas Bull. 2132, 1921.

friend of the late Dr. Böse, W. H. John of Bridgeport, who generously provided Scott and his assistant with the necessary facilities for studying the mines of the Bridgeport Coal Company. Having interested himself for many years in the geology of the area, he had assembled a number of logs of wells drilled in the county and other valuable scientific information which he generously made available.

PHYSIOGRAPHY

Physiographic divisions.—Wise County partakes of two of the major physiographic provinces of Texas, (a) the Central Province, and (b) the East Central Province. Each of these provinces is divisible into sub-provinces and the physiographic features of each division is dependent upon the rock formations underlying it.[7]

(a) The Central Province is represented in the county by the band of hilly country extending across the western edge of the county and far down the Trinity River below Bridgeport. This area is underlain by rocks of Pennsylvanian age and in this report will be referred to as the Pennsylvanian area of the county. It is a part of what was known in the early days of Texas as the Palo Pinto Country. Such local names as Jim Ned Mountains, Rock Hill, Cactus Hill, and Devils Den have, no doubt, been suggested by the rugged nature of the region.

(b) The East Central Province, in which Cretaceous rocks outcrop, includes all of the county except that part belonging in the Central Province.

The Western Cross Timbers Sub-Province of Hill, and other writers, is represented in the southern, central and northern parts of the county. This sub-province is characterized by the sandy soils derived from the sands of the Trinity group of the Comanchean series. The soils are heavily wooded with post oak timber where they have not been cleared for farming.

The eastern part of the county belongs to the Grand Prairie Sub-Province of Hill. Its western border is marked by the scarp passing by Newark, west of Rhome and Decatur, and out of the county into Cooke County at a point west of Greenwood. This

[7]This report follows the physiographic divisions established by Hill in 1900 (Hill, R T., Geography and Geology of the Black and Grand Prairies of Texas, etc., United States Geol. Surv , 21st Ann. Report, Pt 7 p. 26).

division consists of rolling, grass-covered and almost treeless uplands. The Grand Prairie, in the area being discussed, is underlain by limestone, clays and marls belonging to the Fredericksburg and Washita groups of the Comanchean series. In places where the ground is level, a thick mantle of fertile black soil has collected. The more rolling stretches of country are ideal for stock raising.

Topography.—The topography, as well as the features just mentioned, is influenced largely by the geology. The alternate beds of hard and soft materials add greatly to the complexity of surface detail. Since the rocks of the Pennsylvanian area on the west dip to the northwest, and the rocks underlying the remainder of the county dip to the southeast, the two regions have been thrown into sharp topographic contrast by the processes of erosion.

Decatur is located on the highest point in the county (1111 feet). The lowest elevation is approximately 610 feet, at a point where the Trinity River passes out of the county into Tarrant County. The mean elevation is thus around 850 feet.

Drainage.—Wise County is drained entirely by the Trinity River system. The West Fork and its tributaries ramify into most of the area. The Wise-Parker County line lies for a long distance along the divide between the drainage areas of the West Fork and Walnut Creek.

The northeast and east-central parts of the county are drained by the Denton Creek branch of the Trinity system and its tributaries. Rhome, Decatur, and Alvord are located on the divide between the West Fork and Denton Creek, and the Fort Worth and Denver Railroad almost exactly follows the divide entirely across the county.

A small area in the extreme northeastern part is drained by streams which eventually empty into the Trinity River system.

STRATIGRAPHY

Exclusive of gravels, soils, and similar Cenozoic and Recent deposits, rocks belonging to two geological systems, the Pennsylvanian and the Cretaceous, outcrop in Wise County. The Pennsylvanian formations lie along a narrow strip across the western edge of the county, and dip to the northwest. The Comanchean rocks of the Cretaceous system outcrop over the area east of this

belt. They dip to the southeast and, where the drill has penetrated, they are found to lie unconformably over the eroded ends of the Pennsylvanian strata. The depth to the Pennsylvanian rocks becomes greater as one approaches the eastern part of the county. On Plate I is a profile section from Sand Flat School in the western part of the county to Rhome in the eastern part, and gives an idea of the relationship that exists between the Pennsylvanian and Comanchean strata in the area.

PENNSYLVANIAN SYSTEM

Cisco group
Canyon group
Strawn group
Bend group

In the north-central Texas area the rocks of this system (perhaps including some Mississippian strata) are usually divided, in ascending order, into the Bend, Strawn, Canyon and Cisco groups.

Only rocks from the Canyon and the lower part of the Cisco groups outcrop in Wise County. Strawn strata, however, underlie most, if not all, of the area, and it is probable that Bend strata do also. A complete succession of Cisco beds may be seen a short distance to the west in Jack County.

The lowest Pennsylvanian stratum exposed in the county outcrops as a hard, crystalline limestone southeast of Bridgeport in the eastern end of the Rebecca Coleman survey. The outcrop is along the margin of the Trinity River flood plain and crosses the road 200 yards south of Hudson Bridge. It is believed to be of lower Palo Pinto age. The highest Pennsylvanian bed in the area is the Gunsight limestone of upper Cisco age. Its outcrop cuts across the northwest corner of the county.

The total aggregate thickness of the Pennsylvanian formations outcropping in the county amounts to about 2000 feet. The thickness of the Bend and Strawn strata which underlie the area, but are not exposed in it, cannot be determined, since no well has gone entirely through them. The drill, however, has penetrated considerable thicknesses of Strawn rocks at several places in the county.

Pennsylvanian beds in the area dip from 70 to 120 feet to the mile in a direction about 30° west of north, a dip considerably steeper and somewhat more to the north than the normal dips of strata of the same age in the Brazos River area. Minor plunging

anticlinal folds are similar to those in the latter region. Though faulting is not known in the county, it is slightly in evidence a short distance to the west near Vineyard in Jack County.

Over much of the area the Pennsylvanian formations are badly obscured by Comanchean sands, and many outcrops are not continuous for any great distance. For this reason correlations have been difficult. Every outcrop that could be found has been followed. Well samples and logs, and some core drilling information have been used, and satisfactory correlations have been made with the nomenclature established by Plummer and Moore in the Brazos River area.[8]

In spite of the fact that the Pennsylvanian rocks in the region are often poorly exposed, they are of more than usual interest. Most of the formations are considerably thicker and more variable than where they outcrop along the Brazos River. Beds thicken and thin rapidly, and the area seems to have been one of very unequal deposition during Pennsylvanian times.

BEND GROUP

It cannot be definitely proved that formations of Bend age have been reached in wells drilled in the county. No samples were saved from the Magnolia well 2 miles southwest of Chico, but to judge from a correlation based on the log it is possible that this well reached Bend at about 5210 feet. Below that, black shale is logged to 5858 feet with several beds of black limestone from 4 to 35 feet in thickness. One sand 70 feet thick and another 10 feet thick are recorded as showing gas. Bend would be expected to be thicker and have more shale and sand and less lime than in areas to the west. The thickness is estimated at something near 1500 feet, but there are no data to support this estimate.

STRAWN GROUP

Mineral Wells formation
Millsap formation

No outcropping beds of Strawn age are known in the county. Certain limestone beds east of Bridgeport have been classified as Strawn, but it is here proposed to classify them with the Palo Pinto

[8]Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations of north-central Texas, Univ. Texas Bull 2132. 1921.

limestones of the Canyon group. Strawn beds outcropping in Parker County have been mapped by Mr. J. T. Still of the Prairie Oil and Gas Company, and beds in his section can readily be recognized in logs and samples of wells drilled in Wise County.

An interesting subsurface feature is the great thickness of the Strawn. The Magnolia well mentioned above has a thickness of 4300 feet for this group if we accept the correlation of the Bend at 5210 feet. The top of the Strawn is at about 920 feet. The average thickness of the group in southeastern Young County is about 2500 feet. The thickness in eastern Eastland County is about 2100 feet. In general, the intervals expand in all the beds to the eastward and, to some extent, to the northward. This expansion takes place in north-central Texas, being rather gradual and regular in Eastland. Stephens, and Young counties, but becoming more rapid in Comanche, Erath, Palo Pinto, Parker, Jack, and Wise counties. Locally in these counties it is very sudden and abrupt. It is not equally distributed through beds, and the rate of increase in the same interval is very erratic.

Samples have been studied from the Transcontinental well 5½ miles southwest of Chico, center of the south half of W. D. Young survey, and the chief divisions of the Strawn can be satisfactorily correlated by subsurface work and also by matching the members encountered in wells with those of surface sections in Parker County. It must be borne in mind, however, that the intervals are slightly greater in Wise County than farther to the southwest. Several good logs of wells in Wise, Parker and Jack counties, a complete set of samples from Prairie-Brown well near Vineyard just west of the Wise County line, and samples from many other wells have been used in making the correlations.

The Strawn group has been divided into the Millsap and Mineral Wells formations. The Millsap formation includes all the strata from the top of the Bend group to the base of the Thurber coal. The Mineral Wells formation includes the beds between the base of that coal and the lowest ledges of the Palo Pinto formation.

MILLSAP FORMATION

Strata of Millsap age underlying Wise County are known from only a very few well records. Most of the wells drilled in the area have not reached the formation, or have gone only a short distance

into it. Some difficulty is encountered in determining the Thurber coal at the top of the formation, since there are several other coals in the upper Millsap and lower Mineral Wells beds underlying the area. With care, however, the Thurber coal may be located with a fair degree of accuracy.

Thickness.—As noted on a previous page the Magnolia well, two miles west of Chico, probably entered rocks of the Bend group at a depth of 5210 feet. The same well passed through what is believed to be the Thurber coal at a depth of 2400 feet. The thickness of the Millsap at this point should, therefore, be about 2800 feet. It appears certain that the thickness is greater to the northeast, in which direction wells entering the upper members of the formation have revealed a thickening of the beds.

Composition.—The Millsap, as shown by wells, is composed mostly of shale, but there are some important limestones and a few sandstones. The log of the Transcontinental well, drilled near Chico, shows the upper 740 feet of the formation in that area to be composed of shale with several intercalations of thin sand members. Some of the sands have made shows of oil and gas. The next underlying 800 feet is about equally divided between shale and limestone. These limestones, incidentally, are important. Their thinned equivalents outcrop in the Brazos River area at Brannon Bridge and Dennis in Parker County, and at Kickapoo Falls in Hood County. They are being described by the writers in a report on the geology of Parker County now in preparation.

Below the limestones in question, the Magnolia and Transcontinental wells passed through a succession of shales, sandy shales and sands about 700 feet thick. The material is about equally divided between shale and sand. Thin limestones were encountered below a depth of 4000 feet.

Paleontology.—No Millsap fossils have been recorded from the samples taken from wells drilled in the area.

MINERAL WELLS FORMATION

Although this formation does not outcrop in Wise County it has been studied from many well logs and samples. Good surface sections may be seen at the outcrops in Parker and Palo Pinto counties.

Thickness.—The formation is 1480 feet thick in the Transcontinental well near Chico. This is about 300 feet thicker than the

section measured on the surface in western Parker County, and about 600 feet thicker than it measured in eastern Young and eastern Eastland counties. The increase in thickness is greater to the east than to the north. In western Wise County and in western Parker County the thickness sometimes increases as much as 30 feet to the mile. The diagram (Fig. 2) constructed from subsurface data illustrates this change by showing the difference between the strikes of the Thurber coal, Palo Pinto limestone and Gunsight limestone. In the diagram note that two lines are shown on the Palo Pinto. Both are actual contours based on sea-level datum planes. They are

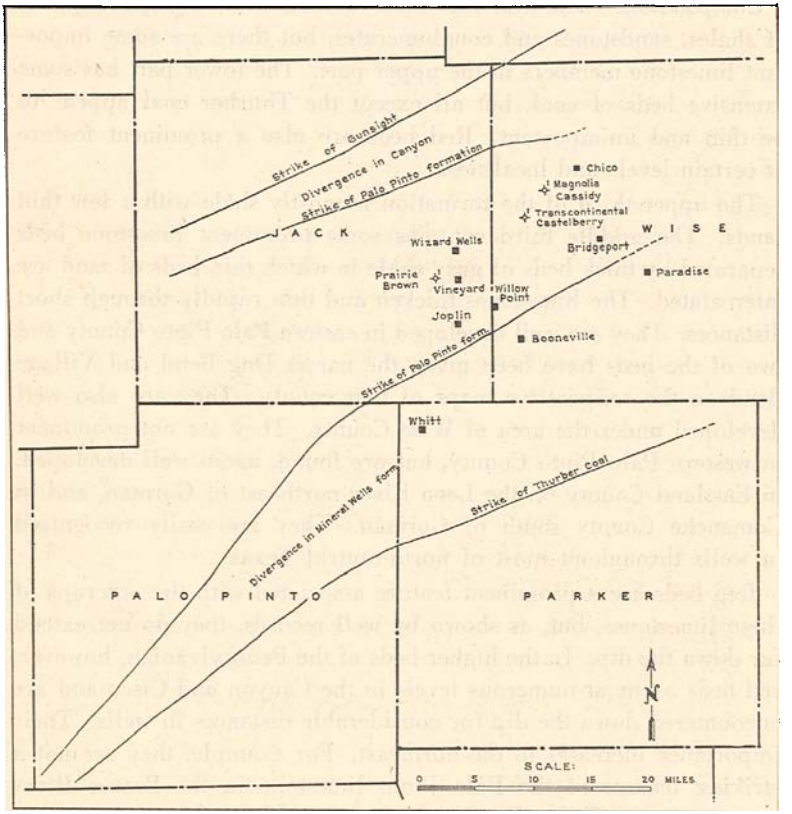

Fig. 2. Diagram showing increase in thickness and change of strike of the Millsap and higher Pennsylvanian formations through Palo Pinto, Parker, Jack, and Wise counties. The data are taken from wells (see text).

closer together in Wise County, because the dip in that area is about twice as steep as in the type region of Palo Pinto County.

A cross-section (Plate II) shows correlations of well sections with the surface section in Parker County. The logs of the Transcontinental and Prairie wells were made from samples. The log of the Magnolia well is a driller's log and the upper beds are changed slightly to conform to known sample determinations in shallow tests around it. The Parker County section does not include all of the Palo Pinto strata, and data to complete the diagram have been taken from well logs and samples, as well as from surface work around Perrin in southeast Jack County.

Composition.—The Mineral Wells formation is largely composed of shales, sandstones and conglomerates, but there are some important limestone members in the upper part. The lower part has some extensive beds of coal, but all except the Thurber coal appear to be thin and unimportant. Red beds are also a prominent feature at certain levels and localities.

The upper third of the formation is mostly shale with a few thin sands. The middle third contains some prominent limestone beds separated by thick beds of gray shale in which thin beds of sand are intercalated. The limestones thicken and thin rapidly through short distances. They are well developed in eastern Palo Pinto County and two of the beds have been given the names Dog Bend and Village Bend on the coöperative maps of that county. They are also well developed under the area of Wise County. They are not prominent in western Palo Pinto County, but are found, again well developed, in Eastland County on the Leon River northeast of Gorman, and in Comanche County south of Gorman. They are easily recognized in wells throughout most of north-central Texas.

Red beds are a prominent feature associated with the outcrops of these limestones, but, as shown by well records, they do not extend far down the dip. In the higher beds of the Pennsylvanian, however, red beds occur at numerous levels in the Canyon and Cisco and are encountered down the dip for considerable distances in wells. Their importance increases to the northeast. For example, they are not a striking feature of the Palo Pinto limestone in the Brazos River area, but are well developed in limestones of Palo Pinto age in Wise County. They must have some paleogeographic significance, since they appear to be characteristic of certain definite conditions of

sedimentation. These red beds are more closely associated with limestones than with shales or sandstones. Ordinarily they are to be found just above or below limestones that are about to pinch out, or at levels where limestones have lensed out laterally. The limestones themselves are splotched red and are even solid red at places where they are about to disappear from the section.

The Brazos River sandstones and conglomerates are below the limestones just described, and are separated from them by thin beds of shale. In some localities the sands and conglomerates form one thick member. At other places there is a shale stratum, often of considerable thickness, about the middle. A few wells have encountered a thin limestone lentil in this shale, and one such limestone outcrops in the shale near the village of Garner in Parker County.

The Brazos River member is exceedingly variable in composition. It is composed of materials ranging from fine grained sands to coarse conglomerates. Usually the particles are angular, and are chert, but in the Transcontinental well some of the material consisted of medium to fine grained, well rounded, well sorted clear particles of quartz. The member is widely distributed and is an important subsurface datum bed. It is believed to be the equivalent of the Buttram oil producing sand of Jack County, and of the so-called Frye sand of Brown County.

Below the Brazos River sandstone and above the Thurber coal is a blue and gray shale member of variable thickness. It is, no doubt, the equivalent of the Mingus shale of the Brazos River section. Its thickness increases rapidly to the northeast.

Coal.—Some unimportant coal seams are in the lower part of the Mingus shale member, and it is difficult to determine which of the seams is the equivalent of the Thurber coal. In Wise County wells a coal has been encountered at about the Thurber coal level, and it has been regularly referred to this coal. The assignment, however, is open to question, since the coal appears to be a little low in the section, and since there are many coals in the upper Millsap and lower Mineral Wells formations under Jack and Wise counties.

In this connection, it is interesting to note that coal seams in the Pennsylvanian of north-central Texas become more numerous toward the northeast. In the Wise and Jack county areas coal seams (not including the bed here referred to the Thurber) have been

encountered in wells in the different formations and groups of the Pennsylvanian as follows: Millsap formation, 3 beds; Mineral Wells formation, 3 beds; Canyon group, 2 beds; and Cisco group, 11 beds. Additional seams are found farther to the southwest in the Bend strata; and the Bend probably contains coal under Wise County.

In all cases it is apparent that the extent of the individual coal seams parallel to the strike greatly exceeds their extent parallel to the dip. The increase in the number of coals to the northeast is shown by a comparison of the logs of wells in widely separated areas. Only one seam is found in the Millsap in the Westheimer and Daube Number 1 C. B. Snyder well in north-central Callihan County. The study of a few scattered samples from the Transcontinental well in Wise County indicates that the Millsap there contains at least three seams. One seam is found in the Mineral Wells formation in eastern Eastland County, and coal has been reported from the formation in one Young County well. The incomplete data in the hands of the writers indicate that at least four seams (including the Thurber coal) are present in the formation in Wise County, and the number probably increases to the northeast. Coal from the Canyon has not been seen in well samples southwest of the Prairie-Brown well in eastern Jack County, but seams outcrop to about the south line of Jack County. Two beds have been encountered in the Canyon strata of Wise County, and it is presumed that the number increases to the northeast.

Depositional conditions indicated by the coal seams.—The coal beds which occur at various levels in the Pennsylvanian strata of Wise County, and which are so numerous in the Millsap and Mineral Wells formations, indicate that the sediments of the system in that area were, for the most part, deposited under very shallow water, near shore conditions. At least the water could scarcely have been deeper than that in which the shallower rocks of the thinner section to the southwest were deposited. The conglomerates also seem to indicate shallow water, near shore conditions of sedimentation for most of these beds. The Strawn and Canyon conglomerates are very abundant at the outcrops in Parker, Wise, and southeast Jack counties. They grade into finer material down the dip and to the southwest, and are not found in wells in that direction. The Cisco conglomerates observe the same gradations, and their zone of occurrence

is from Eastland County to Montague County. The presence of gypsum in some of the shale beds of Parker and Wise counties may indicate rapid evaporation or locally trapped waters in lagunal depressions. Such salts as are found in the mineral waters at Mineral Wells and Wizard Wells were probably similarly precipitated. Sodium chloride in saturated solution in shallow wells is reported by the farmers at Wizard Wells and at Barton's Chapel in Jack County. The latter place, fifty years or more ago, had quite a salt industry. The salt was evaporated from the brines of these shallow wells.

CANYON GROUP

Caddo Creek formation
Brad formation
Graford formation
Palo Pinto formation

The Canyon group of formations is characterized, as elsewhere, by massive limestones and sands which alternate with beds of shale. The total thickness is about 1500 feet. The group is 900 feet thick in southeast Young County. All the sandstones and some of the limestones are very erratic in occurrence. Massive sands are present, but they are not as common in Wise County as in south-central Jack County in the general vicinity of Barton's Chapel. Canyon sands are frequently quite conglomeratic at their farthest up-dip outcrop and become less so down the dip on the outcrops. There are numerous places where this condition has been noticed, but it is best seen in Jack County in the area mentioned above. This is taken to indicate a shore line and source of material to the east. The irregularities of the beds along the strike may be partially dependent on the distance from the old shore line and from stream deltas and other features belonging to it. It seems significant that where erratic interval changes and lensing take place in a series in the area, similar, though less pronounced, changes are found in beds just above and below. Apparently deltaic conditions persisted in some areas long enough to affect deposition in quite a number of succeeding beds.

The formations of the Canyon in order from the oldest upwards are the Palo Pinto, Graford, Brad, and Caddo Creek. All these are present, but not always typically developed, in Wise County.

PALO PINTO FORMATION

The Palo Pinto formation at the type locality of Palo Pinto and at other localities in the vicinity is about 200 feet thick. The lower part, about 125 feet to 150 feet thick, is composed mostly of limestone with some shale breaks. The upper 50 to 75 feet carries thinner limestone with shale predominating.

In Wise County the formation is thicker and consists of several beds of hard crystalline limestone 4 to 15 feet thick, interstratified by shales and sandy shales.

Extent of outcrop.—The Palo Pinto in Wise County is nearly everywhere covered by Comanchean Basement sands and conglomerates. Only where the streams have cut down through these sands can its members be seen. Such outcrops are always isolated and difficult to tie into the section.

In the extreme western part of the county on the J. J. Gohlson survey along Boone Creek, the two upper limestone members outcrop. The second of these ledges is typically Palo Pinto in appearance and is well exposed a few feet below the Sanders Bridge over Boone Creek along the Willow Point-Booneville road. The upper ledge can be studied along the valley of the first creek west of Balsora on the Balsora-Willow Point road, where the limestone lies at the level of the flood plain of the creek.

The limestone members and the intervening and overlying shales are again well shown around the western margin of Martin Lake two miles south of Bridgeport. Here the limestones and shales form a prominent eastward-facing escarpment which overlooks the lake.

One of the ledges may also be seen for a short distance down Dry Creek directly east of Bridgeport, and another outcrops far down the valley of the West Fork of the Trinity. The uppermost Palo Pinto ledge, known as the Willow Point, outcrops more extensively than the others and is found at many localities in the southwestern part of the county.

Thickness.—The total thickness of the beds here referred to the Palo Pinto in Wise County reaches 350 feet.

Composition.—The writers have included the lowest outcropping Pennsylvanian limestone of Wise County in the Palo Pinto formation for the following reasons: These different beds in the isolated outcrops are difficult to distinguish from each other; they form a

natural grouping of similar beds, most individuals of which are separated by short intervals of shale; in wells they can be followed as a group but not as individual members; followed any distance, two members often unite; some members terminate, and new ones are found; the faunas of the various members are all closely related and predominantly Canyon in aspect.

Paleontology.—The Palo Pinto formation in Wise County is richly fossiliferous at many localities and levels, and most of the common Palo Pinto species may be found. On the whole, the fauna is considerably more varied than the typical fauna in the type section in Palo Pinto County. This is to be expected in view of the marked change in facies and the many changes in the lithology both vertically and horizontally. The rich brachiopod and coral faunas of the type section are supplemented by large numbers of common gastropods and pelecypods, and considerable numbers of cephalopods and crinoids are found at certain levels. The principal species occurring in the different beds are listed along with the description of those beds.

Hudson Bridge Limestone.—This name is here assigned to the lowest of the beds in question (Yl_5). It outcrops about three miles southeast of Bridgeport on the south side of the West Fork of the Trinity River at Hudson Bridge, in a ledge about 7 feet thick. Farmers around Paradise have hauled rock long distances from this outcrop to make foundations for their houses. The limestone is hard, crystalline and is stratified in beds 1 foot or less in thickness. The color is dark brown to gray with local pink splotches. The pink is not due to weathering since it is present in freshly broken surfaces. Occasional large masses of chert are found in the top bed. The chert is sparingly fossiliferous, but fossils are not found in great abundance in most of the limestone. They are not easily extracted from the hard, crystalline matrix. There are great numbers of crinoid stems and brachiopods. The member is covered by Comanchean gravels, and the base is not exposed. It dips strongly to the northwest, and passes under the bed of the Trinity River .7 mile west of the road. A second limestone bed (Yl_4) is poorly exposed about 18 feet above it. The outcrop of the Hudson Bridge limestone is an inlier and is totally separated from the Pennsylvanian rocks of the region. It has not been possible to determine

the age of the bed with accuracy, but it can probably be correlated with the stratum marked Sa on the coöperative maps of northwest Parker and northeast Palo Pinto counties, and placed in the Keechi Creek shales (Strawn). The writers believe that this limestone should be included in the Palo Pinto formation, since it is so similar to it lithologically and so close in interval, and since it appears to join the main body of that formation to the southwest.

The following fossils were recognized from the Hudson Bridge limestones:

Fusulina sp. (two specimens)
Composita subtilita (Hall)
Hustedia mormoni (Marcou)
Chonetes mesolobus Girty
Ambocoelia planiconvexa (Shumard)
Squamularia perplexa (McChesney)
Lophophyllum profundum Milne-Edwards and Haime.

Shales and Sandstones above the Hudson Bridge Limestone.—The exact interval between the Hudson Bridge limestone and the limestone exposed in the banks of Dry Creek east of Bridgeport is not known, but it is possibly 90 feet. Only the upper portion of the intervening strata is exposed along Dry Creek. The succession of beds along this stream is shown in the accompanying section (Fig. 3). Two feet of dark friable shales containing red claystone concretions is followed by an 8-foot massive, coarse, brown sandstone above which is 7 feet of sandy shale capped by the limestone mentioned above. The shales carry a few fossils resembling types common to the upper Mineral Wells or lower Canyon. No fossils are found in the sandstone.

Martin Lake Limestone (Yl_3).—This name is here assigned to the lowest of a series of three limestones outcropping around the south and west sides of Martin Lake two miles south of Bridgeport. The limestone is a thin lenticular body lying in the upper part of the shales just described, and it is not found elsewhere in Wise County. The outcrop is only a few hundred feet in extent. The bed is about 4 feet thick, of a reddish-brown color, and is a veritable bed of *Fusulina*. It contains other fossils also, but they do not differ from the species occurring in the richly fossiliferous shales lying a short distance higher in the section. The bed lies at a distance of about 20 feet below the Boone Creek limestone (Yl_2),

which outcrops as the middle one of the three limestones exposed at Martin Lake.

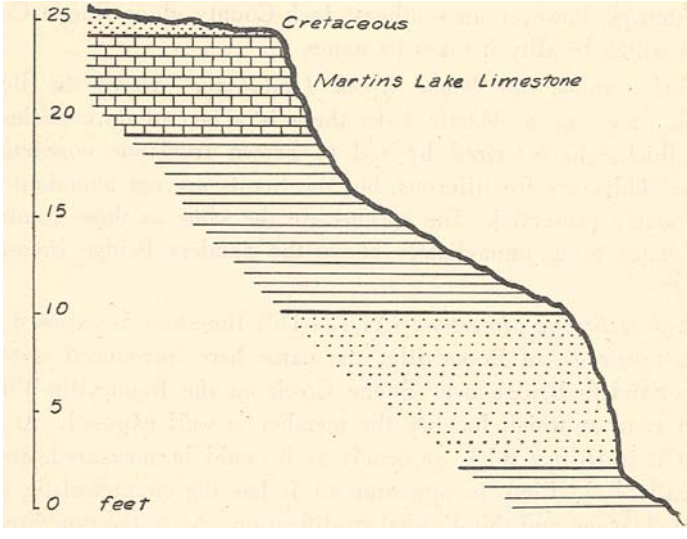

Fig. 3. Section of Palo Pinto strata exposed along Dry Creek 1 mile east of Bridgeport, Wise County, Texas.

Boone Creek Limestone (Yl_2).—The limestone outcropping in Dry Creek is about 7 feet thick, light brown in color, with occasional pink splotches, and weathers to a gray or tan. There are some chert bodies. The bed is richly fossiliferous, but it is difficult to collect good specimens. Crinoid stems are abundant. A surprising feature is the presence of a considerable number of large, poorly preserved corals, probably *Campophyllum sp.* These appear as dark brown areas on the otherwise light colored surface of the weathered beds. The following fossils were identified:

Crinoid stems
Corals (Campophyllum?) very large
Lophophyllum profundum Milne-Edwards and Haime
Composita subtilita (Hall)
Marginifera sp. cf. lasallensis (Worthen)

This limestone is found outcropping as the middle member of the group of three limestones which are exposed, together with the intervening and overlying shales, at Martin Lake, 2 miles south of

Bridgeport. The section is somewhat different at the latter locality, and much more typically Palo Pinto in appearance.

At no other place in Wise County is the Boone Creek exposed. It outcrops, however, in southeast Jack County along Boone Creek, from which locality it takes its name.

Shales above the Boone Creek Limestone.—Above the Boone Creek limestone at Martin Lake there is a bed of dark shales 12 feet thick, characterized by red to brown ironstone concretions. These shales are fossiliferous, but the fossils are not abundant and are poorly preserved. The species are the same as those found in the shales lying immediately above the Sanders Bridge limestone (Yl_1).

Sanders Bridge Limestone (Yl_1).—This limestone is exposed 3¼ miles northwest of Booneville; the name here introduced is taken from Sanders Bridge over Boone Creek on the Booneville-Willow point road at which locality the member is well exposed. At this point it is 16 feet thick, as nearly as it could be measured, and is typically Palo Pinto in appearance. It has the characteristic Palo Pinto cleavage and thin-bedded stratification. As in the type area of the Palo Pinto in Palo Pinto County, huge blocks break off and settle to the bottoms of the slopes. *Composita subtilita* is a common fossil. Other species are present, but the bed here is not very fossiliferous, and specimens are collected with difficulty from the hard matrix.

This bed thins to the east and northeast. At Martin Lake it lies about 12 feet above the Boone Creek bed (Yl_2), and is made up of a single hard limestone ledge. The exposures at the two localities are not at all similar and are correlated only on the basis of well data. The ledge at the Martin Lake locality is very fossiliferous, but specimens are not easily extracted from the crystalline limestone and do not differ from species occurring in the shales immediately above it. The limestone is, in places, a veritable conglomerate of crinoid stems.

Balsora Limestone (Yl).—This limestone member is here named from its outcrop in the valley of a small stream 1 mile west of Balsora. It is found also along Boone Creek where it lies 7 to 10 feet above the Sanders Bridge limestone. The stratum lenses out

into the shales toward the northeast, and is not in the section exposed at Martin Lake.

Where the ledge is exposed west of Balsora and in the valley of Boone Creek in the southwestern part of the county, it is 4 feet thick, is dark brown to gray in color, and is hard and crystalline. Fossils are abundant, but no good specimens were extracted from the hard matrix.

Shales and Sandstones above the Balsora Limestone and below the Bridgeport Coal.—As noted above, the Balsora limestone (Y1) lenses out to the northeast, and the shales underlying it are included in this description.

At Martin Lake the Sanders Bridge limestone is followed by 30 feet of dark, fissile, thinly laminated shales, in which are large numbers of red and brown claystone concretions. On weathering, these turn to yellows and browns.

The shales are unusually fossiliferous, and the beautifully preserved specimens weather out in great abundance and variety. This is, no doubt, the Martin Lake locality which Böse mentions in his report and from which he collected.[9] The following fossils from the locality were recently determined by the writers:

Pseudorthoderas knoxense (McChesney)
Metacoceras sp.
Gastrioceras sp.
Gonioloboceras sp.
Astartella concentrica (Conrad)
Nuculopsis ventricosa (Hall)
Nucula anadontoides Meek
Leda bellistriata Stevens
Anthraconeilo taffiana Girty
Edmondia sp.
Trepospira depressa (Cox)
Worthenia tabulata (Conrad)
Phanerotrema aff. grayvillense (Norwood and Pratten)
Pharkidonotus percarinatus (Conrad)
Patellostium montfortianum (Norwood and Pratten)
Euphemus carbonarius (Cox)
Schizostoma catilloides (Conrad)
Conularia sp.
Dentalium aff. indianum Girty
Lophophyllum profundum Milne-Edwards and Haime
Lophophyllum profundum var. radicosum Girty
Marginifera lasallensis (Worthen)
Composita subtilita (Hall)
Delocrinus? sp.
Fish Tooth

[9]Böse, Emil, Geological conditions near Bridgeport and Chico, Wise County, Texas, with special reference to the occurrence of oil. Univ Texas Bull 1751, p. 10, 1917.

The shales just described are followed by a bed of coarse brown sandstone 12 feet thick. The sandstone outcrops in several isolated localities east and south of Bridgeport, and may be seen capping the scarp west of Martin Lake. It also outcrops just south of the Decatur-Bridgeport highway on Dry Creek and for a considerable distance down that stream. Normally the sand lies about 20 feet below the Bridgeport coal. This stratum is water-bearing and furnishes a satisfactory supply of water for most of the wells in and around Bridgeport. West of that town, however, and at other places down the dip and far away from the outcrop, the waters from this bed are so charged with mineral salts that they are unfit for ordinary uses.

This sandstone member appears to lense out to the southwest along the outcrop. It is followed above by 20 feet of blue to black clay lying immediately under the coal. These clays, together with those overlying the coal, have been used in the manufacture of brick at Bridgeport.

Bridgeport Coal (Yk_1).—This coal seam outcrops at numerous places about Bridgeport and southwest of that town. It was until recently mined at Bridgeport and yielded a good grade of coal from a bed 22 inches thick. Additional material relative to the economic importance of this coal will be given on a later page. Coal plant fossils are found, but they are rare.

The Bridgeport coal is found from Bridgeport to the outcrop southwest of Perrin. It has a very limited down dip extension. It is not found in the Transcontinental or Magnolia wells, or in any of the wells west of Chico. The Prairie-Brown well, near Vineyard in Jack County, had barely a trace of coal. Two shallow tests less than 1 mile west of this town did not show coal, and none has been found in the wells near Perrin or in any other wells in Wise or Jack counties. Subsurface data indicate that a new limestone comes into the section toward the west at about the same level as the Bridgeport coal. It has been reported that in some of the mines at Bridgeport the Willow Point limestone comes down and cuts out the coal to the west; but it is more likely that this condition should be attributed to the new limestone. W. H. John reports that a limestone lies "frozen" to the coal near the Rock Island tracks at Bridgeport.

As noted on a previous page, the coal at Bridgeport was seen by Cummins, but was thought by him to be the same bed that outcrops about Thurber.

Shales above the Bridgeport Coal. — These are blue to black shales, not differing from other shales that normally overlie coal. They were once used extensively about Bridgeport for the manufacture of brick. At one of the two plants material brought up from the mine was used. The shales show a maximum thickness of 55 feet, but in places may be much thinner. In the Number 2 mine shaft of the Bridgeport Coal Company they measure 32 feet.

No fossils were collected.

Willow Point Limestone (Yk).—The type locality of the limestone to which this name is here assigned is Willow Point in the southwest part of the county. The limestone is well exposed, however, in and about the town of Bridgeport and at many localities in the western part of Wise County. This stratum was originally called the Bridgeport limestone by Böse,[10] but since he had already spoken of the coal in connection with Bridgeport, it is thought best to retain that name for the coal. The limestone is about 4 feet thick and of a peculiar composition. It is made up almost entirely of the broken fragments of crinoid stems and many other reworked fossils. When fresh it is hard and crystalline, but it weathers easily and breaks down into a "rotten" limestone. It is light to dark gray when fresh, but weathers to a yellowish-brown. There are many fossils, but most of them are too broken for identification.

The Willow Point limestone is here considered the uppermost member of the Palo Pinto formation. The shale interval below it decreases to the southwest, and, it is believed, lenses out into the Palo Pinto limestone or is taken up by limestone beds of the Palo Pinto in that direction.

The Willow Point is a very persistent limestone and has been followed from the Cretaceous overlap east of Bridgeport to Willow Point. It is covered by Comanchean sands from that town to a point near Perrin in Jack County. but it has been found in all wells drilled in the intervening area. It has been followed from Perrin

[10]Bose, Emil. Geological conditions near Bridgeport and Chico, Wise County Texas, etc, Univ. Texas Bull 1751 p 12 1917.

into Palo Pinto County and is everywhere a very important key bed in subsurface mapping.

GRAFORD FORMATION

Extent of outcrop.—The Graford forms most of the area of outcrop of the Pennsylvanian rocks in Wise County. From a line running through Bridgeport and Willow Point northward to the county line most of the Pennsylvanian rocks belong to this formation. Almost the entire area of the new Lake Bridgeport and much of the surrounding country is on the outcrop of the Graford.

Thickness.—The Graford beds are more than 600 feet thick in Wise County, being considerably thicker there than in the Brazos River section. It is not possible to indicate the exact thickness of the formation since the Adams Branch limestone which normally lies at the top has not been found in Wise County, and some of the lower Ventioner beds which are described under the Brad formation in this report are certainly of Graford age.

Compostion.—The Graford is composed of massive limestones and sandstones, separated by intervening shales which are often very thick. The limestones in particular, and the sandstones to a great extent, are lenticular in cross-section and erratic in occurrence. The accompanying cross-section (Fig. 4) gives some idea of the composition and eccentricities of the Graford in the area under discussion.

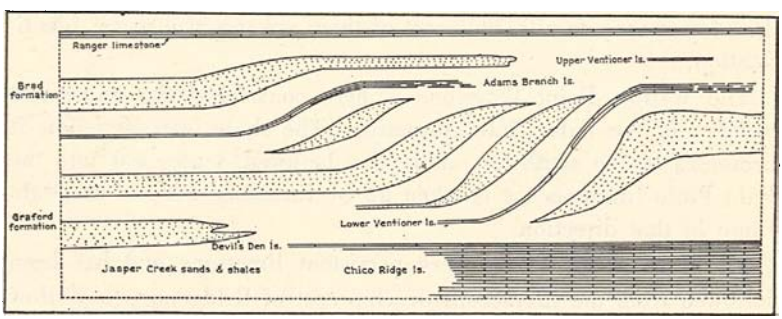

Fig. 4. A composite cross-section showing the variability and relationships of the members of the Graford formation in western Wise County.

The succession of beds differs considerably from that of the standard section along the Brazos River, and on this account it has been difficult to correlate the individual strata.

Paleontology.—Many levels in the Graford of Wise County are richly fossiliferous, and the species are characteristic. Common species of each fossiliferous bed are listed with the description of the member.

Lake Bridgeport Shales.—This name is here given to the shales and sandstones which occupy the interval between the Willow Point limestone below and the Rock Hill limestone above. These beds increase in thickness from less than 100 feet 2 miles northeast of Willow Point to about 300 feet between Bridgeport and Chico and to 550 feet in the Wise-Comanche No. 1 Spann well 2 miles east and ¾ of a mile north of Chico. West and north of Bridgeport the bottom of the series consists of very dark shales, which show up clearly and are so logged in most well records. These shales weather to yellows and browns and leave many claystone concretions on weathered surfaces. They were used in the manufacture of brick at the old Bridgeport plant.

Capping the lower dark shales is a prominent scarp-forming sandstone, which is brown in color, massive, and fine-grained. This sandstone (Yj_{16}) caps the hills immediately to the northwest of the coal mining district at Bridgeport, and maintains a fairly constant interval of about 45 feet below the base of the Rock Hill limestone.

The sandstone is followed above by a series of shales and flaggy sands which becomes more sandy to the northeast. The section near the Magnolia well shows the Lake Bridgeport beds to be 313 feet thick. In this section the upper half is practically all sand, and the lower half is black shale with considerable sand.

Fossils are abundant, varied, and well preserved in at least four levels in the Lake Bridgeport shales as follows: *1st Level.* Trilobites are abundant in the black shales immediately overlying the Willow Point limestone. Several of these were collected in the fresh pit of the Bridgeport Brick Company in north Bridgeport. *2nd Level.* A short distance above this level the shales exposed in the old clay pit of the Bridgeport Brick Company have yielded many beautiful species. The lowest stratum in the pit carries small fossils preserved as pyrite pseudomorphs. The fauna above this level is characterized by the robust size of many of its species. The following fossils have been identified from collections made in this pit:

Gastrioceras spp.
Schistoceras spp.
Popanoceras parkeri (Heilprin)
Goniolobоceras sp.
Metacoceras sp.
Pseudorthoceras knoxense (McChesney)
Agassicrinus sp.
Yoldia glabra Beede and Rogers
Leda cfr. bellistriata Stevens
Nuculopsis ventricosa (Hall)
Astartella concentrica (Conrad)
Trepospira depressa (Cox)
Worthenia tabulata Conrad
Sphaerodoma primigenia (Conrad)
Euphemus carbonarius Cox
Spirifer cameratus Morton
Pustula nebrascaensis (Owen)
Chonetes mesolobus Girty
Lophophyllum profundum Milne-Edwards and Haime

3rd Level. The middle of the upper shale member is unusually fossiliferous. The fauna is characterized by the robust size of many of the species. It is probable that some of these are new, but they are here referred to recorded species.

The following list includes some of the more common forms collected along the scarp east of Hunt Creek and south of the old Bridgeport-Jacksboro road.[11]

Gastrioceras sp.
Shumardites sp.
Marathonites sp.
Pseudorthoceras knoxense (McChesney)
Coloceras sp.
Trepospira depressa (Cox)
Schizostoma catilloides (Conrad)
Worthenia tabulata (Conrad)
Lophophyllum sp.
Pustula nebrascaensis (Owen)

4th Level. The top beds of the Lake Bridgeport shales are one of the most prominent zones of *Fusulina* in the country. These fossils occur in great profusion both in the shales and in the Rock Hill limestone above. There are also other fossils, which do not differ from species found lower in the shales.

Rock Hill Limestone (Yj_{15}).—The lowest limestone lentil in the Graford is the Rock Hill. It first appears on the south line of the F. Edwards survey, 2 miles northeast of the village of Willow Point.

[11]This is no doubt the Hunt Creek locality mentioned by Emil Bose Geological conditions about Bridgeport and Chico Wise County Texas etc Univ Texas Bull 1751 1917

The bed thickens slightly between this point and the Lake Bridgeport Dam, because of the addition of new beds from the bottom. The outcrop forms the range of high hills southeast of Jasper and Hunt creeks, and forms the south beach of the new Lake Bridgeport. Due to lensing, this limestone does not occur on the northwest side of Jasper Creek. The farthest point west at which it has been found is in the Transcontinental well about 6 miles west of Bridgeport. Northeast of the Trinity River it merges into the basal portion of a limestone mass 300 feet thick, which outcrops at Chico and in the bed of Big Sandy Creek near Alvord.

The Rock Hill limestone member is well exposed at numerous places in the western part of the county. At a point where the Trinity River cuts a narrow gap through the limestone and down into the shales beneath it, the Lake Bridgeport Dam has been built This limestone forms the flat top of the long narrow ridge (Rock Hill) extending southwest from the south end of the dam. A convenient place to study it is at the point where the old Bridgeport-Jacksboro road crosses this hill. It was certainly in this general area that Böse first examined and named these rocks and collected fossils from them.

A characteristic feature of the Rock Hill limestone is its conglomeratic appearance. It seems to have been formed by the consolidation of many limestone pebbles cemented by a lime matrix.

Fusulina is abundant, especially just under the limestone.

Chico Ridge Limestone.—This name is here being given to the thick limestone mass the outcrop of which forms the extensive upland known as Chico Ridge, south of Chico and north of the Lake Bridgeport Dam.

The limestone north of the Trinity River interfingers laterally into the shales south of that stream. This relationship is shown in the columnar section on the map accompanying this report (Plate I, in pocket). Two prominent tongues of the limestone (Rock Hill at the base and Devils Den at the top) are well developed south of the river. They thin to the southwest, however, and lense out near Willow Point in Wise County, and Joplin in Jack County respectively.

The Trinity River forms the approximate southern and western boundaries of the Chico Ridge limestone. and its deep valley has

cut through the Rock Hill and Devils Den tongues at their junction with the main limestone mass. South of the river the interval between the Rock Hill and the Devils Den is filled with more than 300 feet of shales and sandstones, named the Jasper Creek shales in this report, which are the exact stratigraphical equivalents of the Chico Ridge limestone north of the river.

The Devils Den limestone and the Jasper Creek shales will be described later.

The Chico Ridge limestone section can be observed at many places between Chico and Lake Bridgeport. The limestone is practically solid and continuous through a thickness of over 300 feet. A small part of the lower portion is dark and somewhat shaly, but most of the mass is white or gray, hard and reef-like in character. The rocks in question disappear beneath the basement Comanchean sands eastward, but the lower portions outcrop on Big Sandy Creek south of Alvord. The rock is quarried and crushed at four large plants.

As already noted, the Trinity River marks the approximate south and west boundaries of the Chico Ridge limestone mass. The small extent of the limestone can be still further appreciated when it is noted that the driller's log and a good set of samples from the Transcontinental well show only 2 feet of the basal portion (Rock Hill limestone) present. This well starts just below a limestone scarp formed by the top ledge of the mass (Devils Den limestone). The interval from this top bed to the bottom limestone stringer exceeds, by at least 80 feet, the total thickness of the limestone beds at Chico.

From a stratigraphic point of view, the Chico Ridge limestone is one of the unexpected features to be found in the Pennsylvanian of the area. Its massive character, its sudden lateral termination to the west and south, the scarcity of well preserved large fossils at most localities, suggest its probable reef-like origin.

It seems that reef-like bodies comparable to the Chico Ridge are not unknown in the Carboniferous in other parts of the world. For example, the well known Cracoe Knolls of the Carboniferous in the north of England are similar, and are present at only a slightly lower level. They are thought to have resulted from the precipitation of calcareous material opposite the mouths of large rivers

carrying great quantities of calcium carbonate in solution. Limestone masses of this order are not to be confused with rapidly thickening lenses which are common in the Pennsylvanian strata of many areas.

It is further interesting to note the influence of this limestone mass on the drainage of the area. The Trinity River, just after it enters Wise County, flows directly toward the mass. Upon encountering the mass, however, the river is deflected in sharp bends around its south edge where a valley has been cut in the soft shales and sands. The river cuts a deep and narrow gap through the lower Rock Hill limestone wedge right up against the main mass, and at this point the new Lake Bridgeport Dam has been recently built.

Jasper Creek Beds.—Above the Rock Hill limestone, lying in the valley of Jasper Creek and on the slopes of the escarpment to the west, is a succession of shales interstratified by four prominent sandstones, each of which is 10 to 15 feet thick. The aggregate thickness of the strata in question amounts to more than 300 feet. The shales are light colored, with yellow and brown beds. Often they are quite sandy or carry thin beds of ripple-marked sandstone flags. Much more sand is present to the southwest of Willow Point, and, according to well samples, near Wizard Wells. In the Transcontinental well the upper half of the section was half sand, but the lower portion was blue shale. On the surface sudden lateral changes may be noted.

The four sandstones mentioned soon pinch out to the northeast: and the shales, which south of the Trinity River lie between the Rock Hill and the Devils Den, show a change of facies to limestone on the north side of the river, as already described.

Characteristic Graford fossils occur in these beds in many places, but there are no outstandingly fossiliferous levels. Near the top of the shales, just under the ledges of the Devils Den limestone on the old Bridgeport-Jacksboro road at the county line, is a bed of *Fusulina* and other fossils; but, except for *Fusulina,* the fauna is sparse.

Devils Den Limestone (Wizard Wells) (Yj^9).—This name was assigned by Böse[12] to the limestone capping the escarpment known

[12]Böse, Emil, Geological conditions near Bridgeport and Chico, Wise County, Texas, Univ. Texas Bull. 1758. p. 17, 1917.

as "Jim Ned Hill" in the western part of the county along the old Bridgeport-Jacksboro road and to the outcropping at Wizard Wells and at Devils Den near by. This stratum, north of the Trinity River, forms the top of the Chico Ridge limestone already described. To the south and west it pinches out into the form of a wedge or finger. It reaches a thickness of 50 feet, but averages about 25 feet in thickness from the Transcontinental well southwestward to the hills east of the villages of Wizard Wells and Vineyard in Jack County. It does not appear on the west side of the valley at Wizard Wells. On the east side of this valley its rapid disappearance to the southwest can be seen on the surface in its wedge-like form. In a distance of about one-half mile it merges into a sandstone that appears above and below it. On the east side of the valley at Vineyard it shows an abrupt thinning, but still exists as a thin ledge on the west side of this valley as far south as the village of Joplin in Jack County.

The Devils Den limestone is fossiliferous in many places, and the species are typical Canyon forms.

For a time it was thought that the Devils Den limestone might be the equivalent of the Adams Branch of the Brazos River section, and, therefore, the top of the Graford formation. A study of the strata exposed in Jack County, however, has demonstrated that the Adams Branch is somewhat higher (perhaps 200 feet) in the section than the Devils Den, and that the Adams Branch lenses out completely before reaching the area of Wise County. In spite of these facts, and because the top of the Graford cannot actually be determined, the Devils Den is arbitrarily taken as the top of the formation in this report.

BRAD FORMATION

Extent of outcrop.—Strata belonging to this formation jut into Wise County from Jack County, and outcrop over an area of about 25 to 50 square miles. On account of the resistant ledges of limestone, the area is topographically very rough. The Trinity River and its tributaries have so dissected the scarps that the traces of outcropping ledges are unsusually dendritic. For reasons already pointed out, it is difficult to indicate exactly the contact of the Brad and the Graford.

Thickness.—The total thickness of the rocks here referred to the Brad formation is about 400 feet in Jack County, and is probably about the same in western Wise County.

Composition.—In the area under consideration, the lower Brad consists of sands, shales, and sandy shales. The Ranger limestone forms the top of the formation as in the standard section.

Paleontology.—The Brad is fossiliferous at several levels, and the species are characteristic Canyon forms.

Ventioner Beds.—The strata to which this new name is assigned overlie the Devils Den limestone and have a total thickness of at least 300 feet. The beds are composed of different proportions of sands and shales with two limestone lentils. In some sections most of the thickness is composed of massive sands, but at other localities it is made up almost entirely of black to blue shale. At different localities the proportion of sand in the section ranges from 20 to 80 percent.

As noted in the description of the Graford formation, the absence of the Adams Branch limestone in the area makes it impossible to accurately place the Graford-Brad contact, and the lower Ventioner beds here described with the Brad are certainly of Graford age. From the standpoint of stratigraphy it would be better to place the Ventioner beds in the Graford since, like the other members of that formation, they are characterized by rapid lateral and vertical changes. This arrangement, however, would leave only the Ranger limestone in the Brad, and it is shown on the map as a line only. For convenience in mapping, therefore, the Ventioner beds, while admittedly partly Graford in age, are grouped with the Brad formation.

The lowest of the limestone lentils (Yj^8) can be observed along the bluff on the west side of the Trinity River up-stream from the mouth of Ventioner Creek. Here it is a limestone bed less than 1 foot thick, interbedded with sand and shale, and rich in specimens of *Fusulina.* It may appear farther south but the writers have not followed it. In this area it maintains a rather constant interval of about 40 feet above the Devils Den limestone.

From the mouth of the Ventioner Creek it can be followed due north to within 1000 feet of the Chico-Jacksboro highway where

it becomes obscured by the Comanchean Basement sands. It reappears again in the banks of both branches of Ventioner Creek ¾ of a mile northwest of the bridge. Its thickness increases rapidly to the north and is about 15 feet near the Chico-Jacksboro highway. This limestone does not appear along the Chico-Wichita Falls highway north of Chico, although streams along the road have cut through the Cretaceous into the Pennsylvanian. It seems likely that this limestone is not present in the section very far east of its northeastern-most exposure.

An interesting feature of this limestone lentil is the rapid increase of its interval over the Devils Den toward the northeast. Within a distance of about 4 miles this interval increases from about 40 feet to 300 feet. The interval above the lentil and below the Ranger limestone does not undergo a similar increase, but decreases to the northeast by an amount about equal to the increase just described, so that the Ranger-Chico Ridge interval is about constant, and the lentil appears to transgress the section to the northeast. Rapid changes of interval comparable to the one just described are not uncommon in the Pennsylvanian of this country and have been observed by the writers and others at various places in Palo Pinto, Jack, and other counties.

The second limestone lentil (Yj_7) is a thin, yellow to brown, fossiliferous limestone which occurs only locally, at a distance of about 40 feet above the one just described. It is exposed 1000 feet south of the Chico-Jacksboro highway 1 mile west of the Ventioner Creek bridge, and in the west fork of the creek ¾ of a mile north of the highway.

Between the limestones just described and the bottom of the Ranger there is an interval of 60 to about 300 feet in thickness. This is not well exposed, but apparently consists mostly of shale. Shales exposed just under the Ranger are dark and fossiliferous. The lower shales are lighter colored and arenaceous and are interspersed with many sandstone flag layers, some of which are beautifully ripple-marked. A short distance south of the highway a thick, massive sand comes into the section, and in the west edge of the county near Wizard Wells the section is composed of massive sands and sandy shales. A good area in which to see this changing section, and all members of the Graford formation, is along the road running slightly

south of west from Chico to the Jack County line near Sand Flat School. The road climbs a scarp of one of these sand lenses (Yf_2) near the school and follows it to the county line. The sandstone is coarse, brown and well consolidated. Huge blocks break off and slide down the side of the scarp. Still farther west, as previously mentioned, the Adams Branch appears in the section and has about the same relation to the Ranger limestone as the limestone lentils on Ventioner Creek bear to the Ranger. A suggested interpretation for this phenomenon (see figure 4) is that these limestone beds were deposited over the basinward flanks of a Pennsylvanian delta.

Typical species of Canyon fossils are found at many localities in the shales, and both limestone lentils carry *Fusulina* and other fossils. No unusually fossiliferous localities, however, were found and no extensive collections were made.

Ranger Limestone.—The Ranger limestone (Yf_1) forms the top of the Brad formation, and in Wise County is well developed along the Chico-Jacksboro highway just east of the Jack County line. It is the most reliable bed to follow from Wise County to the outcrops in the Brazos River section, although it shows evidence of sedimentary irregularity in places. It has been searched for, but not found, in the streams north of Chico along the highway to Wichita Falls. A thin, sandy, crinoidal limestone in a creek west of the highway about one mile south of Park Springs may represent a changing facies of this stratum.

At the northern-most bend in the highway, just south of the road there is an excavation in which the Ranger limestone is exposed. It is 18 to 25 feet thick and very massive. The top part of this limestone usually weathers and does not take part in forming the scarps. Some of the beds show the conglomeratic appearance so characteristic of a number of the Pennsylvanian limestones in this area, and the characteristic chert nodules are present, but in less abundance than farther south. Near the middle of the bed is an iron-stained shale parting a few inches thick in which many species of Bryozoa occur in such profusion that they may be scooped up by the handfuls. Another paleontologic feature is the presence of considerable numbers of brachiopods, particularly large specimens of *Productus cfr. cora.* All the limestone exposed at this place probably

belongs to the lower massive ledge as developed along the Brazos. The upper thin ledge, if present, is covered by Cretaceous sands.

It is possible that the limestone here referred to the Ranger is the same as the one named Elm Creek by Böse,[13] but that writer's description is so sketchy that it is not possible to be certain which stratum he had in mind. Elm Creek is, therefore, being ignored in this report.

The following fossil species have been identified from collections made in the Ranger limestone of Wise County:

Productus semireticulatus (Martin)
Productus cora D'Orbigny
Composita subtilita (Hall)
Marginifera muricata Norwood and Pratten
Marginifera lassallensis (Worthen)
Squamularia perplexa (McChesney)
Spirifer cameratus Morton
Bryozoa (many species)

CADDO CREEK FORMATION

Extent of outcrop.—So far as the region under consideration is concerned, the area of outcrop of the Caddo Creek formation is very limited. Nearly everywhere it is covered by a blanket of Comanchean sands. The lower fossiliferous shales immediately overlying the Ranger limestone can be seen in a small area just east of the Jack County line and north of the Chico-Jacksboro highway. Some of the upper beds are poorly exposed in a limited region southwest of Crafton. Wise County is, therefore, a poor area in which to study the formation. These rocks are much better exposed in the area to the west in Jack County.

Thickness.—No place was found in the county where a complete section of the Caddo Creek could be measured, but the formation probably reaches a thickness of 400 feet where the top member, the Jacksboro-Home Creek limestone, disappears 10 miles northeast of Jacksboro. Here the thickness rapidly increases to the northeast. The writers believe that the increase results from the upward migration of the Jacksboro-Home Creek limestone in the section.

Composition.—The Caddo Creek formation in Wise County contains fewer calcareous members than in the standard section along the Brazos River, since most of these disappear as mappable units

[13]Böse, Emil, Geological conditions about Bridgeport and Chico, Wise County, Texas, Univ. Texas Bull. 1758, p. 18, 1917.

in Jack County. The Jacksboro-Home Creek limestone, which forms the top of the formation, cannot be traced by its surface outcrop into Wise County. In the formation in Jack County there are three limestone ledges which have been labeled the Cundiff limestones on the coöperative map of Jack County. The two upper ledges (Yc_1 and Yc_2 on the map) project into Wise County. They can be seen in a small area southwest of Crafton, but soon disappear beneath the Comanchean sands.

The formation consists in the main of shales and sandy shales with a few thin beds of sandstone; but an accurate description of these strata and their proper succession cannot be given until after the formation has been studied in an area where the rocks are better exposed.

Paleontology.—Fossils are abundant, varied, and well preserved in the basal shales of the formation. A few have also been collected from the Cundiff limestone members and shales associated with them. Elsewhere in Wise County the Caddo Creek formation is relatively barren.

Hog Creek Shales.—These are named from Hog Creek in Palo Pinto County, and compose the lower part of the formation. The Hog Creek shales are well shown at a point along the Jacksboro-Chico highway, 1½ miles north of the road and just east of the Jack County line. They are especially interesting because of the many beautifully preserved fossils which they contain. The shales are light yellows and browns, and contain many small claystone concretions. They have weathered in such a manner that the fossils are placered out in great numbers. It is possible that this is another one of the localities visited by Böse. A partial list of the species collected at this point follows:

Gastrioceras spp.
Marathonites sp.
Schistoceras sp.
Shumardites sp.
Uddenites sp.
Metacoceras sp.
Metacoceras cornutum Hyatt
Metacoceras sculptile Hyatt
Metacoceras cornutum var. carinatum Girty
Nuculopsis ventricosa (Hall)
Astartella concentrica (Conrad)
Leda bellistriata Stevens
Yoldia glabra Beede and Rogers

Schizodus alpinus (Hall)
Schizostoma catilloides (Conrad)
Euphemus carbonarius (Cox)
Pharkidonotus percarinatus (Conrad)
Bellerophon crassus Girty
Conularia sp.
Trepospira depressa (Cox)
Worthenia tabulata (Conrad)
Spirifer cameratus Morton
Spirifer texanus Morton
Productus semireticulatus (Martin)
Chonetes granulifer Owen
Lophophyllum profundum Milne-Edwards and Haime

Cundiff Limestone.—Three ledges of limestone outcropping in the eastern part of Jack County near Cundiff take their name from the village. The lower of the three ledges pinches out before reaching Wise County, and the upper two are only poorly exposed. They are separated by about 75 feet of shale. The ledges are each approximately 3 feet thick and are composed of hard, crystalline limestone, apparently of algal origin. An interesting feature is the roughness of the lower surfaces of the ledges as compared with the smooth upper surfaces. The irregularities are caused by algal impressions left in the underlying muds into which the first layers of the limestones were deposited.

In the shales underlying the lowest of the two ledges there is a sparse fauna. The species are typical upper Canyon forms.

CISCO GROUP

GRAHAM FORMATION

Extent of outcrop.—In the area under discussion only a few of the members of the Graham are exposed well enough for study, and the outcrops are limited in extent. A little of the lower part of the formation is shown along the county line northwest of Crafton, where some sandy shales are poorly exposed through the covering of Comanchean sands. The Graham outcrops, also, in a strip about 1½ miles wide and about 5 miles long in the extreme northwestern part of the county along the Montague County line.

Thickness.—The contact of the Graham formation with the underlying Caddo Creek could not be located, and the thickness of the beds could not be measured, but the Graham apparently thickens to the northeast. According to the composite section compiled by the geologists of the Prairie Oil and Gas Company, there should

be about 350 feet of Graham strata below the Gunsight limestone, which is the highest Pennsylvanian bed exposed in Wise County.

Paleontology.—Fossils are not abundant in most of the Graham examined. The shales, sandy shales, and sandstones appear to be totally barren. A sandy limestone (Cw_2) near the base is fossiliferous, and the Gunsight limestone is another important zone of *Fusulina.*

Strata underlying the Gunsight limestone.—These are partially exposed in the area northwest of Crafton. The soft sandy limestone ledge (Cw_2) and a sandstone immediately overlying it, outcrop more prominently than the other strata. The limestone is about 2 feet thick and is full of crinoid stems and other fossils, but they are poorly preserved and crumble easily. A large species of *Bellerophon* is especially abundant. This ledge again reaches the surface in the eastern end of the band of outcrop lying along the Montague County line.

Above the ledge, in the latter area, quick successions of thin beds of dark shales, sandy shales, and sandstones occur. Across the northwest corner of the county the sandstones are indurated and stand out in low, but prominent, scarps that face southeastward. Several of these scarp forming members have been mapped by the geologists of the Prairie Oil and Gas Company, and have been placed in the section as indicated.

Gunsight Limestone.—This bed of hard, yellow to light brown limestone is only 2 feet thick and is the highest Pennsylvanian stratum to outcrop in Wise County. It caps the succession of shales, sandy shales, and sandstones just described. Here, as in many places elsewhere, it contains great quantities of a species of *Fusulina.*

CRETACEOUS SYSTEM

Comanche Series

Washita group
Fredericksburg group
Trinity group

All three groups of the Comanche series are represented in Wise County. The lowest beds of the series are the Trinity or Basement sands, and the highest are the Fort Worth formation of the Washita group. Higher beds of the series may be seen to the east in Denton

County. All of the Comanchean dips normally to the southeast at the rate of about 40 feet to the mile.

For the succession of Comanchean rocks exposed in Wise County see the composite section accompanying the map.

TRINITY GROUP

Paluxy formation
Glen Rose formation
Basement sands

This group contains three mappable members in Wise County. They are all three parts of a single depositional unit, and though treated here as separate formations they are not really separate. These members are, from bottom to top, the Basement sands and conglomerates, the Glen Rose limestones, and the Paluxy sands. Near the middle of the county the Glen Rose pinches out between the two sands, and from this point northward the Basement sands and conglomerates and the Paluxy sands become indistinguishable. They are there grouped together under the name "Antlers sands." This relationship was long ago described by R. T. Hill[14] and should be continually borne in mind in the study of either or all of the three members.

BASEMENT AND ANTLERS SANDS

Extent of outcrop.—The sands outcrop over large areas of the western, central, and northwestern parts of the county, where they spread broad blankets of sand, often only a few feet thick, over the underlying Pennsylvanain beds. Locally plots of these gravelly sands occur over large regions almost, or entirely, separated from the main body of the outcrop. One such plot is found along the Jacksboro road west of Chico, and there are others farther west in Jack County. These outliers, consisting of numerous patches of sand, bear witness to the fact that Comanchean sediments once covered the entire county and spread beyond its borders to the west. They have been removed from large areas by subsequent erosion which exposed and dissected the underlying Pennsylvanian strata.

[14]Hill, R. T., The Geography and Geology of the Black and Grand Prairies of Texas, etc., U. S. Geol. Surv. 21st Ann. Report, Pt. VII, 1900.

Thickness.—The Basement sands, on account of the nature of their origin, differ greatly in thickness. Because of their unconsolidated nature, they are difficult to measure with any accuracy along the outcrop, but the thicknesses measured in drill holes range from 100 feet to 200 feet.

Most of the well measurements unfortunately are not very reliable since it was not possible to get samples from the wells for checking. The Stone, Priddy, and Cummings well (J. P. Williams, No. 1) on the Hunt County school land started in the Antlers sand about 70 feet below the Walnut shell agglomerate and apparently passed into the Pennsylvanian at a depth of 65 feet, thus giving the Antlers at this point a thickness of around 135 feet.

The Keystone well No. 1 in the southeastern part of the county, if our interpretation of the log is correct, shows 15 feet of Duck Creek, 35 feet of Kiamichi, 100 feet of Goodland, 80 feet of Paluxy, 25 feet of Glen Rose, and 175 feet of Basement sand.

The Paradise well near Paradise apparently went into Pennsylvanian strata at a depth of 131 feet. The well starts about 40 feet below the base of the Glen Rose. The Basement sands should therefore be about 180 feet thick at this point.

The log of the Hattie Bell well seems to indicate about 113 feet of Paluxy and 195 feet of Glen Rose and Basement sands, but this log is very difficult to interpret. A core test drilled by the Pure Oil Company 2 miles southwest of Aubrey, Denton County, was examined by the writer. It went through approximately 200 feet of Basement sand below the Glen Rose. The drill encountered no conglomerate before passing into the Pennsylvanian.

Composition.—The Basement and Antlers sands are composed almost entirely of quartz particles. There are some clay, sandy clay, and even calcareous beds, but they can seldom be seen for the sand. The sand strata break down into deep sandy soils, which are usually heavily wooded with post oak timber where they have not been cleared for farming. Fields wash and blow badly, and many farms have become so denuded of their soils from lack of care that they are unproductive and have had to be abandoned.

The wooded area of the outcrop of the Trinity (Basement, Paluxy, Antlers) sands was long ago named the Western or Upper Cross Timbers to distinguish it from the Eastern or Lower Cross Timbers.

This Lower Cross Timbers belt, the sandy soils of which are derived from the Woodbine formation, passes in a north-south direction through Denton, Tarrant, and other counties.

The quartz particles which compose the Comanchean sands and conglomerates range in size from the finest sand to large pebbles 3 inches in diameter; and all are well rounded. No complete section of these beds has been found where the different levels could be studied. The basal beds, however, are composed of the coarser conglomeratic material and some sand; their thickness varies. Usually the basal beds are made up of loose gravel, but often, where they overlie Pennsylvanian limestone, percolating waters have consolidated the gravel, and chunks of red conglomerate may be found pasted to slabs of the Pennsylvanian limestone. Fragments of these materials are found widely over the Pennsylvanian area in many parts of Texas. The basal conglomerates are not found in wells east of the outcrop, and it is difficult to tell when the drill passes from Comanchean to Pennsylvanian.

The basal conglomerates grade upward into finer sands, known as "pack sands," and thence to clays and limestones of the Glen Rose formation. In many places boulder beds composed of large and small calcareous concretions occur a short distance below the Glen Rose. Locally these are found in fields in considerable quantities and are a hindrance to cultivation. The concretions disappear with the lensing out of the Glen Rose just northwest of Decatur. It is a temptation to map such beds with the Glen Rose, but since they nowhere contain fossils, it seems better on the whole to include them in the sands.

At nearly all levels the Basement and Antlers sands are strongly cross-bedded, though in places the finer material is evenly stratified.

The sands immediately underlying the Glen Rose differ greatly in color. Most of the sands are white or only slightly stained with iron. True "red beds," however, are common and characteristic. These beds, when freshly exposed, are in reality a deep royal purple. The brilliant coloring probably results from the hydration of the iron salts contained in the sands. The Trinity "red beds" are well exposed along the Decatur-Bridgeport road a short distance east of Bridgeport and at many other places.

Paleontology.—The writers found many silicified logs and pieces of wood in the Basement sands of Wise County, but no determinable fossils. Fossils occur in these sands farther south. They were, in fact, first called "dinosaur sands," from the bones and tracks of dinosaurs found in them. Fossils leaves have been found at Glen Rose, and fossils of the Cretaceous plant *Cycadeoidea* have been found at a number of places. Dr. Böse[15] reports that he found a well preserved cycad in the basal conglomerates near the base of one of the Glen Rose outliers southwest of Bridgeport.

GLEN ROSE FORMATION

Although this formation is ordinarily called a limestone over most of the area of Texas where it is well developed, it really contains more clay than limestone at its outcrop in Wise County.

Extent of outcrop.—The Glen Rose in this area consists of only three or four thin ledges of limestone interstratified with clays, sandy clays, and sands, and the total thickness is never more than 25 feet. The outcrop enters the county from Jack County in the extreme southwest corner about 2 miles from the Parker County line. From that place it passes eastward by way of Cottondale and Boyd to the valley of the Trinity River. From here it follows closely the bank of the river and goes under the bed of the stream about 1½ miles below Boyd. The outcrop may be seen in the bed of the Trinity under the bridge on the old John Crump survey.

On the northeast side of the stream the outcrop takes a course slightly west of north, follows the valley closely to a point opposite the town of Paradise, and then takes a course almost due north. It crosses the Decatur-Bridgeport highway 2.3 miles west of Decatur. The outcrop is last seen about 6 miles northwest of Decatur near the Fort Worth and Denver Railroad. This is the farthest point east at which an outcrop of the Glen Rose has been seen and studied in Texas. The formation either pinches out here or becomes so thin that it cannot be traced farther through the sands.

Because of its unusual thinness in Wise County the main outcrop of the Glen Rose is never broad—seldom more than a few feet.

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[15]Böse. Emil. Geological conditions near Bridgeport and Chico, Wise County, etc., Univ. Texas Bull. 1758, p. 19, 1917. See, also, Wieland, G. R., Two new North American cycadeoids. Canada Geol. Surv. Bull. 33, 1921.

Occasionally, as in several places southwest of Bridgeport, the hard limestone ledges cap outliers of considerable extent.

Throughout much of the area of its outcrop the Glen Rose forms prominent escarpments, but often the thick sands above and below the thin limestone ledges obscure them so that the outcrop can be traced only by occasional exposures. Such exposures are found in the southwest part of the county and again in the area west of Decatur. Since the formation thins to the northwest, it is not very thick in either region. In the area around Cottondale and across the river from Boyd and Paradise, prominent escarpments are very common.

Particular types of vegetation are peculiar to the formation. For example, it can often be located from a considerable distance by occasional clumps of live oak which grow on its scarp but not on the sands outcropping above and below.

Thickness.—As already noted, the Glen Rose is thick nowhere in Wise County. At Cottondale, 22 feet of beds belonging to the formation were measured. Near Boyd it is perhaps a little thicker, but at no place could a complete section be measured. The Keystone well in the southeast part of the county reveals a thickness of 25 feet. Northwest of Decatur, where the formation is last seen, it is 2½ feet thick.

It is interesting to compare these thicknesses with those of sections measured in other counties. In the southern part of Parker County one of the writers measured 195 feet of limestone and clay strata belonging to the Glen Rose. At the type locality it is 236 feet thick, and many of the beds of limestone are massive. Near Austin the formation may be nearly 1000 feet thick, and many of its members are composed of massive limestone.

As pointed out in an earlier paper,[16] the thinning of the Glen Rose to the northwest results from the successive pinching out of both its upper and lower members into the Paluxy and Basement sands, so that in Wise County only two members are left. These correspond to members found near the middle of the formation farther south. In Parker County the members which lense out may be seen easily, and two of the upper ones are shown on the map

[16]Scott, Gayle, The stratigraphy of the Trinity division as exhibited in Parker County, Texas, Univ. Texas Bull. 3001, pp. 38–52, 1930.

of that county (KGr and KGr_1). Of these, however, only KGr_1 extends into Wise County. It is seen in isolated outcrops along the east side of the Trinity river just above Newark.

Composition.—From bottom to top and from locality to locality the Glen Rose is unusually varied in composition. The beds grade downward into the underlying sands so imperceptibly that the lower contact is difficult to fix and probably would not be placed at exactly the same level by any two observers. The writers have placed the lower contact at the lowest point where marine fossils occur. Underlying the beds of clay and limestones at different intervals are beds of calcareous claystone concretions. These are sometimes sufficiently numerous to hold up the sands and form a prominence on the topography. Under these conditions they strongly resemble the Glen Rose. Since they contain no fossils, however, they have been excluded from that formation.

In Wise County, the Glen Rose is more of a calcareous clay than a limestone, but there are usually one, two, or three hard crystalline limestone ledges of 1 foot or more in thickness. Sometimes one ledge will be prominent, sometimes another. Clays, sandy clays, and even sands lie between the ledges. If all the ledges are soft (as occasionally they are), they may break down and become so entirely covered by the sands that their outcrops can hardly be followed. There are no very hard ledges at Cottondale, but favorable erosion conditions have caused the formation to stand out in a prominent escarpment south of Salt Creek. Southwest of Bridgeport the outliers are capped by a limestone ledge 4 feet thick and of unusual hardness. Under this ledge after an interval of 10 feet is another of softer nodular limestone 2 feet thick. (See section, Fig. 5b.) This lower ledge caps one of the outliers, which may be distinguished from the others by its more rounded appearance and by the fact that it has no trees around the margin of its cap.

A single ledge of limestone about 2½ feet thick is located 2.3 miles west of Decatur. It is hard and somewhat cross-bedded. Huge blocks have been thrown out in making the highway excavations.

Perhaps the two most interesting features of the Glen Rose in Wise County are the manner in which it lenses out to the northwest and the way in which the trace of its outcrop turns sharply to the east in Jack County just before entering Wise County (see Fig. 6).

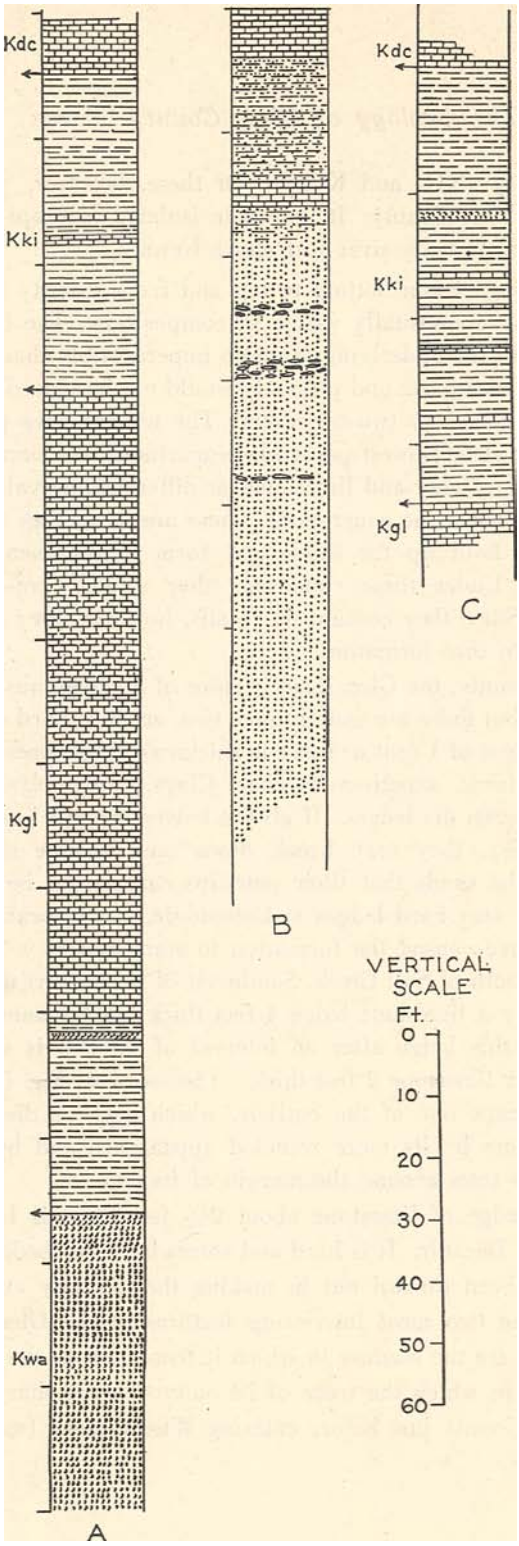

Fig. 5. For explanation see opposite page.

These facts indicate that during Glen Rose time there was here an embayment of considerable size, the apex of which centered itself in western Wise and eastern Jack counties. During Walnut time the apex of this embayment must have moved to the east. This is shown by the way in which the margin of the Glen Rose is overlapped by the Walnut and Paluxy. Of course, the turn in the outcrop is accentuated by the erosion of the Trinity River, but it is marked even when the indentation caused by this stream is neglected. The Glen Rose shore line must have run in an almost east-west direction through Wise County from a point southwest of Bridgeport to the eastern part of the county. Only a little Glen Rose, if any, is present in the Hattie Bell well 6 miles east of Decatur. The cores of the two tests drilled by the Pure Oil Company near Aubrey, Denton County, showed respectively 5 feet and 10 feet of fossiliferous calcareaus sandstone which should probably be referred to the Glen Rose.

Paleontology.—Everywhere in Texas, the Glen Rose is rich in fossils, and Wise County is no exception. The fossils are seldom well preserved, but most of the common species known to the formation can be found in this area. A good collection was made 6 miles northwest of Decatur, but the specimens were mostly undeterminable. Fossils are abundant and fairly well preserved along the scarp south of Salt Creek at Cottondale and at other places.

Certain groups of fossils common to the formation farther south are notably lacking. *Monopleura, Orbitolina, Porocystis,* echinoids *(Loriolia),* and corals have not been found.

Some plant fossils have been described by Torrey[17] from a locality 1 mile south of Cottondale. These might equally well have been from the Glen Rose, the Paluxy, or the Basement sands. The writers found no determinable specimens in either.

[17]Torrey, R. E. The Comparative Anatomy and Phylogeny of the Coniferales, Part 3, Mesozoic and Tertiary coniferous woods, Mem. Bost. Soc. Nat. Hist., Vol. 6, No. 2, 1923.

Fig. 5. a. Section of Fredericksburg strata along the road one mile west of Rhome, Wise County, Texas.

b. Section taken at the large Glen Rose capped outlier to the north of the Bridgeport-Balsora road southwest of Bridgeport, Wise County, Texas.

c. Detailed columnar section of the Kiamichi formation as it is exposed on the south side of the valley of Sweetwater Creek and along the Decatur-Stony road in Wise County, Texas.

The following fossils have been collected from the Glen Rose in Wise County:

Exogyra weatherfordensis Cragin
Trigonia stolleyi? Hill
Anomia sp. Hill
Modiola branneri Hill
Pholadomya? knowltoni? Hill
Cucullaea (Idonearca) terminalis Conrad
Cucullaea (Idonearca) gratiota Hill
Arctica mediale (Conrad)
Natica? pedernalis Roemer
Astarte (Eriphyla) pikensis Hill
Isocardia medialis (Conrad)
Lunatia pedernalis Hill (Not Roemer)
Glauconia branneri Hill
Nerinea austinensis Roemer

PALUXY SANDS

Under this heading are included all the sands lying between the fossiliferous Glen Rose limestones and the base of the Walnut shell agglomerate.

It has been customary in the past to include with the Walnut, under the caption "Walnut clays," beds of different thicknesses which are here included in the Paluxy.

One of the writers has shown in previous papers[18] that sands and not clays immediately underly the shell beds throughout northeast Texas; his conclusions are borne out in the study of Wise County. There is some clay in the Paluxy, but it is well down in the formation and is lenticular in form. Furthermore, the Walnut shell agglomerate lies unconformably upon the sands. This feature will be more fully discussed in the description of the Walnut.

Extent of the outcrop.—The Paluxy sands, which take their name from Paluxy Creek in Somervell County, outcrop over a wide area in Wise County. They form the upper member of the Trinity group in this region, and lie with apparent conformity upon the Glen Rose. In fact, the lower sands lense out into the Glen Rose in Parker County and farther south until about Gatesville they finally disappear as a mappable unit. Northwest of Decatur, where the Glen Rose pinches out, the Paluxy is not distinguishable from the Basement sand, and the two carry the name of Antlers, from the

[18]Scott, Gayle, The stratigraphy of the Trinity division as exhibited in Parker County, Texas, Univ. of Texas Bull. 3001, p 51, 1930.
Scott, Gayle, and Armstrong, J. M., The Geology of Parker County, Texas (MS.).

village of that name in southern Oklahoma. The Antlers sands have already been discussed in connection with the Basement sands.

All the southern part of the county south of the outcrop of the Glen Rose and west of Newark to the Jack County line is covered with Paluxy sand. North from Newark the Paluxy outcrops in a broad belt lying west of the Walnut scarp and east of the Glen Rose outcrop. In the northeastern quarter of the county the sands extend far down the stream cuts, and in some places, as along Denton Creek, reach the Denton County line. In the northern part of the county the Paluxy part of the Antlers covers large areas.

The Paluxy outcrop is nearly always covered with post oak timber where it has not been cleared for farming.

The soils derived from the formation are sandy and deep. Unless properly cared for, their strength is rapidly exhausted and they wash and blow badly. In the southern and northern parts of the county many farms have thus become almost worthless. Fences have been covered by the blowing sand, and great gullies, of the "bad land" topography type, have been washed out. Many such farms, like those in the Basement sand area, have been abandoned. They can be brought back to productivity only by extreme and prolonged care.

Thickness.—The thickness of the Paluxy, like that of the Basement sands, is irregular and difficult to measure. It ranges from less than 100 feet in the embed to 150 feet or more along the outcrop.

Water wells drilled at Decatur show the Paluxy to be 100 feet thick under that town. The Hattie Bell well east of Decatur shows a thickness of 113 feet, but the Keystone No. 1 well in the southeast part of the county shows only 80 feet of Paluxy. The figures from these old wells, however, may not be entirely reliable.

Composition.—The Paluxy is composed almost entirely of fine quartz sand. It never contains gravel such as that found in the lower part of the Basement sand. There is some clay in the middle part of the formation, but it usually occurs in thin seams or limited lenses. The clays are usually white, yellow, to light blue and green. There are also some argillaceous sands which are often of a royal

purple color both before and after exposure, as has already been pointed out by one of the writers.[19]

The color, as previously mentioned, is probably due to the degree of hydration of iron. Such bodies of purple, sandy clay are found in the Paluxy throughout northeast Texas. They are also lenticular in form, although this feature does not always show up at the outcrop. One of the writers, at the invitation of Major John B. Hawley, has recently examined in detail one of these purple lenses, which is 200 feet long and 10 feet thick at its thickest point. It was exposed in an excavation for the east end of the Eagle Mountain Lake Dam in Tarrant County. This exposure will, of course, soon be covered. These highly colored strata recall the vari-colored Cretaceous beds which are so prominent in many parts of Mexico.

Except under the conditions just mentioned, the sands of the Paluxy are usually white, gray, or light brown to yellow. Some appear to be pure enough to be used in the manufacture of glass, but they have not been utilized for that purpose.

The sands, for the most part, occur as unconsolidated, water-bearing "pack sand," but in places there are large concretions of consolidated material. Some of these concretions were encountered in the excavation for the Eagle Mountain Lake Dam and were broken up with some difficulty. They also occur at places on the surface as large sandstone concretions.

Near the middle of the formation there is often a thin bituminous stratum which may produce slight oil seeps and oily scums on the water of some of the wells. This stratum, however, can be seen at the outcrop in only a few places, is encountered in wells only occasionally, and, therefore, does not appear to be continuous. The only outcrop of the stratum that the writers know in Wise County is in the bed of a small tributary of Black Creek northeast of Decatur.

Paleontology.—No determinable fossils were found in the Paluxy of the county. There are a few petrified sticks and logs and some lignitized sticks of wood.

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[19]Scott, Gayle, The stratigraphy of the Trinity division as exhibited in Parker County, Texas, Univ. Texas Bull. 3001, pp. 38–52, 1930.

Scott, Gayle, and Armstrong, J. M., The Geology of Parker County, Texas (MS.).

FREDERICKSBURG GROUP

Kiamichi clays
Goodland limestone
Walnut shell agglomerate

WALNUT SHELL AGGLOMERATE

The Walnut shell agglomerate is the lowest unit of the Fredericksburg group. It is literally composed of the shells of *Gryphea marcoui* Hill and Vaughan and *Exogyra texana* Roemer. Its outcrop is the most dendritic of any of the Cretaceous formations in Texas. It lies conformably below the Goodland in Wise County and is, in fact, a part of that depositional unit. The Walnut as defined here includes only those beds which are calcareous in nature and composed of the shells just named. The so-called clays often spoken of as underlying the shell beds and forming the lower part of the formation are non-existent in the area north of the Brazos. As already mentioned, the shell beds lie immediately and unconformably upon sands which are not distinguishable from the Paluxy, and there is no mappable level below this contact until the top of the Glen Rose is reached. The writers make this statement after having mapped and studied in detail considerable areas of Walnut in northeast Texas. This relationship is well shown 5 miles south of Decatur. It is also indicated in the overlap of the Trinity rocks by the Walnut in Wise and Denton counties. (See sketch map, Fig. 6.)

The base of the Walnut often presents a wavy contact with the Paluxy. The lowest stratum is composed of gravelly sand filled with fossils, but there are no fossils below this bed. In places the contact level is replaced by a sandy plant bed which is literally filled with broken, reworked pieces of lignitized wood. Exposures of this bed have been described from Parker County, and many such contacts may be seen in Wise, Tarrant, and Montague counties.

The length of the hiatus represented in this unconformable contact cannot be determined until a more accurate determination has been made of the beds immediately above and below it.

The Walnut may be interpreted as a transgressive oyster bed which grades upward into the clays and limestones of the Goodland.

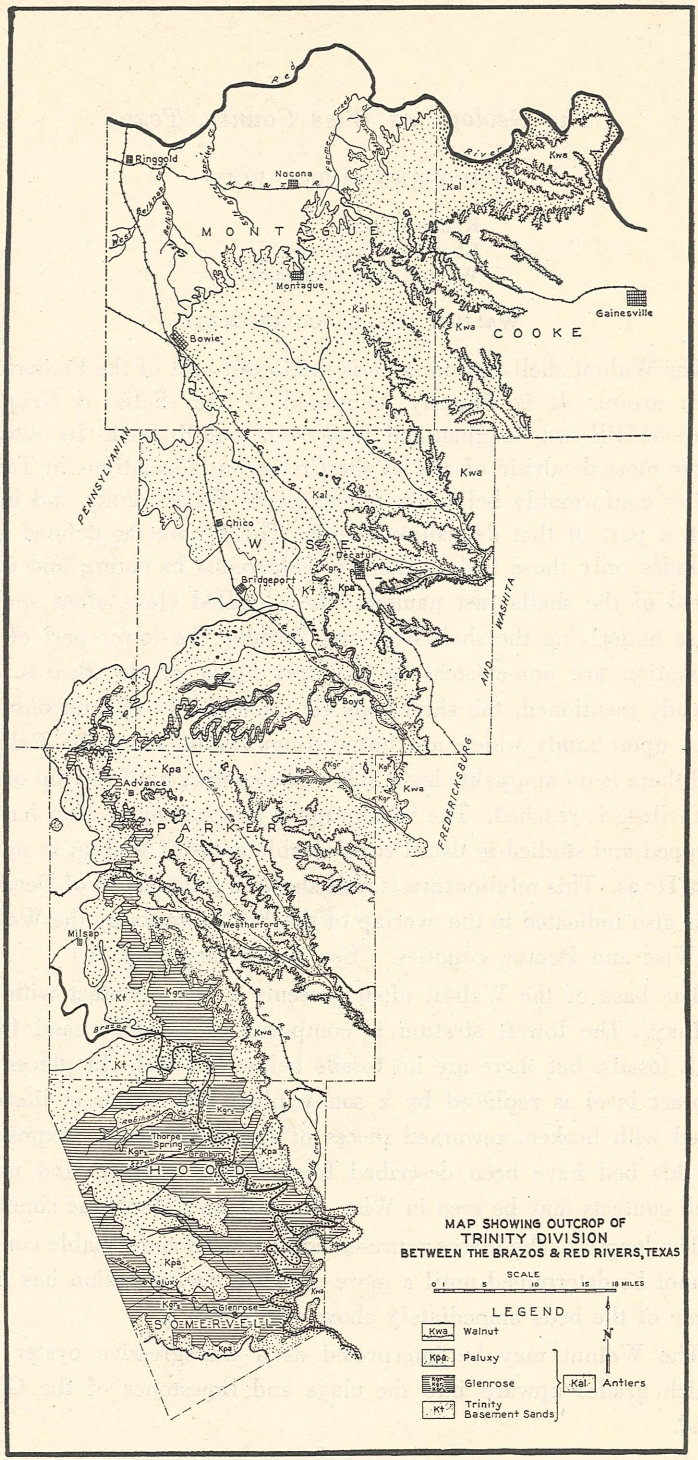

Fig. 6. Sketch map of the outcrops of the formations of the Trinity group and the Walnut formation of the Fredericksburg group over most of northeast Texas, showing how the Trinity group is overlapped to the northeast by the Walnut shell agglomerate.

Extent of outcrop.—As previously stated, the Walnut has the most dendritic outcrop of any Cretaceous formation in Texas. The width of the outcrop, however, is seldom broad—usually only a few feet. Consequently, it is indicated on the map simply as a line marking the base of the Goodland trace. Almost everywhere, except in the lower reaches of stream valleys, it forms prominent scarps, many of which are more than 100 feet high. In stream cuts its outcrop results in falls and bluffs. Locally, in the northern part of the county, up the dip from the main outcrop, and elsewhere, it caps flat-topped outliers from which the Goodland has already been removed by erosion. In these places its outcrop may cover considerable areas.

The Walnut enters Wise County from Tarrant County near the town of Newark, and after following a very tortuous course passes into Montague County at a point northeast of Greenwood. The trace extends far down the stream cuts and in one instance (along Denton Creek) passes into Denton County on the east.

There is, also, one interesting inlier of considerable size along the valley of Oliver Creek in the eastern part of the county.

Thickness.—The Walnut is remarkably uniform in thickness, being 27½ feet thick at all points measured.

Composition.—The Walnut is essentially an arenaceous limestone composed mostly of the shells of *Gryphea marcoui* Hill and Vaughan and *Exoyra texana* Roemer, but there are many other fossils. It is distinctly and evenly stratified. The ledges are usually 3 inches to 1 foot in thickness and are interstratified with thin seams of clay.

The lower beds are often very hard and crystalline, and are characterized by large numbers of a species of *Protocardia* and a species of *Trigonia.* Some of the outliers in the northern part of the county are capped by this hard member, the higher ledges having been eroded off. Here the limestone is locally termed the "bluff rock." In other localities, where the upper ledges are only partly worn off, the surface has a hummocky appearance. The mounds thus formed are sometimes mistaken for Indian mounds.

Paleontology.—The Walnut is a veritable fossil bed of *Gryphea marcoui* Hill and Vaughan and *Exogyra texana* Roemer, but other

fossils are varied and abundant. The following list includes the most important species:

Gryphea marcoui Hill and Vaughan
Exogyra texana Roemer
Exogyra weatherfordensis Cragin
Protocardia texana (Conrad)
Trigonia emoryi (Conrad)
Pecten (Neithea) irregularis Böse
Anatina texana Cragin
Cyprimeria texana Roemer
Natica pedernales Roemer
Turritella seriatim-granulata Roemer
Oxytropidoceras acuto-carinatum (Shumard)
Engonoceras sp.
Heteraster texanus (Roemer)
Epiaster whitei (Clark)
Phymosoma texanum (Roemer)
Holectypus planatus Roemer
Macraster texanus (Roemer)

GOODLAND LIMESTONE

The Goodland is the middle unit of the Fredericksburg group and was named from the village of Goodland in southern Oklahoma. South of the Brazos River the upper part of the Goodland is made up of massive crystalline limestone and is known as the Edwards limestone. The lower part is composed of softer nodular white limestones and some dark to yellow shales and clays, and is called the Comanche Peak limestone, from Comanche Peak in Hood County where it is typically exposed.

The Goodland lies conformably upon the Walnut and in turn is conformably overlain by the Kiamichi, although the contact in the latter case is a sharp one.

Extent of outcrop.—The Goodland, like the Walnut, is a scarp former, but the scarps are less pronounced. It may, and does in Wise County, form extensive uplands, particularly along divides such as that between the West Fork of the Trinity River and Denton Creek.

The Goodland outcrop enters Wise County from Tarrant County just east of Newark, passes in a direction slightly west of north to a point just beyond Decatur; the town is built upon the outcrop. It then turns in an easterly direction and passes into Denton County along the southwest side of Denton Creek opposite the village of Stony. On the east side of the stream the formation again enters

Wise County and cuts the northeast corner twice. The trace of the top of the Goodland is also very dendritic, but less so than the Walnut.

The outcrop extends far down all the stream valleys, since the dip of the strata is in the same direction as the flow of the streams. The Goodland extends far down Oliver Creek and surrounds the Walnut inlier already described.

Thickness.—The Goodland thins toward the northwest, but the change is not rapid and is barely perceptible in Wise County. At Fort Worth the formation is 117 feet thick. At a point just west of Rhome, in the southeast part of the county, it measures 66 feet. (See section, Fig. 5a.) On the Denton-Wise County line near the village of Stony it measures 49 feet. At Goodland, Oklahoma it is said to be 17 feet thick.

Composition.—For the most part, the Goodland in this region is a soft, nodular, blue to gray limestone, which turns white on exposure. The white slopes formed by the outcrop seldom bear much vegetation and are always a prominent geological landmark.

Though the main body of the formation is made up of the soft nodular limestone just mentioned, there is at its base, immediately overlying the Walnut, 13 feet of soft, yellow, calcareous marl, as measured in the section 1 mile west of Rhome. The top 16 feet in the same section is composed of harder material and is probably the equivalent of the Edwards of regions south of the Brazos. Above the basal marl is a hard, nodular limestone member about 15 feet thick, which in some places forms the substratum of Goodland uplands. Although this is a very firm member, it is not as resistant and crystalline in character as the top one. About the middle of this member is an oyster bed which is especially interesting because of the large ripple marks which it often exhibits.

These ripples, previously described by one of the writers,[20] are often as much as 5 feet apart and 3 to 6 inches high. They are found wherever this level is well exposed and have been examined at many localities in Hood, Tarrant, Parker and Wise counties. In all places studied, the crests of the ripples trend in a northeast-southwest direction.

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[20]Scott. Gayle, Ripple marks of large size in the Fredericksburg rocks west of Fort Worth, Texas, Univ. Texas Bull. 3001, pp. 53–56, 1930.

Paleontology.—The Goodland is everywhere very fossiliferous, and all the common species that have been listed from the formation in other areas have been found in Wise County. Certain species such as *Oxytropidoceras acuto-carinatum* (Shumard), *O. trinitense* (Gabb), *Heteraster texanus* (Roemer), and others, are diagnostic of the formation. The following list contains the more common species to be collected from the Goodland:

Parasmilia austinensis Roemer
Coelosmilia americana Roemer
Pinna guadalupae Böse
Inoceramus sp. aff. concentricus Parkinson
Ostrea crenulimargo Roemer
Pecten (Neithea) irregularis Böse
Lima (Mantellum) bravoense Böse
Pholadomya sancti-sabae Roemer
Anatina texana Cragin
Protocardia texana (Conrad)
Protocardia filosa (Conrad)
Cyprimeria texana (Roemer)
Tapes spp.
Natica pedernalis ? Roemer
Tylostoma spp.
Turritella seriatim-granulata Roemer
Turritella spp.
Cerithium bosquense Shumard
Oxytropidoceras acuto-carinatum (Shumard)
Oxytropidoceras supani (Lasswitz)
Oxytropidoceras trinitense (Gabb)
Engonoceras spp.
Holectypus planatus (Roemer)
Heteraster texanus (Roemer)
Epiaster whitei (Clark)

KIAMICHI CLAYS

The Kiamichi lies immediately and conformably upon the Goodland in this area. The contact is a sharp one when viewed at a distance, but examination at close hand shows that no unconformity exists at this level, and that there is a uniform though rapid transition from one formation to the other.

The contact of the Kiamichi with the Duck Creek above, on the other hand, is very sharp; and there are many evidences of an unconformity, or at least of a diastem, at this level. This is in spite of the fact that the similarity in color of the two formations somewhat obscures the sharpness of the contact. The limestones of the Duck Creek lie unevenly on the Kiamichi shales, and the wavy line of contact is marked by a thin "rusty" seam. A well rounded

quartz pebble almost ½ inch in diameter and pasted to the overlying Duck Creek limestone was found in this layer by one of the writers.

The Kiamichi was originally placed in the Washita, but in recent years a number of geologists who have studied the formation have insisted that its affinities are with the Fredericksburg rather than with the Washita. Work in northeast Texas is substantiating this contention.

Extent of outcrop.—The Kiamichi clays are soft and intercalated in a few places with thin flaggy layers of limestone. They weather rapidly, and, consequently, seldom form uplands. In Wise County the outcrop is usually a narrow band lying immediately adjacent to the Goodland terrain. It is too narrow to be mapped except on a relatively large scale map. Occasionally, along the crests of divides, as in the northeastern part of the county, small uplands are formed. Such areas usually collect rich soils.

The outcrop enters Wise County from Tarrant County near the southeast corner, and, after a very tortuous line of outcrop and a number of re-entries along the Denton County line, finally passes definitely out of the county near the northeast corner.

Thickness.—The thickness of the Kiamichi differs considerably from locality to locality, but over the general area of northeast Texas it thickens toward the north.

In a section just west of Rhome (see Fig. 5a) it measured 35 feet. Another section along the south side of the valley of Sweetwater Creek on the Stony (Denton County) road, also measured 35 feet (see section Fig. 5c). Northeast of Denton Creek along the Denton County line west of Stony, a 33 foot section was measured. In the extreme northeast part of the county a carefully measured section showed only 22 feet of Kiamichi. Just over the county line in Montague County the beds are much more fossiliferous, and a measured section showed 41 feet of strata belonging to the formation.

Composition.—As the accompanying section shows, the Kiamichi consists of stratified and thinly laminated clays with occasional thin beds of limestone flags. When freshly exposed, the clays are dark to gray, but they soon turn yellow. They form a gentle terrace on the usually steep slopes formed by the outcrop of the Goodland and Duck Creek limestones.

Paleontology.—As already mentioned, the fauna of the Kiamichi is distinctly Fredericksburg in its affinities. A few species, such as *Oxytropidoceras belknapi* (Marcou) and *Gryphea navia* Hall, are diagnostic of the formation, but most of the Kiamichi species are also found in the Goodland. Very few of its species, on the other hand, are found in the Duck Creek beds lying immediately above.

The following list includes the common fossils of the Kiamichi, all of which may be collected from the formation in Wise County:

Pteria leveretti (Cragin)
Gryphea navia Hall
Exogyra plexa (Cragin)
Pecten (Neithea) irregularis Böse
Pholadomya sancti-sabae Roemer
Oxytropidoceras belknapi (Marcou)

WASHITA GROUP

Fort Worth formation
Duck Creek formation

Of the seven Washita formations recognized in northeast Texas, only the lower two (Duck Creek and Fort Worth) are represented in Wise County. The Duck Creek may be studied in its typical development at many localities along the eastern margin of the county. Only the lower beds of the Fort Worth, however, outcrop in the area, and these exposures are limited and poor. The Fort Worth and higher formations of the Washita may be seen to advantage in Denton County on the east, in Tarrant County on the south, and in Cooke County on the north.

DUCK CREEK FORMATION

Extent of outcrop.—The Duck Creek outcrops in an irregular and interrupted band across the extreme eastern part of Wise County. The lower, or limestone, part often forms the top of prominent escarpments on top of which are dip, or near dip, slopes. These, together with the lower beds of the Fort Worth limestones, form extensive uplands in the southeastern and northeastern parts of the county. Such uplands are covered with some of the richest black soils to be found anywhere in this or neighboring counties.

Thickness.—No place was found in Wise County where a complete section of the Duck Creek could be accurately measured, but the formation in this general area is known to measure no less than

65 feet; and to the northeast, in which direction it thickens, it may reach a thickness of 75 feet or more. It is 65 feet thick at Fort Worth, 110 feet thick in places in Denton County, about 100 feet thick in Cooke County,[21] and 158 feet thick along Duck Creek northeast of Denison in Grayson County where Scott measured it.

Composition.—The Duck Creek consists of two fairly distinct members, and in Wise County the thickness of the formation is about equally divided between them.

The lower member is composed mainly of soft marly limestone arranged in beds a few inches to 4 feet thick, separated from each other by thin beds of calcareous marl. When freshly exposed these beds are white or light gray to yellow. After considerable weathering the marls become yellower, and the limestones become whiter, except for brown streaks caused by the oxidation of pyrite nodules contained in them.

The upper member is composed almost entirely of soft yellow to brown calcareous marl in which are occasional thin beds of weak or "rotten" limestones. These beds break down readily to form rich soils. The so-called Duck Creek marls are often slightly water-bearing. In wet weather they give rise to seeps and, when dirt roads cross them, to bogs. In the dry summer months these same marls can be traced for considerable distances by their green vegetation, and form a sharp contrast to the withered weeds and grass on the stony formations on either side.

Paleontology.—The Duck Creek is always rich in fossils. Furthermore, the species are widespread geographically and often limited in vertical extent, so that there is a succession of separate and distinct paleontological zones in the formation, which, considering its thickness, is nothing short of remarkable.

Adkins and Winton[22] recognized these zones a number of years ago and traced them throughout northeast Texas.

From top to bottom they are as follows:

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[21]Winton, W. M., The geology of Denton County, Univ. Texas Bull. 2544, p. 22, 1925.
Bybee, H. P., and Bullard, F. M., The geology of Cooke County, Univ. Texas Bull., 2710, p. 23, 1927.

[22]Adkins, W. S., and Winton, W. M., Paleontological correlation of the Fredericksburg and Washita formations in north Texas, Univ. Texas Bull. 1945, 1919.

1. Horizon of *Holaster simplex* Shumard
2. Horizon of *Scaphites worthensis* Adkins and Winton
3. Horizon of *Pervinquieria trinodosa* (Böse)
4. Horizon of *Inoceramus comancheanus* Cragin
5. Horizon of *"Desmoceras" brazoense* (Shumard)
6. Horizon of *Hamites comanchensis* Adkins and Winton

Most of the fossils in the lower member of the Duck Creek, particularly the ammonites, are large and are preserved as mud casts; those in the upper member are usually smaller. From Tarrant County north the marls are often rich in small fossils, particularly cephalopods, preserved as pyrite and marcasite casts. This phase is best developed in Grayson County, but good specimens may be collected along the Fort Worth and Denver Railroad cuts in the southeastern part of Wise County.

The following list includes the common fossils of the Duck Creek formation:

Kingena wacoensis Roemer
Inoceramus comancheanus Cragin
Gryphea washitaensis Hill
Lima wacoensis Roemer
Pecten subalpinus Böse
Protocardia texana (Conrad)
Protocardia filosa (Conrad)
Hamites nokonis Adkins and Winton
Hamites fremonti Marcou
Hamites varians Scott
Worthoceras platydorsum (Scott)
"Desmoceras" brazoense (Shumard)
Prohysteroceras spp.
Pervinquieria trinodosa (Böse)
Pervinquieria spp.
Scaphites worthensis Adkins and Winton
Holaster simplex Shumard
Heteraster adkinsi Lambert
Macraster elegans (Shumard)
Epiaster whitei (Clark)

FORT WORTH FORMATION

Extent of outcrop.—The Fort Worth formation is nowhere well exposed in Wise County. There are two small areas of outcrop. One, in the southeastern part of the county, forms an upland of considerable extent. The other, in the northeast section, is small. Only the lower beds of the formation, however, are represented in these areas, and they are so obscured by thick, black soils that no good exposures exist, and the contact with the Duck Creek is

mapped with difficulty. The Fort Worth is the youngest marine formation exposed in the area.

Thickness.—In northeast Texas the Fort Worth formation is uniformly about 25 feet thick.

Composition.—The Fort Worth consists of alternate beds of limestone separated by thin seams of marl. The limestones are usually marly, and range from light gray to brown in color. The ledges are 6 inches to 2 feet thick. The marl seams are usually no more than 4 inches thick and are yellow to brown in color.

Paleontology.—The formation is characterized by a number of easily recognized and diagnostic fossils. The following list includes the common species. Fossil collecting from the formation in the area contained in this report, however, is poor.

Alectryonia quadriplicata (Shumard)
Exogyra americana (Marcou)
Pecten subalpinus Böse
Pleurotomaria austinensis Shumard
Prohysteroceras austinense (Roemer) Lasswitz
Pervinquieria leonensis (Conrad)
Holaster simplex Shumard
Macraster elegans (Shumard)
Macraster texanus Roemer
Macraster aguilerae (Böse)

CENOZOIC AND RECENT DEPOSITS

The Cenozoic and Recent deposits of Wise County are limited to soils of the uplands and valleys, and to sand and gravel terraces along the larger streams.

The stream terraces, as in other areas surrounding the county, are usually three: an upper one just below the level of the uplands, thought to be Pliocene in age; another of Pleistocene age just above the level of the flood plains; and a third at present being deposited as sand, soil and some gravel in the streams and their flood plains.

The Pliocene and Pleistocene terraces have been removed by erosion, except at favorably situated points. They consist of limestone and quartz gravel mixed with sand and some clay. The limestone elements in the gravel are derived from the various calcareous formations of Pennsylvanian and Comanchean ages through which the streams pass. The Walnut formation of the Comanchean, in particular, has contributed largely to these accumulations, as may readily be seen from the many shell fragments of *Gryphea marcoui*

Hill and Vaughan and *Exogyra texana* Roemer, of which that formation is mainly composed.

The quartz gravels are in all cases transported and reworked from the Basement conglomerates of the Comanchean.

None of these deposits have been worked for gravel, and no fossils, other than those transported from the source rock, have been found in them so far as the writers were able to learn. Farther down the Trinity River, however, near Fort Worth and Dallas, where similar deposits have been worked on a large scale, many mammalian fossils have been recovered. These confirm the Pliocene and Pleistocene ages of the two upper terraces. Most of the specimens, unfortunately, are poorly protected from waters percolating through the gravels, and crumble easily upon exposure. Most of those determined have been obtained from the Pleistocene deposits.

HISTORICAL GEOLOGY

Pre-Pennsylvanian History.—The drill has nowhere in Wise County passed through all of the Carboniferous strata, and it is impossible to say with certainty what underlies rocks of that age. In Denton and Cooke counties some wells have gone through the Pennsylvanian, and possibly through some Mississippian, into rocks believed to be of Cambro-Ordovician age, and on even into granite. These facts would seem to indicate that such rocks underlie the Pennsylvanian in Wise County, and that a vast unconformity representing several geological periods separates the two series. If this is true, the area, of course, was land for a long time before Carboniferous seas came in. This, however, is a problem much too large and too complex to be dealt with in the study of a single county.

Mississippian and Pennsylvanian History.—Fairly conclusive evidence is that after the Ordovician the area in question was dry land until late in Mississippian time or the beginning of Pennsylvanian time. It is difficult to say from which direction the seas of the latter periods came in, but it was probably from the northwest. There must have been, however, a land mass of considerable extent to the southeast throughout the Pennsylvanian period from which the sediments were derived. That this land mass was at no great distance and of considerable relief, is shown by the greatly increased thicknesses of muds and coarser clastic sediments which make up

most of the Pennsylvanian rocks in Wise County. This feature is particularly noticeable in the Strawn and Cisco groups. During Canyon time sedimentation was occasionally limited to the deposition of limestones such as the ledges of the Palo Pinto (these, however, are thin and show a tendency to finger out in a northeasterly direction), the Wizard Wells, the Chico Ridge, and the Ranger. A further confirmatory feature is seen in the rapid change in facies, both vertically and horizontally, and in the greater regional dip, as compared with sediments of the same age in the Brazos River section. Even in the Canyon formations the number of members is greatly increased, many sandstones come in, and the shales are much thickened. This feature is in accordance with the general structure of the Pennsylvanian sediments in north-central Texas, as pointed out some years ago by Plummer and Moore.[23] It should be noted, however, that the conglomerates, at least those observable in the area, are not necessarily of coarser texture. The rock particles in them, as elsewhere in the Pennsylvanian, are composed mostly of chert and novaculite, and are angular.

The sediments also indicate, as the same writers have shown, that during Strawn time there was an oscillating but gradually encroaching sea. During Canyon time, so far as the general region was concerned, the sea reached its greatest extent and depth; but in Wise County there were intervals of shallowing of the sea, and even of withdrawal, and of erosion, as is shown by the unconformity associated with the Willow Point limestone, by the presence of the Bridgeport coal seam, and possibly by the conglomeratic appearance of some of the Canyon limestones in the region.

Climatic conditions, as noted by Plummer and Moore, were warm and equable. Coal plants thrived in swamps; and in the seas, under favorable conditions of food, water, and bottom, animals such as gastropods, caphalopods, pelecypods, corals, and other invertebrates were abundant.

Post-Pennsylvanian and Pre-Cretaceous History.—From the time of the retreat of the Pennsylvanian sea to the advent of the Comanchean, the area was probably dry land. If sediments of

[23]Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations in north-central Texas, Univ. Texas Bull., 2132, 1921. See also, Plummer, F. B., Pennsylvanian Sedimentation in Texas, Ill. State Geol. Surv., Bull. 60, pp. 259–269, 1931.

intervening periods were deposited, they were removed by erosion before the Comanchean sea came in. The region must have been a flat and featureless plain, since the Pennsylvanian rocks are undisturbed, depositional dip having been changed little if at all.

Comanchean History.—The sea again advanced through a depression over northeast Texas in late Comanchean time. Coming from the southeast, it reached the area of Wise County at the greatest extent of the Glen Rose. As it advanced, irregularities in the Pennsylvanian floor were cut off, and the beach deposits were worked over into conglomerates and sands. The beaches in the area must have been very broad and sandy. In spite of a hinterland of probably low relief, the sea at this stage moved very slowly or was from time to time stationary, for the Basement sands are 200 feet or more thick. The conglomerates at the base are apparently a phenomenon associated with the greatest extent of the sea where its waves pounded for a long time on the same beaches, much of the finer sand being removed by attrition, and the gravel being concentrated. The conglomerates were not encountered in the core tests at Aubrey in Denton County or in other wells down the dip.

The greatest depth of the Trinity sea was in Glen Rose time, when clays and a few limestones were deposited in an embayment, the apex of which centered in Parker, southeastern Jack, and southern Wise counties. The sketch map in Fig. 6 shows how the northeastern shore of this embayment ran in an almost east-west direction through the center of Wise County.

After the Glen Rose beds were laid down, the sea again withdrew, depositing the Paluxy sands in its wake. These finger out into the Glen Rose limestones down the dip. How long the sea remained out cannot yet be accurately determined, but, with the advent of Fredericksburg time, it again approached over these sands and deposited the Walnut shell beds unconformably upon them in a manner already detailed on previous pages of this report. This time the apex of the embayment moved much farther east than it had in Glen Rose time. The Fredericksburg sea advanced across northeast Texas into Oklahoma, completely overlapping the margin of the Glen Rose as is shown by the sketch map in Fig. 6. As the sea deepened, the Goodland was put down. It shallowed again to deposit the Kiamichi, and at the end of the Kiamichi was possibly

withdrawn enough to permit a brief period of erosion. This is indicated by the considerable uneveness in the thickness of the Kiamichi, its sharp and irregular contact with the Duck Creek, and the marked change in fauna immediately following in that formation.

The sea deepened somewhat to deposit the Duck Creek, and then oscillated in such a manner as to form the well known alternations of limestones and marls so well developed in the Washita.

In all probability upper Cretaceous sediments, also, covered Wise County at one time, and later were removed. At any rate, since the withdrawal of the Cretaceous sea, the area has remained dry land.

In Pliocene, Pleistocene, and Recent times the northwestward-facing scarps of the Comanchean and the southeastward-facing scarps of the Pennsylvanian have slowly receded. The drainage system of the Pennsylvanian region is formed on the southeastward-dipping strata of the Comanchean, then superimposed upon the Pennsylvanian strata and altered somewhat by their opposite dip.

The large stream terraces of Pleistocene time seem to indicate that rainfall throughout northeast Texas at that time was much greater than at present; the streams were, consequently, of much greater importance.

ECONOMIC GEOLOGY

SAND

Sand for ordinary and probably for special uses is available almost everywhere in Wise County, but the deposits have not been developed. No analysis of the sands has been made, but in Parker County tests have shown that some of the beds in both the Basement and Paluxy sands are suitable for glass manufacture. In Wise County the sands appear to be little, if any, different from those at the localities tested.

The Pennsylvanian sands are all highly colored. They would, therefore, be unsuited for glass manufacture, and do not appear to be sufficiently consolidated to make good and durable building stone.

GRAVEL

Gravel deposits appear along all of the larger streams in the county, but most of them are too limited in extent to be of any great commercial value. Most of the deposits of any size are along the valley of the West Fork of the Trinity River in the southern part of the county. Even these are much contaminated with sand and clay. In building the Lake Bridgeport Dam, sufficient gravel of good grade for the concrete work could not be found close at hand, and crushed stone had to be used.

There is an unlimited amount of gravel in the Basement sands of the Comanchean, but it appears to be so mixed with sand as to be useless. Where basal conglomerates are consolidated, as they often are, they probably could be made usable by crushing.

CLAY

At Bridgeport, the Canyon shales lying immediately above and below the coal seam were for years used in the manufacture of brick.

The first plant, on the north edge of town, established in 1908, used the clays lying between the coal seam and the Willow Point limestone. It is a mud plant, in which the clay was burned without any special cleaning. The material produces a dark, dull red brick of good quality. Most of the output has been ordinary-run brick, but a few facing brick and some tile have been manufactured.

Another, and newer, plant is located north of the railroad near the mines of the Bridgeport Coal Company, and utilized the tailings from the No. 2 shaft of that company. This is also a mud plant, and produced a quality of brick similar to that in the No. 1 plant. Both plants belonged to the Bridgeport Brick Company and used coal for fuel.

The maximum capacity of each establishment is about 45,000 brick per day, but both were shut down in 1929 and have not been opened since. Most of the product was marketed in Fort Worth, Dallas, Houston, Shreveport, and other southern cities.

LIMESTONE, LIME, AND CRUSHED STONE

Limestone.—Limestone of good grade can be quarried in enormous quantities from the Canyon limestones in the region south and southeast of Chico. Many of the beds are evenly stratified and would

break out into satisfactory building stones. At other levels the stone is massive and would require special quarrying machinery. The possibility that any of these deposits may be developed on a large scale for building purposes is remote, however, since the stone appears to have no special features to recommend it, and no suitable market is close at hand.

None of the other Pennsylvanian limestones, such as the Palo Pinto and Ranger, appear to be of sufficient quality to be exploited for building purposes. The sandstones, also, are badly discolored, and in most cases are too porous and too unconsolidated to be of value.

Some of the Glen Rose ledges of the Comanchean are of good grade, but the deposits are always limited in thickness and usually carry so much over-burden that they are practically useless except for local purposes.

The other Comanchean limestones in the county would not produce satisfactory building stones, but many of them, as well as most of the Pennsylvanian limestone beds, are available for rip-rap in building dams and for similar purposes.

Lime.—No lime is burned at present in Wise County, but many of the limestones, particularly the Chico Ridge, are sufficiently pure to be used for that purpose should there ever be a demand for lime.

Crushed Stone.—Many of the more indurated strata of the Pennsylvanian are capable of yielding large supplies of crushed stone of excellent grade. At the present time there are three large stone crushers in operation in the region south and southeast of Chico. The No. 1 and No. 2 plants of the Southwest Stone Company are northeast of the Bridgeport-Chico highway. The No. 1 crusher near the road has a capacity of about 20 cars per day and employs 80 to 90 men. It utilizes the stone near the base of the Chico Ridge limestone mass. The No. 2 plant further north has a capacity of about 8 cars per day and employs about 30 men. The stone for this crusher comes from near the top of the Devils Den. Both plants yield crushed stone of a grade that meets all specifications of the Texas State Highway Commission. The raw material at the No. 2 plant is a little more economical to handle.

When the Lake Bridgeport Dam was started, a crusher was built a short distance north of the dam site to crush stone for the concrete work, since no satisfactory gravel in sufficient quantities could be found close at hand. The product of this crusher could not meet the engineers' specifications because the very massive limestone broke too evenly and with faces too smooth to be used in concrete. The crusher was moved up in the formation to a level where some thin-bedded strata yielded a satisfactory product. A fourth large crusher is located on the Chico Ridge limestone mass outcropping in the valley of Big Sandy Creek just south of Alvord.

For local use on roads, the Ranger limestone has also been the source of some crushed stone. The Walnut formation of the Comanchean, when crushed, produces a material very satisfactory for road building. The rock is literally made of fossil oyster shells and is easily crushed. There is sufficient clay for binder, and this material when spread and rolled makes most excellent lateral roads.

CEMENT

No cement plants have been built in Wise County, but cement materials are abundant. All of the Pennsylvanian limestones in the western part have shales closely associated with them, and proper combinations of these materials could be found at many places about Bridgeport and westward to the county line.

At Fort Worth, the large Trinity plant uses Duck Creek limestone and Kiamichi clay, and has Goodland limestone available. This same combination is found in many places throughout the eastern half of Wise County, and in the southeastern part is favorably located for market, fuel, and transportation.

WATER

Underground water in the western part of the county is obtained from the various sandstones of the Pennsylvanian series. The most important of these is the sandstone lying normally about 20 feet under the coal. As pointed out in the description of that stratum, the water derived from it in the town of Bridgeport and to the east of the town is of good quality; but to the west, down the dip, the water is charged with salt and is not potable.

Other Pennsylvanian sandstones present the same phenomenon, but on the whole produce less favorable supplies; and in many

places cisterns are found to be more satisfactory and more economical than wells.

Over most of the county, large quantities of excellent water are available at shallow and moderate depths from the Comanchean sands. Water conditions in these sands have changed but little, if at all, since Hill[24] some years ago wrote his excellent description of underground water conditions in Wise County. As this report is no longer obtainable, his remarks relative to the county are reproduced here:

> This county has an area of 893 square miles. The eastern half lies within the general area of the Grand Prairie, the highest portion of which is about 1,100 feet above the sea. The western portion, occupied by the belt of the Western Cross Timbers and threaded by the Trinity River, is much lower, the altitude of the valley of that stream varying from 956 feet at the northwest corner to 500 feet at the southeast corner.
>
> The formations exposed embrace the Washita division on the highlands, the Fredericksburg division in the escarpment, and the Trinity division along the valley of the Trinity River. These in turn rest upon the Carboniferous in the northwestern portion of the county.
>
> The combined Trinity-Paluxy (Antlers) water-bearing strata have a wide area of outcrop throughout the west-central portion and are embedded beneath the eastern half. The surface of the prairie region, except in the deeply incised valley of the Trinity River in the southeast corner, is generally higher than the outcrop, and hence flowing wells are improbable.
>
> Only one flowing artesian well has been reported from Wise County. This is at Newark (altitude 692 feet), in the Trinity Valley, in the extreme southeast corner. This well, drilled for the Chicago, Rock Island and Texas Railway, is 385 feet deep and penetrated three artesian reservoirs at depths of 60, 150, and 385 feet. The quantity of flow is not given.
>
> At Rhome (altitude 923 feet), on the crest of the Grand Prairie, Mr. J. T. Hoggsett drilled a well 200 feet deep into the upper reservoirs of the Antlers (Paluxy) formation. The water rose to within 50 feet of the surface, or to an altitude of 873 feet. Shallow nonflowing wells of this character could undoubtedly be procured throughout the eastern portion of the county lying within the Grand Prairie belt.

Hill also gives a schedule of a number of wells in the county, indicating depth, rise of water, quality, etc.

Surface water.—Surface water conservation projects are just beginning to receive attention in the area. The big Lake Bridgeport Dam has created one of the largest artificial bodies of water to be

[24]Hill, R T., Geography and Geology of the Black and Grand Prairies, Texas, etc., United States Geol. Surv., 21st Ann. Report. Pt. VII, 4554, 1901.

found anywhere in the country. This lake covers more than 10,000 acres, has a maximum depth of 90 feet, and a maximum capacity of more than 300,000 acre feet. It impounds all the flood waters of the upper drainage area of the West Fork of the Trinity River and makes them available for power, irrigation, and other purposes. Hundreds of acres of rich valley land are thus reclaimed for agriculture. Other dams of less importance might be built on the Denton Creek Fork near the Denton County line, on the lower reaches of Catlett Creek, on Salt Creek below Cottondale, and possibly elsewhere. At present, the water supply of Decatur comes from a small artificial lake across an upper tributary of Sweetwater Creek.

COAL

Coal outcrops in and near Bridgeport, and, until recently, it was mined there. The stratigraphy of the beds of coal that occur in the Pennsylvanian rocks of Wise County has been described on an earlier page of this report.

The only coal of economic importance in the area occurs in a single seam 18 to 22 inches thick. It is sub-bituminous with a fixed carbon ratio of 46 to 47 per cent and a B.t.u. of 12,000. It is thinner than the Thurber coal at Thurber but is of better grade. In fact, it is said to be the best coal in Texas. When the mines were closed early in 1932, the seam was the only one being mined in the state. The mines of the Bridgeport Coal Company were operated on the "long wall" plan; miners were paid for lump coal, and 98 per cent of the coal was recovered. Keeping the tunnels open was sometimes made difficult by the "heave" or swell of the underlying shales. Most of the product was sold to the Chicago, Rock Island and Texas Railroad or was marketed in Fort Worth and Dallas.

The railroad opened a mine on the east side of its tracks in 1896, but this mine was long ago worked out or drowned out, and abandoned. On the west side of the tracks the Bridgeport Coal Company has two shafts, but only No. 2 has been in operation in recent years. The output and the number of men employed differed from time to time.

In addition to the mines of the Bridgeport Coal Company there were several small slope mines about the town which were worked intermittently.

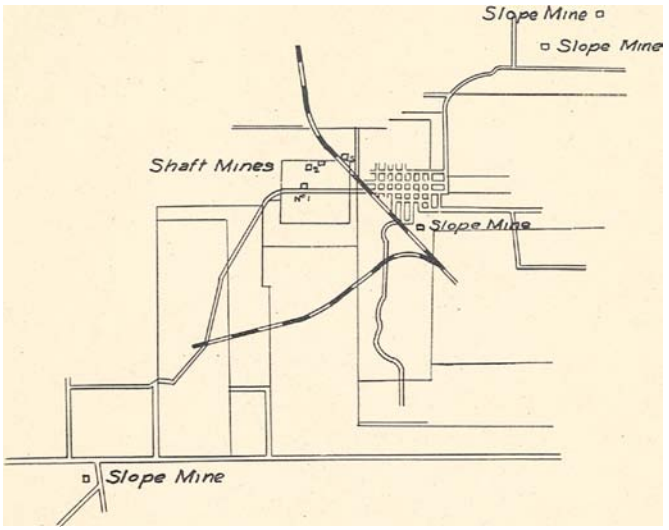

Fig. 7. Sketch map of the Bridgeport area showing the locations of coal mining operations.

OIL AND GAS

Oil and gas in commercial quantities have not yet been produced in Wise County, but the area is at present undergoing considerable exploration.

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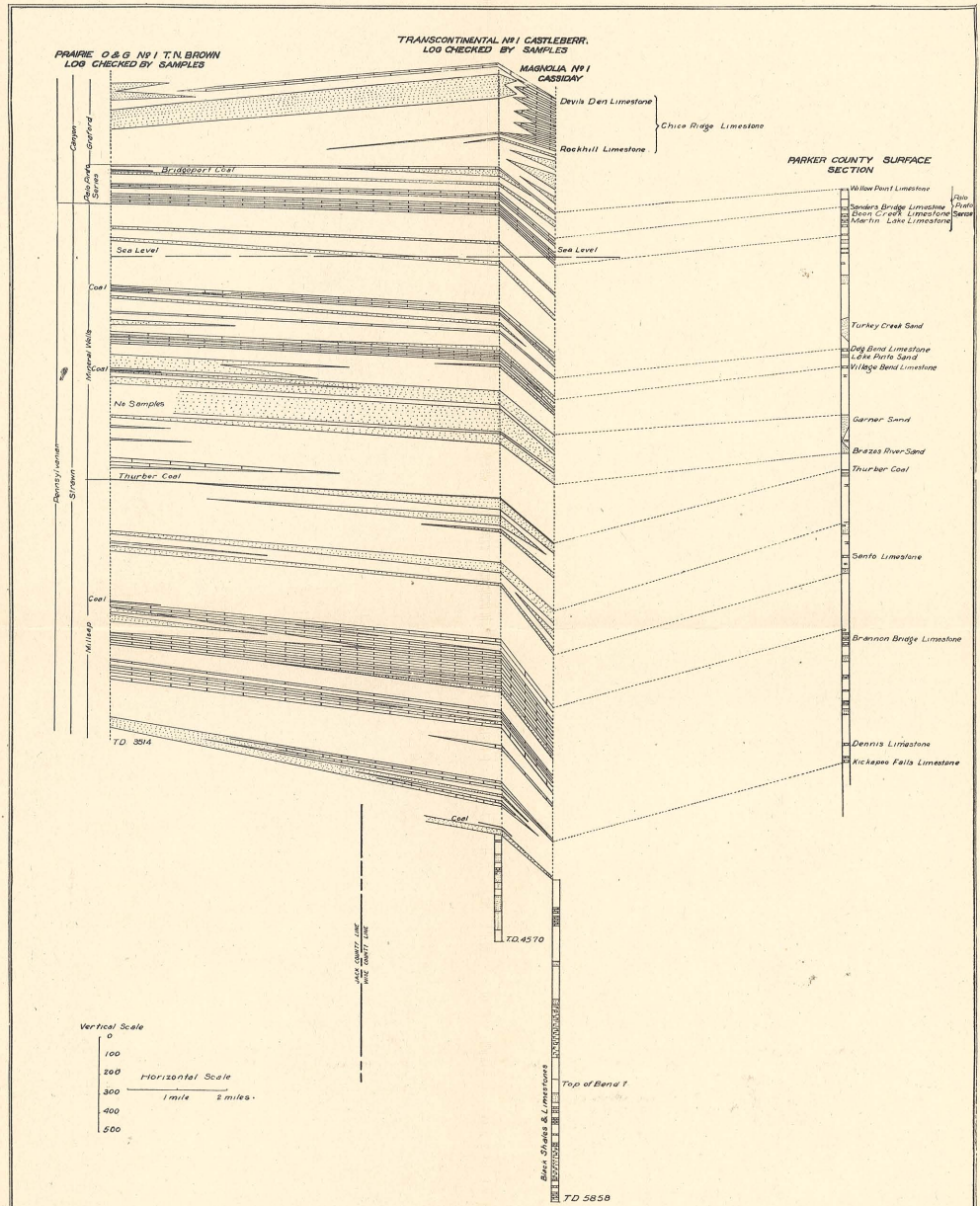
PROFILE SECTION of PENNSYLVANIAN and CRETACEOUS ROCKS OUTCROPPING between SAND FLAT SCHOOL and RHOME

GEOLOGIC MAP OF WISE COUNTY, TEXAS

By

GAYLE SCOTT AND J. M. ARMSTRONG



Cross section showing correlations of well sections in Jack and Wise counties with surface section in Parker County, Texas.