Stratigraphy of the Basal Trinity (Lower Cretaceous) Sands of Central Texas

PETER A. BOONE
"Creative thinking is more important than elaborate equipment--"

FRANK CARNEY, PH.D.
PROFESSOR OF GEOLOGY
BAYLOR UNIVERSITY
1929-1934

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Stratigraphy of the Basal Trinity (Lower Cretaceous) Sands, Central Texas

PETER A. BOONE

BAYLOR UNIVERSITY
Department of Geology
Waco, Texas
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## PLATE

I. Antlers, Hosston, and basal Trinity sands, outcrops and lithologies |
II. Hensel and Sycamore sands, outcrops and lithologies |
III. Sycamore, Bluff Dale, and Antlers sands, outcrops and lithologies |
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Stratigraphy of the Basal Trinity (Lower Cretaceous) Sands of Central Texas

PETER A. BOONE

ABSTRACT

The basal Trinity sands occur as a wedge of clastic sediments which thickens downdip and becomes interbedded with carbonate units. Where the carbonate units are well developed the strata of the Trinity Group can be divided into upper, middle, and lower units, each consisting of a basal terrigenous phase succeeded by a carbonate phase. Updip and on the outcrop only the near-shore terrigenous phase of the lower two Trinity couplets is present. Both phases of the upper Trinity couplet occur on the outcrop in the northeastern part of the study area.

The lower Trinity subdivision consists of the Hoss-ton Sand and the Sligo Limestone. The middle Trinity subdivision consists of the Hammett Shale and Cow Creek Limestone members of the Pearsall Formation. The upper Trinity subdivision consists of the Hensel Sand and the Glen Rose Limestone.

In Mills and southern Brown counties, the Sycamore Sand, a local facies of Trinity deposition which occurred around the margins of the Llano uplift, is the outcrop equivalent of the Hosston, Pearsall, Hensel, and lower part of the Glen Rose formations. In Callahan and Taylor counties (beyond the updip limit of recognizable Glen Rose Limestone), the Antlers Sand is equivalent to the Pearsall, Hensel, and Glen Rose formations of the Trinity Group and the Paluxy Sand of the Fredericksburg Group.

Deposition of the basal Trinity sands is believed to have been controlled more by rejuvenation of the source area—by uplift and/or increase in runoff—than by the minor transgressions and regressions that occurred during the major transgression of the Comanchean sea across the Texas craton.

The basal Trinity sands were deposited upon the Wichita paleoplain, an erosional surface which developed upon the Paleozoic rocks of the Texas craton. The Wichita paleoplain had topographic relief similar to that now present in the Paleozoic outcrop area in North-Central Texas. Major drainage valleys separated by divides also developed on the Wichita paleoplain. These major valleys funneled clastic material to the depositional area and acted as basins for the thickest sediment accumulations when they were drowned by the transgression of the Comanchean sea. In the southeastern part of the study area, the Hamilton Valley trends to the southeast through southern Brown, Mills, Hamilton, and Coryell counties. The McGregor Divide parallels the Hamilton valley on the north and extends southeast to McGregor, McLennan County. North of the McGregor divide, the Meridian Valley is well developed in Bosque and southern Erath counties. West of Erath County, the Callahan Valley can be considered an extension of the Meridian Valley. The Meridian Valley is accompanied by lesser drainage networks extending to the north: the Twin Mountain Valley in north-central Erath County and the Granbury Valley in eastern Somervell and Hood counties. The Twin Mountain Divide marks the eastern margin of Twin Mountain Valley and the Granbury Divide marks the eastern limit of Granbury Valley.

INTRODUCTION

Exposures of Cretaceous rocks in Texas are among the most complete of any in the world. Rocks of Lower Cretaceous age (Comanchean Series) and Upper Cretaceous age (Gulfian Series) crop out in broad belts across Central Texas and underlie younger strata of the Gulf Coastal Plain. The type locality of the Comanchean Series is in Central Texas, and this region also includes most of the type localities of lesser stratigraphic units of Lower Cretaceous age.

The Comanchean Series, named for the town of Comanche, Texas, by R. T. Hill (1887b), is divisible, in ascending order, into Trinity, Fredericksburg, and Washita groups. This study encompasses the Trinity Group and lowermost part of the Fredericksburg Group.
Fig. 1. Location Map.

Structure adapted from Longwell, et. al., 1964 and FIsen, 1961.
PURPOSE

The purpose of this study is to interpret the stratigraphic relationships and depositional history of the basal Trinity sands in the outcrop area between the Colorado and the Brazos rivers, and to correlate these relationships with the subsurface sequence along the western edge of the East Texas Basin in McLennan County. The basal Trinity sands from base to top consist of the Hosston Sand, Pearsall Formation, and Hensel Sand. The Sycamore Sand, Bluff Dale Sand, Antlers Sand, and Glen Rose Limestone are partial equivalents to the previously named units.

LOCATION

The area of study includes all or parts of Bell, Bosque, Brown, Callahan, Comanche, Coryell, Eastland, Erath, Hamilton, Hood, Lampasas, McLennan, Mills, Palo Pinto, Parker, Somervell, Stephens, and Taylor counties (fig. 1).

Rocks of the Trinity Group crop out in Central Texas in a north-south belt locally called the Western Cross Timbers and Glen Rose Prairie (fig. 3), and extend in a narrow band to the west more than one hundred miles along the Callahan Divide.

In the outcrop area rocks of the Trinity Group occur as a wedge of clastic sediments which thicken and grades into carbonate units downdip. Lozo and Stricklin (1986, p. 68) in working the type Travis Peak Formation of the Colorado River valley divided the Trinity Group into upper, middle, and lower units consisting of "tectonic-sedimentary lithogenetic entities." Each cyclic unit was described as a "couplet consisting of a basal terrigenous detritus phase, ... succeeded by a carbonate phase often with evidence of extremely shallow, turbulent, terminal depositional conditions" (idem).

The lower Trinity subdivision consists of Hosston Sand and the Sligo Limestone; the middle Trinity subdivision consists of the Hammer Shale and Cow Creek Limestone members of the Pearsall Formation; and the upper Trinity subdivision consists of the Hensel Sand and the Glen Rose Limestone.

These subdivisions are most distinct in the subsurface in the vicinity of Waco. Updip and on the outcrop only the nearshore terrigenous phase of the lower two Trinity couplets is present. In Erath, Hood, and Parker counties, the upper couplet is well developed, but to the west this depositional unit is less well defined.

In Mills and southern Brown counties, the Sycamore Sand is the outcrop equivalent of the Hosston, Pearsall, Hensel, and lower part of the Glen Rose formations. In Callahan and Taylor counties (beyond the updip limit of recognizable Glen Rose Limestone), the Antlers Sand is equivalent to the Pearsall, Hensel, and Glen Rose formations of the Trinity Group and the Paluxy Sand of the Fredericksburg Group.

In the present study the Glen Rose Limestone becomes unrecognizable as a mappable unit in the western part of the study area, where the basal sands of the Trinity Group and the Paluxy Sand of the Fredericksburg Group coalesce to form the massive Antlers Sand. The Walnut Clay overlies the Paluxy and the Antlers sand units throughout the area.

PROCEDURES

Field studies included the preparation of an aerial geologic map, measurement and description of a number of sections, and descriptions of numerous localities. U. S. Geological Survey topographic maps (scale: 1/250,000) were used as the base for geologic mapping. The small scale base map was supplemented by 7½-minute and 15-minute quadrangle maps where available, and by aerial photograph mosaics. Laboratory study included microscopic determination of grain size, roundness and sorting of the sands, and sand-mud ratio. Isopach maps, a topographic map of the Wichita paleo plain (sub-Cretaceous surface), and diagrammatic cross-sections were constructed using measured sections and electric logs.

PREVIOUS INVESTIGATIONS

Studies of rocks now included in the Comanche Series of Texas were initiated during the middle of the nineteenth century by Ferdinand Roemer, G. G. Shumard, Jules Marcou, and B. F. Shumard. None of these workers recognized the Lower Cretaceous age of rocks comprising the Comanchean Series and, therefore, placed rocks belonging to this series above those of Upper Cretaceous age (Gulfian Series).

It was not until 1886 that R. T. Hill demonstrated the true stratigraphic relationship of this sequence of rocks and applied the name "Comanche series." Hill's studies spanned the last quarter of the nineteenth century and first part of the twentieth century and resulted in much of our present knowledge, as well as many of the formal names in the series.

Considerable geologic interest in the region continues today, and numerous workers (see References) have contributed to our knowledge of the Comanchean Series. Considerable information has also been recorded in geological theses of the Texas region.

ACKNOWLEDGMENTS

Appreciation is extended to Professors O. T. Hayward and L. F. Brown, Jr., Department of Geology, and to Professor James L. McAtee, Department of Chemistry, Baylor University, for guidance and help during this study. Messrs. J. B. Brown and A. R. Smith, Texas Water Development Board, provided electrical and drillers' logs of Central Texas and assisted in their interpretation and correlation. The National Science Foundation sponsored the research during the summer of 1964.
Fig. 2. Outcrop and thickness, basal Trinity sands, Central Texas. Kf undifferentiated Walnut Clay, Comanche Peak Limestone, and Edwards Limestone; Kgr-pa undifferentiated Glen Rose Limestone and Paluxy Sand; Kgr Glen Rose Limestone; Kbs undifferentiated Houston Sand, Pearsall Formation, Hensel Sand and Bluff Dale Sand; Ka Antlers Sand; Kay Sycamore Sand; P undifferentiated Paleozoic.
DEVELOPMENT OF NOMENCLATURE

Earliest reports of Cretaceous rocks in Texas were made by explorers and travelers to the state. These reports were general and geographic rather than geologic in nature. However, several of the early visitors did mention the great extent of Cretaceous rocks in Texas. True geologic reporting on the Cretaceous strata of Texas began with Ferdinand Roemer in 1845 and was continued by reconnaissance studies of Jules Marcou, G. G. Shumard, and B. F. Shumard during the middle part of the century. These early Cretaceous studies culminated with the work of R. T. Hill in the late nineteenth and early twentieth centuries. Recent work is largely concerned with more detailed studies of the major regional aspects described and defined by Hill or earlier workers.

Ferdinand Roemer, a German geologist and paleontologist, visited Texas from 1845 to 1847 and made a study of the New Braunfels-Fredericksburg area to determine its adaptability for German settlement. Of his papers on the geology of the New Braunfels-Fredericksburg area, the one of greatest value to Texas geology is "Die Kreidebildungen von Texas und ihre organischen Einschluss" published in Bonn in 1852.

In this work Roemer divided the Cretaceous strata in the area studied into two great subdivisions on the basis of the different fauna. These subdivisions were: (1) "Die Kreidebildungen am Fusse des Hochlandes" (the Cretaceous formations at the foot of the highlands), and (2) "Die Kreidebildungen des Hochlandes" (the Cretaceous formations of the highlands). In the latter subdivision he included the Cretaceous rocks exposed near Fredericksburg and those exposed eight miles west of New Braunfels. Roemer mistakenly believed the rocks at Fredericksburg to be the youngest and "Die Kreidebildungen am Fusse des Hochlandes" to be the oldest. Collectively he assigned to them the same age as the Upper Chalk of England (Hill 1887c, pp. 72-73).

The Cretaceous rocks of Texas were further studied by geologists accompanying federal expeditions sent by geologists accompanying federal expeditions sent to determine mineral wealth and survey routes for a transcontinental railroad. In 1852, G. G. Shumard accompanied Captain R. B. Marcy on an expedition to the upper Red River and surrounding country. In the report of the expedition, Shumard described the Cretaceous strata in the vicinity of Fort Washita and westward to the Cross Timbers. Jules Marcou, who accompanied Lieutenant A. W. Whipple's exploration of the railroad route near the thirty-fifth parallel in 1853, assigned the Cretaceous groups of the Mississippi region to the "Comanche series" for the town of Comanche, or the "Comanchean" possessing sufficient diversity to divide it into many minor divisions" and cautioned that "this should not be attempted until several years more of thorough stratigraphic study of the whole is made" (1887b, p. 301). Provisionally, he therefore divided the Comanchean Series into two groups based upon his Fort Worth (Trinity River) section, one of the three "typical" general sections used in his discussions. The lower group was called Fredericksburg because its paleontologic features were originally described by Roemer. Hill was aware that the "members of this series [Comanchean] possess sufficient diversity to divide it into many minor divisions" and cautioned that "this should not be attempted until several years more of thorough stratigraphic study of the whole is made" (1887b, p. 301).
from the strata found in the area of Fredericksburg, and the upper group was named Washita, for the strata described by G. G. Shumard and Jules Marie at Fort Washita. The base of the Fredericksburg Group was taken as the base of the "Caprotina Limestone" of Shumard. Below the Fredericksburg Group, but still in the Lower Cretaceous, he placed the "basal sands" ("Dinosaur sand" or "Upper Cross Timbers") which "are the shore detritus of the Mesozoic sea bordered upon the Carboniferous continent" and "may prove to have Jurassic affinities" (Hill, 1889, pp. 118).

As Hill continued his studies of the Texas Cretaceous, he divided the Comanchean Series "into three grand divisions, . . . the Trinity or Basal (sandy beds), the Fredericksburg or Medial . . . , and the Washita or Upper division" (Hill, 1889b, p. 118). Originally (1888) Hill had assigned the name "Trinity Formation" to the beds which underlie the Comanchean Series and overlie the Paleozoic rocks but now he included these beds in the lower part of the strata he called the Trinity Group (Wilmart, 1938, pp. 2184-2185). To the sands of the Trinity Group, Hill applied the name Travis Peak sands or "Water-bearing Beds" for their exposure near the Travis Peak post office in Travis County. Hill described the group as being "essentially arenaceous in composition, clastic in structure, and composed at its base of conglomerates or sands" followed by "a coarse, angular, cross-bedded sand, which becomes finer and finer until it reaches the condition known in Texas as "pack sand" (1889, p. 118).

The "Caprotina Limestone" was still placed in the Fredericksburg Group but Hill now applied the name "Alternating beds" to this formation because of the alternation of hard limestones with softer marls that characterizes it on the outcrop. The middle member of the formation was tentatively placed at the base of the Paluxy Sand.

By this time Hill had applied the name Glen Rose to the alternating beds, since it was his custom to apply the name of the locale where he found the best exposures of the formation. The type locality was the bluffs along the Paluxy River near the town of Glen Rose, Somervell County.

At the same time he recognized the lower part of the Glen Rose to be a separate subdivision which he called the "Thorpe Spring limestone subdivision." The Thorpe Spring crops out along the bed of the Brazos River at Granbury and Thorp Spring and in the bed of the Paluxy River at Glen Rose (idem, p. 509).

The Paluxy Sand was recognized north of the Colorado-Brazos divide and named for "the town and creek of that name [Paluxy] in Somerville [sic] County." Earlier, the Paluxy Sand had been confused with Trinity sands but the Paluxy Sand has no pebbles and is "calcareous and argillaceous in places, while those [beds] of the Trinity are more ferruginous" (idem, p. 510).

In 1891, J. A. Taff, who was conducting a broad survey of the Cretaceous strata north of the Colorado River, defined the "Roscoe division" in which he included the Paluxy Sand, the Glen Rose Limestone, and the Trinity sands (Taff, 1891, p. 272).

Hill (1901, p. 131) retained the term "Trinity division" and defined the Paluxy Sand as its upper unit. At the same time he gave a more detailed picture of the Trinity Group. Hill subdivided the "Travis Peak formation," in descending order, into the "Hensel sands," the "Cow Creek beds," and the "Sycamore sands" for exposures in the Colorado River valley of Travis and Burnet counties (idem, pp. 142-143). At Comanche Peak, Hill applied the name "Bluffdale sands" to the sands below the Glen Rose Formation and considered them "the northern equivalent of the Hensel sands of the Colorado section" (idem, p. 152).

North of the Brazos River where the Glen Rose Limestone thins and pinches out, the Trinity and Paluxy sands coalesce into one formation. Where this occurs, Hill called the resulting formation the "Antlers sands" for Antlers, Indian Territory (idem, p. 152).

In 1926, G. Scott identified fossils of the "Travis Peak beds" and considered them equivalent to the upper Aptian (Gargasian) of Europe.

Hill (1936) redefined the Paluxy Sand as the basal formation of the Fredericksburg Group. His "reversal of opinion" was based upon "paleontologic and stratigraphic evidences, which demonstrate the fact that the formation is the logical beginning of a cycle of sedimentation of the character which should be the true criterion for classification into groups, instead of solely paleontologic data" (1937, p. 80). In the subsurface stratigraphy of the Trinity Group became known, names were applied for units absent at the outcrop. R. W. Imlay (1940) applied the names Sligo and Hosston formations to the strata found below the Glen Rose and above the Cotton Valley Formation in the subsurface of Arkansas, Louisiana, and Texas. The term "Sligo formation" was proposed by the Shreveport Geological Society for the "gray to brown shale containing local lenses of sandstone and limestone which represent the lowest beds of the Lower Glen Rose formation" (Imlay, 1940, p. 30). The name of this formation was taken from the Sligo field of north-western Louisiana.

The term "Hosston formation," named for the town of Hosston, Caddo Parish, Louisiana, was proposed for "the Lower Cretaceous red and gray shales, dolomites, and sandstones lying above the Cotton Valley formation and below the Sligo formation" in the subsurface of Arkansas, Louisiana, and Texas by the Shreveport Geological Society (idem, p. 28).

From the subsurface studies in Frio County, Texas, Imlay (1945, p. 1441) applied the name Pearsall Formation to the "sequence of dominantly shaly beds lying above the Sligo formation and below the Glen Rose limestone, and representing the subsurface equivalents of the Travis Peak formation of the outcrop."

The Pearsall Formation is named for the Pearsall Field, Frio County, and it is divisible into three members—the lower, middle, and upper. Imlay considered the lower member equivalent to the basal gravel and sand (Sycamore Sand) of the Travis Peak Formation of the outcrop. The middle member of the formation occupies the same stratigraphic position as the Cow Creek Limestone and the upper member is equivalent to the Hensel shale member (idem, pp. 1441-1442).

Hill's Travis Peak-Glen Rose terminology remained unchanged until Barnes (1948) noted that the Cow...
Creek Limestone in Travis County overlaps and rests directly on the Paleozoic rocks. Noting also that the Hensel Sand appeared to be the “clastic shoreward facies of the Glen Rose limestone” that rests “on the massive coquinas of the Cow Creek limestone” and is therefore “more closely allied to the Glen Rose limestone,” he proposed a new formation, the “Shingle Hills,” in which the Hensel Sand and Glen Rose Limestone would be members.

In 1949, F. E. Lozo, while studying the surface and subsurface stratigraphic relations of the Fredericksburg limestones in Central Texas, assigned the Paluxy Sand to the Fredericksburg Group on the basis that it is the lateral equivalent of the Walnut Formation, following Hill’s reclassification of 1936 (1949, pp. 85-91).

Lozo, restudying the type “Travis Peak formation,” subdivided the Trinity Group of the Colorado River valley into three “tectonic-sedimentary lithogenetic entities”—the lower, middle, and upper (Lozo and Stricklin, 1956, pp. 67-68). Each of these subdivisions consists of a basal terrigenous phase followed by a carbonate phase. The lower Trinity subdivision consists of the Hosston Sand and the Sycamore Limestone in the subsurface and the Sycamore Sand at the outcrop; the middle subdivision consists of the Hammett Shale and the Cow Creek Limestone; and the upper subdivision includes the Hensel Sand and the Glen Rose Limestone.

At the same time Lozo referred to the groups of the Comanchean Series as divisions re-establishing the designation of Hill. He also proposed that the term “Travis Peak formation” should be “deleted from modern stratigraphic terminology” because “intra-Travis Peak disconformities at the boundaries of the original members (top of the Cow Creek and the top of the Sycamore) effectively eliminate any implication of unity within the ‘formation’” (idem).

The Hammett Shale of the middle subdivision is a new term applied to the buff-colored shales between the Sycamore Sand and the Cow Creek Limestone (idem, p. 69). It was named by Lozo for Hammett Crossing, Travis County.

During his study of the Trinity aquifers of McLennan County, Holloway (1961, p. 10) followed Lozo’s subdivision of the Trinity Group. Holloway reviewed the development of subsurface terminology of Central Texas (idem).

Rodgers (1965, p. 33), while studying the Glen Rose Limestone of the type area, stated that the “Bluff Dale Sand may be a shoreward clastic facies of the Glen Rose Limestone.” He considered the upper part of the Bluff Dale Sand to be time equivalent to the lower part of the Glen Rose in the subsurface and the lower part of the Bluff Dale Sand to be the outcrop equivalent of the Hensel Sand of McLennan County.

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Fig. 3. Western Cross Timbers (on right) and Glen Rose Prairie (on left).
SUB-CRETACEOUS SURFACE -- THE WICHITA PALEOPLAIN

Cretaceous seas transgressed northwestward across an erosional surface developed upon truncated, metamorphosed Paleozoic rocks of the Ouachita fold-belt, eastward-dipping Pennsylvanian strata of the Fort Worth Basin, and slightly westward-dipping Pennsylvanian and Permian strata of the Texas craton. This erosional surface was first recognized by Hill (1901, p. 363) who named it the Wichita paleoplain.

The “topography” of the Wichita paleoplain, which dips southeastward into the subsurface at the base of the Cretaceous section at about 15 feet per mile (figs. 4, 13), resembles the topography of the Pennsylvanian and Permian outcrop area in North-Central Texas. Pre-Cretaceous erosion of Paleozoic rocks resulted in resistant limestone and sandstone ridges and hills which stood as highs until buried by sediments in the transgressing Cretaceous seas. “Topography” on the sub-Cretaceous surface is especially prominent in central Brown County and northeastern Erath County where relief exceeds 100 feet. Minor dissection (2 to 3 feet) is visible at locality 43. Visible relief exceeds 100 feet at locality 43. At localities 2, 14, 48, and in northeastern Erath County, this local relief is particularly prominent.

A sub-Cretaceous high possessing a steep east face (cuesta?) and trending northeast-southwestward is present east and south of Brownwood, and may be seen at several localities (43 and 48). Along Steppe Creek (locality 42) Cretaceous sediments are exposed in hills on the east side of the creek but hills on the west side consist entirely of Pennsylvanian rocks. The difference in elevation between the Cretaceous-Pennsylvanian contact on the east side of the creek and the top of the hills of Pennsylvanian rocks on the west is about 100 feet and greater relief undoubtedly occurred at the time of Cretaceous deposition. Relief on a much smaller scale occurs along the east side of Steppe Creek where the elevation of the contact varies several feet.

Further evidence of sub-Cretaceous surficial relief is present at the Brownwood Country Club. The Cretaceous-Pennsylvanian contact is 60 feet higher on the west side of the club than on the east side, reflecting considerable relief on the sub-Cretaceous surface at the time of deposition (fig. 5). West of the club (locality 47) Cretaceous sediments of channelled sands and muds rest upon the Adams Branch Limestone of Pennsylvanian age. This thick limestone supports the sub-Cretaceous high (cuesta?). East of the club (locality 48), where the Cretaceous-Pennsylvanian contact is considerably lower than to the west, Cretaceous sediments overlie Pennsylvanian shales and thin clayey limestones.

On the Jones Ranch (locality 2) west of Oplin, Callahan County, sub-Cretaceous relief of lesser magnitude occurs. Antlers Sand is exposed in the valley and on the hillsides, but Pennsylvanian limestone is exposed capping the hills (fig. 6). The Jones house is located on one of these limestone-capped hills. West and about 30 feet below house level, a stock tank is located in Antlers Sand. It is apparent that the present topography is partially controlled by hills on the sub-Cretaceous surface that are now being exhumed by removal of the overlying Cretaceous sediments. Initial Cretaceous deposits filled these valleys on the Wichita paleoplain.

While mapping the Pennsylvanian rocks of northern Eastland County, L. F. Brown (personal communication) found numerous examples of buried relief on the Wichita paleoplain which show clearly on aerial photographs. Outcropping Pennsylvanian limestones can be traced from one area to another by the way the Cretaceous sediments drape over the underlying
limestone ridges even though the intervening area is covered by a thin veneer of basal Trinity sands. This draping of the Cretaceous sediments clearly shows that they were deposited upon topography of considerable relief, now being exhumed and modified by recent erosion.

Northeast of Lipan (locality 23) the Cretaceous-Pennsylvanian contact is at an elevation of 810 feet and rises to the west at about 12 feet per mile. Further west the elevation of the contact is approximately 1100 feet at Patilo (locality 19), and 1250 feet where Lost Creek crosses Farm Road 1715 (locality 18). This westward increase in elevation of the sub-Cretaceous surface greatly exceeds the regional dip (15 feet per mile) and suggests the existence of a pre-Cretaceous topographic high (Twin Mountain Divide) in this area.

The “topography” on the Wichita paleoplain cannot be as accurately mapped in the subsurface as in areas where it is exposed. However, several major “topographic” trends are recognizable in the subsurface and suggest that appreciable relief existed over all the Wichita paleoplain (figs. 1, 4; Pl. 1, fig. A).

These trends suggest several major drainage valleys separated by divides. In the southern part of the study area, the Hamilton Valley trends to the southeast through southern Brown, Mills, Hamilton, and Coryell counties.

The McGregor Divide parallels the Hamilton Valley on the north and extends southeastward to McGregor, McLennan County (fig. 4). Southeast of McGregor there is inter-communication between the southern and northern sedimentary provinces.

North of the McGregor Divide the sub-Cretaceous surface is complicated by a set of major valleys with minor offshoots to the north (fig. 4). The Meridian Valley is well developed in Bosque and southern Erath counties. In central Erath County the Meridian Valley becomes less distinct. West of Erath County the Callahan Valley can be considered an extension of the Meridian Valley. The Meridian and the Callahan valleys apparently constituted the major drainage pattern in the northern part of the study area.

The Meridian Valley is accompanied by two lesser “drainage networks” extending to the north (fig. 4). Both these valleys are bounded on their eastern sides by highs, the Twin Mountain Divide and the Granbury Divide respectively. The Twin Mountain Divide marks the eastern margin of Twin Mountain Valley and the Granbury Divide marks the eastern limit of Granbury Valley.

Topography on the Wichita paleoplain is suggested not only by the map of the sub-Cretaceous surface but also by the overlying basal Trinity sands. The topography of the Wichita paleoplain influenced the deposition of the basal Trinity sands and is reflected by them. The basal Trinity sands thin over the McGregor Divide and thicken in the Hamilton and Callahan-Meridian valleys (fig. 2).

Supplemental evidence supporting the presence of topography on the Wichita paleoplain is found in Henningsen’s study of the Trinity aquifers of Central Texas (1962). In this study Henningsen delineated two dominant sources for the water present in these aquifers: (1) a northwestern or “Stephenville source” which enters the present study area through Erath County, and (2) a southern or “Llano source” which enters through Coryell County. These two water masses mix in Hamilton and western Bosque Counties to form a third water mass.

The characteristics of the water in the Trinity aquifers most probably reflect the configuration of the underlying Wichita paleoplain. The two major sources of the water are confined to the Meridian and Hamilton valleys where the basal Trinity sands are best developed. Mixing of these two water sources is restricted by the McGregor Divide except in Hamilton and western Bosque counties where a saddle in the divide allowed better development of the basal Trinity sands and a path whereby the two main sources can mix.
Plate I. Antlers, Hosston, and basal Trinity sands, outcrops and lithologies.
STRATIGRAPHY

The main consideration of the present investigation is the determination of the stratigraphy and depositional history of the basal Trinity sands; from base to top, the Hosston Sand, the Pearsall Formation, and the Hensel Sand. The Sycamore Sand, Bluff Dale Sand, Antlers Sand, and Glen Rose Limestone are partial equivalents to the previously named units. The term "basal Trinity sands" is used as an informal name for the Trinity Group.

The Glen Rose Limestone of the Trinity Group and the Paluxy Sand and Walnut Clay of the Fredericksburg Group receive limited consideration. These units are considered because the distinctive Glen Rose Limestone becomes unrecognizable as a mappable unit in the western part of the study area, where the basal sands of the Trinity Group and the Paluxy Sand of the Fredericksburg Group coalesce to form the massive Antlers Sand. The Walnut Clay overlies the Paluxy Sand and the Antlers Sand throughout the area.

Rocks of the Trinity Group occur as a wedge of sediments that thickens and contains carbonate units downdip. Lozo, in working the type Travis Peak Formation of the Colorado River valley, divided the Trinity Group into upper, middle, and lower units consisting of "tectonic-sedimentary lithogenetic entities" (and Stricklin, 1956, p. 68). Each cyclic unit was described as a couplet consisting of a basal terrigenous detritus phase succeeded by a carbonate phase which shows evidence of shallow water deposition.

The lower Trinity subdivision consists of the Hosston Sand and the Shilo Limestone; the middle Trinity subdivision consists of the Hammett Shale and Cow Creek Limestone members of the Pearsall Formation; and the upper Trinity subdivision consists of the Hensel Sand and the Glen Rose Limestone.

These subdivisions are most distinct in the subsurface in the vicinity of Waco. Updip and on the outcrop only the nearshore terrigenous phase of the lower two Trinity couplets is present (fig. 13). In Erath, Hood, and Parker counties, the upper couplet is well developed, but to the west this depositional unit is less well defined.

In Mills and southern Brown counties, the Sycamore Sand is the outcrop equivalent of the Hosston, Pearsall, Hensel, and lower part of the Glen Rose formations (fig. 13). In Callahan and Taylor counties, beyond the updip limit of recognizable Glen Rose Limestone, the Antlers Sand is equivalent to the Pearsall, Hensel, and Glen Rose formations of the Trinity Group and the Paluxy Sand of the Fredericksburg Group (fig. 14).

THE BASAL CRETACEOUS CONTACT

Rocks of the Trinity Group are the oldest Comanchean deposits of Central Texas. They overlie strata ranging in age from Paleozoic to Jurassic. East of the present area of study Comanchean strata overlie rocks of Jurassic age, assigned to the Cotton Valley Group (Swain, 1949, p. 1206). In the southeastern part of the study area, strata of the Trinity Group rest upon truncated rocks of the Ouachita foldbelt (Flawn, 1961). West of the Ouachita foldbelt strata of the Trinity Group unconformably rest upon Pennsylvanian and Permain rocks of the Texas craton.

Throughout most of the mapped area the actual basal Cretaceous contact is obscure, though along creeks and in road cuts excellent exposures of the contact can be found.

Normally, where the contact zone is exposed in fields and pastures, the contact between the basal Trinity sands and the underlying Paleozoic rocks is difficult to map. The basal Trinity sands weather rapidly upon exposure, and the slopes below the outcrop are covered with an outwash of sand which obscures the contact.

In Hood County (localities 22, 23) dark red-brown muds of Pennsylvanian age are overlain by gray-green to red-brown sandy mud, muddy sandstone and pebbly sandstone of the Hosston Sand. At locality 23 a dark red, clay-pebble conglomerate rests directly on the Pennsylvanian mud, probably indicating reworking of the underlying Pennsylvanian sediments by the transgressing Comanchean sea.

In Erath County a number of different Pennsylvanian lithologies are overlain by Hosston Sand. At localities 18 (Pl. 1) and 19, red-brown mud and thin mudstone of Pennsylvanian age are overlain by gray sandstone and gray-green mud of the Hosston Sand. Thick-bedded sandstone of Pennsylvanian age is overlain by Hosston Sand at locality 16. At Twin Mountain (locally 15) brown to gray-green muddy fine-grained sandstone and sandy mud of the Hosston Sand overlie gray to green conglomeratic limestone and sandstone of Pennsylvanian age.

Southwest of Cisco, Eastland County, Brown (L. F., Jr., 1965, personal communication) reported that conglomerates of the basal Trinity sands overlying the Lake Cisco Conglomerate of Pennsylvanian age have

*Editor's Note: In Hood and Erath counties red muds, here assigned to the Pennsylvanian, have been found to contain Cretaceous charophytes. Beneath these, perhaps 100 feet, are crinoidal limestones definitely of Paleozoic age. How much of the overlying red section is Pennsylvanian and how much is Cretaceous is not yet certain. However, for mapping purposes, the contact here described is still the most useful.
reworked pebbles of the Lake Cisco in the lower several feet.

At Devil’s Hollow, Callahan County (locality 3, Pl. I), the contact between the Pennsylvanian strata and the Antlers Sand is gradational. Sandy mud with thin mudstone beds of Pennsylvanian age are overlain by a zone of reworked Pennsylvanian mud which grades upward into sandy mud characteristic of the basal Trinity sands.

At Bear Cove, Taylor County (locality 66), muddy pebble conglomerate of the Antlers Sand overlies dark red-brown mudstone of Permian age.

On the Sabana River, Comanche County (locality 31), calcitic sandy Hosston pebble conglomerate overlies steeply dipping maroon, green and brown thin-beded sandstone and siltstone of Pennsylvanian age. At Round Mountain (locality 35), the Hosston Sand, consisting of gray to red-brown sand conglomerate interbedded with muddy sandstone and sandy mud, overlies steeply dipping light green, indurated, thin-beded sandstone of Pennsylvanian age.

In Brown and Mills counties the Sycamore Sand overlies Pennsylvanian rocks of varying lithologies. At locality 47 sandstone, muddy sandstone, and shale with a caliche zone near the base overlie the Adams Branch Limestone of Pennsylvanian age. In Mills County (localities 58, 64, 65), red-brown to gray, calcitic sandy pebble conglomerates at the base of the Sycamore Sand overlie shale and thin mudstone of Pennsylvanian age.

**HOSSTON SAND**

The Hosston Sand is the lowermost formation of the Trinity Group in Central Texas. The term “Hosston Sand” was proposed by the Shreveport Geological Society for “the Lower Cretaceous red and gray shales, dolomites, and sandstones lying above the Cotton Valley formation and below the Sligo formation” in the subsurface of Louisiana (Inlay, 1940, p. 28). Holloway (1961, p. 16) applied the name to the lowermost Trinity sand in McLennan County.

On the outcrop in Central Texas, the Hosston Sand consists of fine- to medium-grained, immature to submature, friable, compact, orthoquartzitic sandstone interbedded with sandy mud and muddy pebbly sandstone (terminology modified from Folk, 1964). The sands are commonly thin- to massively bedded. Cross-bedding is commonly associated with the conglomeratic parts of the unit. Microcross-bedding is present in the lower few feet of the formation at localities 16, 18, 19, and 35. The color of the Hosston Sand ranges from tan to gray through red-brown with some green and yellow-brown sandy muds.

The Hosston Sand on the outcrop ranges in grain size from 0.06 to 2.0 mm (very fine- to very coarse-grained). The predominant size range is 0.25 to 0.50 mm (medium-grained). Quartz sand in the units ranges from about 15 percent in the sandy muds to over 96 percent in some of the fine-grained sandstones. The sand grains are subrounded and moderately sorted to well sorted (Pl. I, fig. C).

Sandy pebble conglomerates and pebbly sandstones are found throughout the Hosston Sand (locality 15, units 5, 6, 11) but the greatest concentration is in the lower part (localities 13, 17, 19, 23, units 3, 5; localities 31, 35). The conglomeratic units consist predominantly of chert and quartz pebbles with a maximum range of 2 to 20 mm (granule to large pebble). The median diameter of the pebbles is 6 to 8 mm (small pebble). Locally (locality 31) sandstone blocks of Pennsylvanian age up to 300 mm in diameter are present.

Sandy conglomerates and conglomerates with opaline cement occur at the base and in the lower part of the Trinity sands in Callahan, Eastland, Stephens, and Erath counties (localities 4, 9, 10, 12, 21). These are probably Hosston Sand. At Twin Mountain (locality 15, unit 6) a bed of pebbly medium-grained sandstone 2 feet thick with siliceous (opaline) cement occurs about midway in the Hosston Sand (Pl. I, fig. D).

Towe (1962, p. 26) has suggested that “the post-depositional transformation of montmorillonite and/or mixed-layer illite-montmorillonite to illite” is a possible source of silica cement in some sedimentary rocks. When montmorillonite or illite-montmorillonite is converted to illite “substitutions involving replacement of sufficient Si\(^{4+}\) by Al\(^{3+}\) so as to increase the positive tetrahedrally seated charge deficiency appear to be required to ‘fix’ potassium” (idem, p. 27). The silica immediately combines with oxygen upon release to form silica. The silica so produced can be transported by ground water and deposited as cement. A process similar to this is a possible source for the opaline cements found in the basal Trinity sands.

In the subsurface of McLennan County, the Hosston Sand is “commonly fine to coarse, red to white, silty porous sand, locally cemented with calcite and interbedded with variegated shale” (Holloway, 1961, p. 16). Conglomerates have been reported at and near the base of Hosston Sand in Central Texas wells such as C. M. Stoner #1 Spring Valley (locality 139).

The Hosston Sand occurs as a recognizable unit throughout the area of study except in Callahan and Taylor counties beyond the updip limit of Hosston Sand deposition and in Mills County where the Sycamore Sand was being deposited. The Hosston Sand is thickest in the vicinity of Waco where 219 feet occur in the J. L. Myers & Sons #1 Dr. Barnes well (locality 146). Regionally the Hosston thins to the west and northwest of Waco, though there are local variations in thickness throughout the area (fig. 8). Thick lobes of sand occur in the Hamilton and Meridian valleys and thin across the McGregor Divide. In the vicinity of McGregor, McLennan County (locality 140), the Hosston Sand is absent, apparently due to non-deposition over a prominent high on the McGregor Divide.

Near Hamilton, the Hosston Sand is 116 feet thick.
in the Amerada Petroleum Corp. #1 N. F. Tate well (locality 133) and consists of massive sandstone with interbedded muds. West of locality 133, the Hosston Sand thins and is replaced by Sycamore Sand in the Bryon Hoffman #1 J. S. Owens well (locality 119).

The Hosston Sand thins to 48 feet in the Amerada Petroleum Corp. #1 L. S. Burney (locality 124) and the C. M. Stoner #1 Jonesboro Water Supply Corp. (locality 132) wells on the McGregor Divide. The Hosston Sand is absent at McGregor in the Hervie Meadows & Sons #2 City of McGregor well (locality 140).

North of the McGregor Divide the Hosston Sand thickens into the Meridian Valley. On the northern flank of the Meridian Valley the Hosston again thins. The Hosston Sand attains a maximum thickness of 152 feet in the Meridian Valley at the C. M. Stoner #1 City of Meridian well (locality 127). Throughout the Meridian Valley, the Hosston consists of massive sandstones with interbedded muds.

The Hosston Sand locally thickens along the northern flank of the Meridian Valley and in the Twin Mountain and Granbury valleys. In these valleys the Hosston Sand has a thickness of 40 and 41 feet respectively. The thinning of the Hosston Sand and corresponding thickening of the Pearsall Formation at these localities (no. 108, 107) are believed to be the result of deposition of the Pearsall sandy mud facies which is contemporaneous with the upper part of the Hosston Sand throughout the rest of the area (figs. 8, 9).

At Twin Mountain (locality 15) the Hosston Sand is 57 feet thick. Thirty-five and one-half miles southwest, at Round Mountain (locality 35), the Hosston Sand is 6 feet thick. West of Round Mountain no recognizable Hosston Sand was found.

PEARSALL FORMATION

The Pearsall Formation was named by Imlay (1945, p. 1441) for the "sequence of dominantly shaly beds lying above the Sligo formation and below the Glen Rose limestone" in the subsurface of Frio County, Texas. In the area of study, the Pearsall Formation consists of a lower Hammett Shale Member and an upper Cow Creek Limestone Member. This sequence is found in the extreme southeastern part of the area in the subsurface. Immediately west of Waco, the Cow Creek Limestone Member grades into Hammett Shale lithology. In electric log characteristics, the entire Pearsall Formation resembles the Hammett Shale (fig. 13).

Hill (1901, p. 142-143) recognized the "Cow Creek beds" as the middle unit of the "Travis Peak formation" on the outcrop in the Colorado River valley of Burnet and Travis counties. In McLennan County, the Cow Creek Limestone Member is a "cream to tan, oolitic, finely sucrosic, slightly porous limestone" (Hollway, 1961, p. 16).

In the Golinda Co-op #1 well (locality 148), the Cow Creek is 63 feet thick (fig. 13). Westward the Cow Creek thins to 42 feet in the J. L. Myers & Sons #1 Dr. Barnes well (locality 146) and is absent in the Smith and Falcon Oil Corp. #1 McKethan well (locality 145).

The Hammett Shale Member of the Pearsall Formation was named by Lozo and Stricklin (1956, p. 69) for the huff-colored shales between the Sycamore Sand and the Cow Creek Limestone found on the outcrop and in cores at Hammett Crossing, Travis County. In McLennan County, the Hammett Shale consists of "gray shale with some cream, slightly oolitic crystalline limestone beds which become sandy westward" (Hollway, 1961, p. 16). West of McLennan County the limestone beds grade into the shale and the whole unit becomes more sandy. In Comanche and Erath counties, outcrops of the Pearsall Formation consist of red-brown to green sandy mud.

The Pearsall Formation occurs as a recognizable unit throughout most of the study area. In Mills and southern Brown counties the Pearsall Formation is replaced by the Sycamore Sand. In Callahan and Taylor counties, beyond the updip limit of the Pearsall sandy mud facies, the lower part of the lower sand unit of the Antlers Sand is probably contemporaneous with the Pearsall throughout the remainder of the study area.

The Pearsall Formation is 132 feet thick in the J. L. Myers & Sons #1 Youngblood well (locality 147) south of Waco. Regionally the Pearsall Formation thins west and northwest of Waco, although local variations in thickness do occur (fig. 9). The Pearsall Formation thickens in the Hamilton and Meridian valleys and thins over the McGregor Divide. The thinning across the McGregor Divide is not as great as in the underlying Hosston Sand but it does show that the topography of the Wichita paleoplain continued to influence sedimentation during deposition of the Pearsall Formation.

In the Hamilton valley (figs. 4, 9), the Pearsall Formation is 132 feet thick in the J. L. Myers & Sons #1 Youngblood well (locality 147). It thins to 80 feet at the American Manufacturing Co. #1 T. W. Winters well (locality 121) in southern Hamilton County, and again thickens northwestward to 97 feet at the Humble Oil and Refining Co. #1 J. M. Foreman well (locality 115) in Comanche County. This is the westernmost Pearsall locality on the south side of the McGregor Divide. Possibly part of the Sycamore Sand section at Steep Creek (locality 43, unit 11) is a continuation of the Pearsall Formation. In Mills County, the Pearsall is apparently replaced by Sycamore Sand.

In the Meridian Valley the Pearsall Formation is thinner in the central part of the valley than along the
margins. Thinning of the Pearsall Formation in the central part of the valley corresponds to a thickening of the overlying Hensel Sand indicating sand deposition in the central part of the valley contemporaneous with sandy mud deposition along the margins of the valley.

Along the southern margin of the valley the Pearsall Formation reaches a maximum thickness of 97 feet in the J. L. Myers & Sons #1 Turnersville well (locality 131). The Pearsall thins to 46 feet in the C. M. Stoner #1 City of Meridian well (locality 127) in the central part of the valley. North of Meridian the Pearsall thickens to 85 feet in the C. M. Stoner #1 Cedar Valley Ranch well (locality 106). West of Meridian the Pearsall Formation thins to 6 feet in the

The Hensel Sand was named by Hill (1901, pp. 142-143) for the upper subdivision of the "Travis Peak formation" in the Colorado River valley of Burnet and Travis counties.

The Hensel Sand occurs throughout the area of study except in Mills and southern Brown counties where it is replaced by Sycamore Sand. In the far western part of the study area, the Hensel Sand is represented by the lower sand unit of the Antlers Formation (fig. 14).

The Hensel Sand consists of fine to medium, sub-rounded, moderately to well sorted, friable, gray, green, and red-brown immature to supermature orthoquartzitic sandstone. Muddy sandy pebble conglomerate is scattered throughout the unit and occurs as lenses in the lower part. Commonly the Hensel Sand is massive (Pl. II) to cross-bedded, but laminated sand and mud occur locally.

In the subsurface of McLennan County, the Hensel Sand is a "white, fine to course-grained, sub-rounded to sub-angular unconsolidated sand" with interbedded green shales (Holloway, 1961, p. 16).

The Hensel Sand ranges in grain size from 0.06 to 2.0 mm (very fine-grained to very coarse-grained). At Twin Mountain (locality 15) the median range is from 0.25 to 5.0 mm (medium-grained). At Round Mountain (locality 35) the Hensel Sand has a median range of 0.12 to 0.25 mm (fine-grained). The grains are sub-rounded and moderately sorted (Pl. II).

The Hensel Sand ranges from 25 percent quartz sand in the sandy mud at Twin Mountain (locality 15, unit 2) to 98 percent quartz sand in some of the sandstones at Round Mountain (locality 35-F, unit 4; locality 35-P, unit 5). At Twin Mountain (locality 15), muddy pebble conglomerate is present at the base of the Hensel Sand. The pebbles in this conglomerate are of chert and quartz, ranging in size from 2 to 20 mm (granule to large pebble). Median pebble size is 6 mm.

In the area of study, the Hensel Sand is thickest in northern McLennan County where 162 feet of sand with interbedded mud occur in the H. W. Bass & Sons #1 Delmar Ranch well (locality 143). Regionally the Hensel Sand thins to the northwest, but local variations in thickness do occur (fig. 10). These variations occur in the southeastern part of the study area and cannot be related to the topography of the Wichita paleoplain as clearly as those in the underlying Pearsall and Hosston formations. However, the Callahan Valley continued to influence the deposition of the Hensel and Antlers sands in the western part of the study area. A thick lobe of Hensel Sand extends from the southeast through southern McLennan County into eastern Coryell County. One hundred fifty-nine feet of Hensel Sand occur in the J. L. Myers & Sons #2 City of Moody well (locality 138). The Hensel Sand thins to 57 feet in the J. L. Myers & Sons #3 Gatesville School for Boys well (locality 135) at Gatesville, Coryell County. West of Gatesville the Hensel Sand continues to thin, but at a less rapid rate, until it interfingers with the upper part of the Sycamore Sand in Mills County (fig. 13).

In central McLennan County 65 feet of Hensel Sand occur in the J. L. Myers & Sons #1 Dr. Barnes well (locality 146). Another thick lobe of Hensel Sand occurs in northern McLennan County. The maximum thickness of the Hensel Sand in the study area, 162 feet in the H. W. Bass & Sons #1 Delmar Ranch well (locality 143), occurs in this lobe.

The main accumulation of Hensel Sand occurs as a broad lobe throughout the central and northern portion of the study area. The axis of this lobe enters the area in northern Bosque County and extends westward through Comanche County. The Hensel Sand is thickest in northern Bosque County where 119 feet occur in the Jess Hickey Oil Corp. #1 Bnie well (locality 104). West and northwest of Bosque County the Hensel Sand thins before interfingeric with the lower sand unit of the Antlers Sand in western Eastland County (fig. 10).

At Round Mountain (locality 35) and immediately to the west (locality 113) the Hensel Sand is thicker than would normally be expected—106 feet and 82 feet respectively. This thickening of the Hensel Sand occurs near the updip limit of the Pearsall Formation and may mark the position of the strand line during most of the Pearsall deposition. At this locality
Fig. A. Hensel Sand (locality 35-C, unit 3).

Fig. B. Hensel Sand (10X).

Fig. C. Sycamore Sand, cross-bedding in basal conglomerate (locality 65-A, unit 1).

Fig. D. Sycamore Sand, pebbles and boulders in basal conglomerate (locality 65-A, unit 1).

Plate II. Hensel and Sycamore sands, outcrops and lithologies.
Sycamore conglomerate at Elliot Creek. This section consists of immature sandy pebble conglomerate and green sandy clay blebs in the lower part. The sand beds are cross-bedded and friable. Overlying this basal unit is a section composed of 4 feet of green sandy mud containing small amounts of muscovite in the upper part.

At Round Mountain (locality 35) the Hensel Sand consists of immature to supermature fine-grained sandstone with interbedded muddy fine- and medium-grained sandstone. It is medium- to massively bedded, commonly cross-bedded, friable compact sand. Sand ranges from 52 percent in the muddy sandstone to 98 percent in the sandstones. Minor amounts of muscovite, glauconite and chlorite occur throughout the section.

West of Round Mountain recognizable Glen Rose Limestone no longer occurs due to facies gradation. In this area the Hensel Sand is coextensive with the lower sand of the Antlers Formation.

SYCAMORE SAND

The Sycamore Sand of Hill (1901, p. 142-143) occurs in the subsurface and on the outcrop in Mills and southern Brown counties, where it is a local facies of Trinity deposition which occurred around the margins of the Llano uplift.

South of the area of study, the Sycamore Sand is the outcrop equivalent of the subsurface Hosston Sand. In the study area, the Sycamore Sand is equivalent to the Hosston Sand, Pearsall Formation, Hensel Sand, and lower part of the Glen Rose Limestone (fig. 13).

In Burnet County, the Sycamore Sand is overlain by the Cow Creek Limestone (A. R. Smith, 1965, personal communication). In Mills County (locality 65) the Sycamore Sand is overlain by a limestone bed believed to be equivalent to the Thorp Spring Limestone of the Glen Rose type area.

In the area of study, two facies of the Sycamore Sand are recognized: a fluviatile to near-shore facies consisting of interbedded sandy pebble to very large pebble conglomerate, arenaceous limestone, and paleosols (locality 65); and a more marine near-shore facies consisting of sandstone and sandy mud. The fluviatile facies occurs throughout Mills County. Near the Mills-Brown county line the fluviatile facies grades into more marine facies of the Sycamore Sand. This more marine facies occurs throughout southern Brown County and grades northward into sandstones and muds of the basal Trinity sands.

The fluviatile to near-shore facies of the Sycamore Sand is well exposed at Elliot Creek (locality 65) where 154 feet of interbedded sandy pebble to very large pebble conglomerate, arenaceous limestone, and paleosols occur. The Sycamore Sand at this locality is overlain by Glen Rose Limestone which is believed to be equivalent to the Thorp Spring Limestone of the Glen Rose type area.

Sandy pebble conglomerate is widespread at the base of the Sycamore Sand throughout Mills County (localities 54, 58, 60, 64, 65). At Elliot Creek the base of the Sycamore Sand consists of 25 feet of red-brown to pink mottled gray to brown sandy, very large pebble conglomerate (locality 65-A, unit 1). The upper part of unit 1 becomes less pebbly and more calcareous with arenaceous pebbly limestone occurring at the upper boundary. Unit 1 is cross-bedded to irregularly bedded (Pl. II) with the upper calcareous portion being indistinct to massively bedded.

Damon (1940, p. 50-52) determined the percentage of pebbles derived from outcropping formations of the Llano area occurring in the conglomerate at this locality. The cobbles are all Ellenburger dolomite; the pebbles are 54 percent chert of the Chappel Formation, 30 percent dolomite of the Ellenburger Formation, and 10 percent quartz. The sand fraction consists of 92 percent quartz and 7 percent chert from the Chappel Formation. Quartzite pebbles and blocks of angular thin-bedded Pennsylvanian sandstones up to 512 mm are also found in the conglomerate (Pl. II). Cobbles and pebbles are subrounded to round though some are angular to subangular.

Seventy feet of interbedded arenaceous limestone, argillaceous limestone, limestone conglomerate, sandstone, and pebbly sandstone occur above the basal Sycamore conglomerate at Elliot Creek. This section has much in common with the caprock of the High Plains and is believed to represent a paleosol section formed under subaerial conditions. Limestone (locality 65-A, unit 3; Pl. III) with box-work structures filled with red-brown mud, conglomeratic limestone (unit 5) with etched and partly altered pebbles (Pl. III), and arenaceous limestone (locality 65-B, unit 1) with what appear to be relic pebble structures are similar to features found in the caprock of the High Plains (Brown, 1965; Swineford, et al., 1958). The arenaceous and argillaceous limestones found throughout the section may be the result of recrystallization of a caliche soil. The sandstone and pebbly sandstone occur for the most part as channel deposits in the more or less continuous paleosol section.

Above the paleosol more sandstones and muds are interbedded with conglomeratic limestones (locality 65-D, unit 2) and sandstones (locality 53). These are channel deposits which occur 50 to 60 feet below the Glen Rose Limestone.

The marine facies of the Sycamore Sand is well exposed on Steepe Creek (locality 43) seven miles east of the circle in Brownwood. Here the Sycamore Sand overlies purple mud of Pennsylvanian age and consists
of red and yellow-brown muddy fine sandstone and sandy mud with 4 feet of light brown to red-brown granular to conglomeratic sandstone. This section is capped by 16 feet of arenaceous gray pebbly limestone. The Sycamore sandstones are immature orthoquartzites containing small amounts of calcite and glauconite, with some quartz and quartzite fragments. Pebbles are dominantly limestone with calcareous mudstone and chert present in lesser amounts.

**BLUFF DALE SAND**

The term “Bluffdale sands” was applied by Hill (1901, p. 152) to the sands below the Glen Rose Formation at Comanche Peak. Hill considered them “the northern equivalent of the Hensel sands of the Colorado section” \(\text{(idem)}\). Rodgers (1965, p. 33) considered the Bluff Dale Sand to be “a shoreward clastic facies of the Glen Rose Limestone,” time equivalent to the lower Glen Rose Formation and the Hensel Sand of McLennan County. As the result of the present study, the Bluff Dale Sand is considered to be equivalent only to the lower part of the Glen Rose Limestone of McLennan County (fig. 13).

The Bluff Dale Sand crops out in Hood, Parker, Erath, Eastland, and Comanche counties. It extends downdip as far south as northern Bosque and Hamilton counties and southern Comanche County, where it interfingers with the lower part of the Glen Rose Limestone.

On the outcrop the Bluff Dale Sand consists of interbedded muddy fine sandstone, sandy mud and mud with thin beds of calcareous mudstone and arenaceous limestone (localities 14, 15, 20, 27, 28, 29, 35). At Paluxy townsite (locality 29; fig. 11) the Bluff Dale Sand consists of 25 feet of interbedded sandstone, muddy sandstone, sandy mud and mud with a thin lenticular limestone bed near the base of the section. Some of the sandstone beds are burrowed, and fragments of Ostrea are found near the base.

At Robinson Creek (locality 27) 16 miles north-northeast of Paluxy townsite, the Bluff Dale Sand is 40 feet thick and consists of interbedded fossiliferous sandy mud and sandstone.

Near Rattlesnake Mountain (locality 14) 40 miles west-southwest of Robinson Creek, the Bluff Dale Sand is 57 feet thick and consists of interbedded muddy fine sandstone and sandy mud with beds of calcareous mudstone, muddy fine calcareous sandstone and arenaceous limestone.

At Round Mountain, Comanche County (locality 35), 30 miles south-southwest of Rattlesnake Mountain, 9 feet of muddy medium-grained sandstone and sandy mud occur 3 feet below a fossiliferous limestone bed near the base of the Glen Rose Formation. This limestone bed is apparently coextensive with the Thorp Spring Limestone of the Glen Rose type area. Field checking, stratigraphic position, and lithologic character combine to suggest that this muddy sandstone and sandy mud is also equivalent to the Bluff Dale Sand of Hood, Parker, Erath, and Eastland counties. This locality is apparently near the western margin of this unit.

On electric logs the Bluff Dale Sand can be traced in the subsurface to northern Bosque County. Section B-D (fig. 13) shows Bluff Dale Sand thickening from 59 feet at Twin Mountain (locality 15) to 106 feet in the Roy Burgin #1 Mrs. W. W. Roberson well (locality 107). From locality 107 southward the Bluff Dale Sand thins, and is no longer present at Meridian in the C. M. Stoner #1 City of Meridian water well (locality 127).

On electric logs the Bluff Dale Sand appears as interbedded shale and sandstone with a few thin hard beds of limestone or calcareous mudstone. The Bluff Dale Sand is replaced to the south by limestones of Rodgers' Unit I (1965, fig. 8) of the Glen Rose Formation.

*Editor's Note*: Recent work by Epps and Trippet has shown the upper Bluff Dale Sand to be most typically clean packsand which grades into muds as it approaches the basin.

Epps, Lawrence (1967) The Thorp Spring Member, Glen Rose Formation, (Lower Cretaceous), North-Central Texas: Unpublished student report no. 518, Geology Department, Baylor University.

Trippet, William A. (1967) The stratigraphy of the pre-Thorp Spring Member of the Glen Rose in the type area: Unpublished student report no. 508, Geology Department, Baylor University.

Cross-section of the Trinity sands: Unpublished student report no. 517, Geology Department, Baylor University.
Fig. A. Sycamore Sand, paleosol (locality 65-A, unit 3).

Fig. B. Sycamore Sand, polished slab of conglomeratic limestone paleosol (?) (locality 65-A, unit 5).

Fig. C. Bluff Dale Sand (locality 29).

Fig. D. Antlers Sand, conglomerate and sandstone of lower sand unit (locality 1).

Plate III. Sycamore, Bluff Dale, and Antlers sands, outcrops and lithologies.
ANTLERS SAND

The Antlers Sand was named by Hill (1901, p. 192) for sand sections near Antlers, Indian Territory (Oklahoma) beyond the updip limit of the Glen Rose Limestone where the basal Trinity sands and Paluxy Sand coalesce.

The Antlers Sand occurs in southeastern Eastland, Callahan, and Taylor counties beyond the last recognizable occurrence of the Glen Rose Formation. In this area the Antlers Formation can be divided into a lower sand unit, a middle red bed unit, and an upper sand unit.

The lower sand unit is believed to be equivalent in part to the Hensel Sand. The red bed unit is believed to be equivalent to the Glen Rose Formation and may be equivalent also with the red sandy mud of the Bluff Dale Sand at Twin Mountain (locality 15, unit 1). The upper sand at Bear Cove (locality 66) is similar in appearance to the Paluxy Sand farther east and is probably correlative with it.

The lower sand unit of the Antlers Formation consists of sandy mud and muddy pebble conglomerate overlain by medium- to fine-grained friable conglomeratic sandstone and fine- to medium-grained friable sandstone (Pl. III, fig. D).

At Devil's Hollow (locality 3) the lower sand unit of the Antlers Formation is 109 feet thick and consists of interbedded sandy mud, muddy pebble conglomerate, medium-grained conglomeratic sandstone, and fine sandstone. The sandstones and conglomerates are gray to red-brown, friable, compact, immature orthoquartzites. The pebbles are subrounded quartz and chert with a range of 2 to 64 mm and a median diameter of 4 to 6 mm.

The lower sand of the Antlers Formation thins to the west and at Bear Cove (locality 66), 30 miles west of Devil's Hollow, is 70 feet thick. The section consists of interbedded muddy pebble conglomerate, fine- and medium-grained muddy conglomeratic sandstone, and fine- and medium-grained sandstone. The sandstones and conglomerates are gray to red-brown, friable, compact, immature orthoquartzites. The pebbles are subrounded chert and quartz with a range of 2 to 32 mm and a median diameter of 4 to 6 mm.

The red bed unit of the Antlers Sand consists of red-brown sandy mud with interbedded muddy sandstone. At Devil's Hollow the red bed unit is 54 feet thick and poorly exposed. Thin beds of muddy fine sandstone are exposed though much of the section is covered by red-brown sandy soil.

At Bear Cove 66 feet of red-brown sandy mud with interbedded muddy fine sandstone are exposed. Subrounded quartz sand constitutes about 54 percent of the samples and ranges from 0.06 to 1.0 mm with a median value of 0.06 to 0.12 mm.

The upper sand unit of the Antlers Sand consists of yellow-brown to gray sandy mud and gray, friable, compact, massively bedded fine-grained sandstone. At Devil's Hollow, the upper sand unit is 52 feet thick and consists of interbedded red-brown to gray-green sandy mud, muddy fine sandstone, and mud. At Bear Cove, the upper sand unit of the Antlers Formation is 38 feet thick and consists of interbedded yellow-brown to gray, sandy mud, and fine muddy sandstone. Gray, friable, compact, massively bedded fine-grained sandstone, similar to the Paluxy Sand farther east, is exposed on the north side of Bear Cove.

The Antlers Sand thins from 201 feet in eastern Callahan County to 182 feet in central Taylor County.

SOURCE OF CONGLOMERATES

A northwestern source for the conglomerates in the basal Trinity sands on the north side of the McGregor Divide is indicated by an increase in the amount of conglomerates and conglomeratic sandstones and an increase in pebble size in the sediments in that direction. Two pre-Cretaceous formations could provide the pebbles found throughout the basal Trinity sands in the northern part of the study area. The major source of the pebbles is the Dockum Group of Triassic Age. The San Angelo Formation of Permian age probably contributed a minor amount of the pebbles.

The San Angelo Formation contains thick sandstones and conglomerates in the basal section along the eastern part of its outcrop in west Central Texas (Henderson, 1928, p. 18; Beede and Christner, 1926, p. 7). The conglomerates in the San Angelo Formation consist of "small iron-stained quartz pebbles and some black chert" (Henderson, idem). Conglomerate up to 65 feet thick is found in the basal part of the San Angelo Formation at Tennyson, Coke County (Beede and Christner, 1926, p. 7).

Conglomerates of the San Angelo Formation contain the same type of pebbles as are found in the basal Trinity sands. Present outcrop of the San Angelo Formation is close enough to the study area (20 miles west) that it could provide part of the pebbles found throughout the basal Trinity sands.

The major source of conglomerates in the basal Trinity sands is probably the Triassic Dockum Group, which presently crops out 50 miles west of the study area. The Dockum Group is composed predominantly of non-indurated sandstones, shales, and conglomerates (Adams, 1929, p. 1047). The sandstones are fine- to coarse-grained, poorly sorted, predominantly quartz "with minor amounts of feldspar and mica and a good crop of heavy minerals" (idem, p. 1048).

Conglomerates of the Dockum Group are represented by two phases; (1) "a siliceous conglomerate dominant from Motley County southward," and (2) "a clay-ball conglomerate dominant from Motley County northward" (Roth, 1943, p. 622). The siliceous conglomerates in the southern part of the outcrop probably provided the major portion of the pebbles to the basal Trinity sands.

Roth (idem, pp. 624-625) found that 90 percent of the pebbles in the Dockum conglomerates in Motley County "are composed of chalcedony represented by a variety of species . . . differentiated by their color": (1) chert—white, gray, or other light colors; (2) flint—smoky gray to nearly black; (3) jasper—red,
Plate IV. Paluxy Sand and Glen Rose and Walnut formations, outcrops.
brown, or yellow; and (4) agate—variegated colors in concentric bands. The remaining 10 percent of the pebbles consists of quartz, quartzite, quartzitic conglomerate, quartz schist, mica schist and hornfels. Roth postulated that the source of the pebbles in the Dockum conglomerate was an “area south and southwest of the Glass Mountains” (idem, p. 631).

Size and shape of pebbles in the Dockum conglomerates appear to substantiate them as the source of the conglomerates in the basal Trinity sands. Maximum size for some of the chert pebbles is 87 mm. This maximum is greater than that for the pebbles in the basal Trinity sands indicating that the Dockum conglomerates were reworked and transported before being redeposited in the basal Trinity sands. The Dockum pebbles are angular to blocky and some of the chert is commonly bounded on two sides by bedding planes (idem, pp. 625-629). Reworking and transportation of these pebbles produced the subround to round pebbles found in the basal Trinity sands. Bedding planes in the chert also explain the elongated, flat chert pebbles with round sides found in some of the Trinity conglomerates.

GLEN ROSE LIMESTONE

The Glen Rose Formation occurs throughout most of the study area except in the region west of Brown County. Discussion of the Glen Rose Formation in this report is essential for two reasons: (1) where the Glen Rose Formation occurs, the top of the basal Trinity sands was mapped at the base of the Glen Rose; (2) where the Glen Rose Formation becomes unrecognizable westward in the vicinity of May, Brown County, the overlying Paluxy Sand coalesces with the basal Trinity sands to form a single unit.

In the vicinity of Waco, the Glen Rose Limestone is 655 feet thick and can be divided into three informal units—the Upper Glen Rose, the Massive Anhydrite, and the Lower Glen Rose.

At Waco the upper part of the Glen Rose Limestone “is dense, finely crystalline, gray limestone interbedded with thin dark shale beds. Some limestone beds are granular or oolitic, and contain disseminated sand grains and some glauconite. The massive anhydrite section contains crystalline white anhydrite interbedded with chalky limestone and thin laminated gray shale beds. The lower part of the Glen Rose Formation contains arenaceous limestone, chalky limestone, and thin laminated dark shale beds” (Rogers, 1965, pp. 20-22). The Glen Rose Formation thins northward and westward from Waco (fig. 13). At Paluxy townsite, 68 miles northwest of Waco, it is 153 feet thick. At Twin Mountain, 31 miles northwest of Paluxy, it is 5 feet thick. Near May, Brown County, it is represented by a thin calcareous sand with limestone nodules, calcareous sandstones, and muds (fig. 12, Pl. IV). West of May, the Glen Rose is no longer a recognizable unit. North of the area of study, the Glen Rose pinches out in Wise County.
Rodgers (1965, p. 24) states that “the northwestward regional thinning of the Glen Rose Formation probably results from a successive northwestward onlap of the basal Cretaceous sands by limestones of the Glen Rose Formation, rather than from a thinning of individual beds” (fig. 13).

In the type area, near Glen Rose, Somervell County, Rodgers (1965) divided the Glen Rose Formation into informal units I, II, and III. The basal bed of Unit II is the “Thorp Springs limestone subdivision” of Hill (1891, p. 509), the most extensive mappable unit of the outcropping Glen Rose. In Somervell County, the Thorp Springs Limestone Member overlies “argillaceous limestone, arenaceous clay and sandstone” of Unit I, but in Hood, Erath, and Parker counties, it directly overlies Bluff Dale Sand. Rodgers, (1965, p. 33) considered that “the Bluff Dale Sand may be a shoreward clastic facies of the Glen Rose Limestone,” time equivalent to Unit I of the Glen Rose. The lower part of the Bluff Dale Sand, he interpreted to be the outcrop equivalent of the Hensel Sand.

However, the current study strongly suggests that the entire Bluff Dale Sand is time equivalent to Rodgers’ Unit I of the Glen Rose Formation. The Hensel Sand has been traced on electric logs from the subsurface near Waco to the outcrop in Erath County near Twin Mountain (fig. 13).

In Mills and Comanche counties (localities 61, 52, 53) the Glen Rose is from 70 to 90 feet thick and consists of a basal 3 to 4 feet of fossiliferous limestone overlain by interbedded mudstones, muds, and fine-grained sandstones, some of which are fossiliferous. Immediately north of the Mills-Lampasas county line (locality 65), the basal unit of the Glen Rose Formation consists of 2 to 3 feet of thin-bedded, arenaceous limestone containing numerous Turritella sp (?) and small pyrite nodules. Overlying the basal unit is 77 feet of interbedded mudstone, mud, sandstone, and argillaceous limestone.

North of Mullin (locality 52) the basal limestone unit of the Glen Rose Formation is absent and basal Trinity sands are overlain by fossiliferous muds containing celestite nodules and geodes. The total Glen Rose unit consists of 85 feet of interbedded muds containing a few limestone lentils.

In Comanche County (locality 35), the basal unit of the Glen Rose Formation is medium-bedded biomicrite with 3 feet of biosparite overlying 3 feet of fossiliferous yellow clay resting on the basal Trinity sands. The biomicrite-biosparite limestone is overlain by 74 feet of bedded muds, calcareous mudstones, fine sands, and limestone, some of which are fossiliferous. The limestone bed near the base of the Glen Rose section at locality 35 can be traced westward for about 6 miles where it pinches out in the vicinity of the Brown-Comanche county line. In Brown County, it is difficult to trace the outcrop of the Glen Rose Formation, and west of May it is not a distinct unit.

In the vicinity of Delaware Junction (locality 42), the Glen Rose Formation consists of interbedded mud, calcareous mudstone, and fine-grained sands. A thin fossiliferous coquinit limestone bed occurs near the middle of the section. At Salt Mountain and immediately to the northwest (localities 40, 39, 37), the Glen Rose Formation consists of interbedded muds, calcareous mudstones, indurated calcareous sandstones (some of which contain invertebrate and vertebrate fossils), and, at locality 38 (Pl. IV), a thin nodular, fossiliferous limestone. At locality 39 medium- to massive-bedded fine sands interfinger with the interbedded muds, calcareous mudstones and indurated calcareous sandstones.

Further west, near Abilene (locality 66), the red bed unit of the Antlers Sand is believed to be equivalent to the Glen Rose Formation (fig. 14).

In the vicinity of Glen Rose, Rodgers (1965, p. 52) considered that the Thorp Springs Limestone marked the major Glen Rose transgression. In the western part of the current study area, the basal limestone unit at localities 35, 61, and 65, and other localities throughout Mills and Comanche counties, is the most extensive mappable limestone unit and is believed to represent the major Glen Rose transgression. Limited field checking suggests that this basal limestone may be coextensive with the Thorp Springs of the Glen Rose type area. Therefore, this basal limestone is considered time equivalent to the Thorp Spring Member in the Glen Rose type area.

The Glen Rose Formation of the western part of the study area appears to have been deposited in a marginal marine environment. Evidence suggesting this environment includes the large number of Turritella sp (?) and absence of other fauna (localities 61, 65), micrite pebbles included in the argillaceous basal limestone bed (locality 65), and thin-bedded biomicrite with coquinit placers of pelycypod fragments (locality 42). These suggest marginal nearshore environments.

The occurrence of sting ray and turtle remains among the vertebrate fossils of localities 37, 38, and 39, and the absence of shark remains led Bob H. Slaughter (1965, personal communication) to postulate a bayside environment for deposition of the muds, mudstones, and fine-grained sandstones of these localities.

PALUXY SAND

The Paluxy Sand or its equivalent occurs throughout the area of study. Coalescence of the Paluxy Sand with the basal Trinity sands beyond the updip limit of recognizable Glen Rose strata in Brown County, necessitates a brief discussion of the Paluxy Sand in this report.

Throughout the area of this study the Paluxy Sand exhibits remarkable homogeneity in petrography and
outcrop characteristics. Local depositional environments modify the broad characteristics of the Paluxy Sand, but generally the Paluxy Sand consists of light gray, fine-grained, friable, compact to calcareously cemented sandstone and interbedded gray muds.

In the area of study, the Paluxy Sand is thickest at Twin Mountain (locality 15) where it consists of 166 feet of yellowish friable sands. "Southward . . . the Paluxy sand facies thins and is replaced by successively older, lower members of the Walnut formation" (Atlee, 1962 p. 18) until in the vicinity of Waco it is absent through facies interfingerling with Walnut Clay. West of Waco the Paluxy Sand thickens to 24 feet in Mills County (locality 61). North from Mills County, the Paluxy thickens to 80 feet at Round Mountain, Comanche County (locality 35). West of Round Mountain, the Paluxy Sand thins to 68 feet at Salt Mountain, Brown County (locality 40). West of Salt Mountain, the Glen Rose Formation is no longer a recognizable unit and the Paluxy Sand coalesces into a single unit which is equivalent to the Antlers Sand of northeast Texas and southeast Oklahoma.

Near Abilene (locality 66) the upper sand unit of the Antlers Sand is 38 feet thick. This sand is similar and probably equivalent to the definable Paluxy Sand farther east, although no true Glen Rose unit is present to separate these sands from those lower in the section.

The Paluxy Sand is composed of light gray to red, fine- to very fine-grained sand with interbedded gray mud. Pyrite nodules, pyrite concretions, and coal smuts are commonly present. The Paluxy Sand is petrographically similar to the basal Trinity sands (Atlee, 1962, p. 10), and for many years was mistakenly considered to be basal Trinity sands. It was in 1887 that Hill distinguished the two sands separated by the Glen Rose Limestone.

Atlee (idem) reported that the Paluxy Sand is extensively cross-bedded. Laminated evenly bedded sands and massive sands occur but are less common. In the western part of the study area, the Paluxy Sand is most commonly laminated, evenly bedded (localities 34, 59, 61, 62; Pl. IV), or massively bedded (localities 40, 61) with numerous cut and fill sand channels near the top (localities 34, 40, 41). At locality 41, a well-defined cut and fill sand channel, which trends south-southwest, contains microcross-bedding and pyrite nodules with carbonized wood centers.

The Paluxy Sand unconformably overlies the Glen Rose Limestone in parts of Hamilton, Bosque, and Hill counties, but where the Paluxy Sand pinches out in southern McLennan County, it is probable that the Glen Rose-Walnut contact is conformable (Atlee, 1962, p. 18). In the western part of the study area, in Mills, Brown, and Comanche counties, the clastic nature of the Glen Rose Formation makes it difficult to determine whether the contact with the Glen Rose Limestone is conformable or unconformable.

Northeast of Morgan Mill, Erath County (locality 3 of Atlee, 1962) the Paluxy-Walnut contact is unconformable. Atlee (1962, p. 17) did not believe this to "necessarily indicate a conformable contact" and postulated that the Paluxy-Walnut contact throughout Erath, Hood, and Somervell counties is diastemal.

Atlee (idem) cites as evidence the fact that where the Paluxy Sand is extensively cross-bedded, "topset beds are always missing and foreset beds are sharply truncated by relatively horizontal beds of the basal Walnut formation." He also notes that reworked fossils occur in the basal bed of the Walnut Clay and a "wavey formational contact" exists between the Paluxy and Walnut formations.

In Mills County (locality 62) thin-bedded Paluxy sands are overlain by thin-bedded Walnut limestone beds containing reworked fossils. The formational contact is undulating. In Comanche County (locality 34; Pl. IV) evenly bedded Paluxy sands are cut by a large cut and fill sand channel. Overlying the Paluxy Sand and truncating the sand beds of the channel are relatively flat lying thin- to medium-bedded fossiliferous Walnut limestone beds. The basal Walnut limestone bed is about 6 inches thick and consists predominantly of reworked fossil debris. This evidence suggests that Paluxy-Walnut contact is diastemal throughout the northern and western parts of the study area.

Atlee (1962, p. 19) concluded that the Paluxy Sand was "deposited near the ancient Comanchean coast line" and "that several depositional environments were probably responsible for the Paluxy formation." These range from non-marine through fluvial or fluvio-marine to marine. The cut and fill sand channels, some of which contain carbonized wood in pyrite nodules in the western part of the area, along with the horizontally- and massively-bedded nature of the sands indicate near-shore deposition where the sand could be deposited and reworked by deltaic distributaries and wave and current action.
Fig. 13. Stratigraphic cross section, basal Trinity sands, Central Texas.
Fig. 14. Correlation section, basal Trinity sands, Central Texas.
Fig. 15. Wichita paleotopographic map.

Fig. 16. Profile, Wichita paleoplain.
SEDIMENTARY HISTORY

Deposition of the Trinity Group was controlled by a series of transgressions and minor regressions of the Comanchean sea northwestward across the relatively stable Texas craton from the subsiding East Texas Basin. The transgressions and minor regressions during Trinity deposition were the beginning of a major transgressive phase that "culminated in early Gulfian time with the deposition of the Austin Chalk, after which the overall history has been one of regression" (Hayward and Brown, 1967).

Three minor transgressions are recorded by the rocks of the Trinity Group. The first transgression is recorded by the Hosston Sand and the second by the Pearsall and the third by the Hensel Sand and the Glen Rose Limestone. There is no obvious evidence of an unconformity between these phases in the study area. However, disconformities at the top of the Sycamore (Hosston) Sand and the top of the Cow Creek Limestone have been reported from the outcrop in Blanco, Burnet, and Travis counties (Lozo and Stricklin, 1956, p. 68).

The repetition of a clastic phase followed by a carbonate phase "is believed to reflect tectonic activity more pronounced in the detritus source area than in the depositional area; the interpretation presented is that of episodic rejuvenation in the source area, resulting in an increased supply of clastics and a consequent detrital depositional phase, followed by relatively quiescent sedimentation of carbonate deposits, the latter phase in part contemporaneous with and transitional into the clastic phase" (idem).

In the study area it appears that availability of coarse clastic material had a greater influence in the cyclic nature of the Trinity sediments than minor transgressions and regressions of the Comanchean sea.

The sedimentary history of the basal Trinity sands is presented in a series of diagrammatic facies maps and cross sections. These maps and sections follow a chronological order, beginning with a depiction of the Wichita paleoplain before deposition of Trinity sediments, and continuing through deposition of Walnut Clay.

WICHITA PALEOPLAIN

The Wichita paleoplain exhibited well developed topographic relief at the time of Trinity deposition. Several major drainage valleys, the Hamilton Valley and the Meridian-Callahan Valley, separated by the McGregor Divide were present (figs. 15, 16). The Meridian Valley had two lesser "drainage networks" extending to the north, the Twin Mountain Valley and the Granbury Valley.

The valleys of the Wichita paleoplain were the first areas to be drowned by the advancing Comanchean sea. The first deposition of the Trinity Group on the Texas craton occurred in these drowned valleys. The valleys were also the major areas of deposition during most of "Trinity time." Figure 17 shows how the axes of thickness of the basal Trinity sands coincide with the axes of the major valleys on the Wichita paleoplain.

EARLY HOSSTON TIME

Deposition of the Hosston Sand began in the East Texas Basin before the Comanchean sea transgressed onto the Texas craton. As the sea slowly transgressed to the northwest across the relatively stable Texas craton, subsidence was active in the East Texas Basin.

The first areas of the Texas craton to become inundated by the transgressing Comanchean sea were along the eastern edge of the study area (fig. 18). Eastern McLennan County and Hamilton and Meridian valleys were the first areas to be flooded and receive Hosston sediments.

In the southwestern part of the map area the Sycamore Sand was building out from the Llano area in a broad fluvial plain (fig. 18).
Fig. 17. Relationship of the axes of thickness of the Hosston, Pearsall, Hensel, and Bluff Dale formations with the axes of the Hamilton and Callahan-Meridian valleys.
Fig. 18. Early Hosston paleogeologic map.
Fig. 19. Middle Hosston paleogeologic map.

Fig. 20. Cross section, Middle Hosston time.
Fig. 21. Late Hosston-Early Pearsall paleogeologic map.

Fig. 22. Cross section, Late Hosston-Early Pearsall time.
Fig. 23. Extent of Hosston Sand and areas and axes of thickest accumulation.
Fig. 24. Middle Pearsall paleogeologic map.

Fig. 25. Cross section, Middle Pearsall time.
Fig. 26. Areas of thickness, Pearsall Formation.
MIDDLE HOSSTON TIME

Northwestward transgression by the Comanchean sea continued throughout deposition of the Hosston Sand. By middle Hosston time the strand line had advanced as far west as central Comanche and western Erath counties (fig. 19). The sea was beginning to transgress across the McGregor Divide, but the crest still had not been submerged and continued to contribute sediment to the valleys on either side. In the southwestern part of the region the Sycamore Sand continued to build out from the Llano area as a broad fluvial plain (fig. 19, 20).

The transgressive nature of the Hosston Sand is reflected (1) in its relationship to the underlying Wichita paleoplain, (2) the lithology of the unit, and (3) the interrelationships of individual sand bodies within the unit as a whole. The transgressing sea reworked underlying units exposed on the Wichita paleoplain and incorporated them in the basal part of the Hosston Sand. In Hood County (locality 23) the Comanchean sea transgressed across red-brown mud of Pennsylvanian age. The muds were reworked and deposited as a clay pebble conglomerate.

In Eastland County, southwest of Cisco, pebbles from the underlying Lake Cisco Conglomerate (Pennsylvanian) are reworked and incorporated in the basal few feet of conglomerate in the Hosston Sand. Throughout the area (localities 16, 18), the lower several feet of the Hosston Sand are micrconglomeratic. The crossbeds are due to migration of ripple marks and indicate near-shore shallow water deposition.

The Hosston Sand thins updip (figs. 8, 13). Conglomeratic sands are concentrated in the lower part (localities 12, 13, 17, 19) with a few conglomeratic lenses interstratified throughout the section. In the subsurface of McLennan County, the Hosston Sand grades upward from coarse sands and conglomerates into sands, silts, clays, and eventually into the limestone of the Sligo Formation (Hayward and Brown, 1967) indicating a sequence ranging from near source to more marine conditions. Individual sand beds within the Hosston can be correlated for short distances in the subsurface on electric logs, but combine and coalesce laterally, suggesting nearshore conditions.

LATE PEARSALL—EARLY PEARSALL TIME

Transgression of the Comanchean sea during Hosston deposition reached maximum extent during late Hosston—early Pearsall time, when sediments were deposited in the western part of Comanche County and central Eastland County (figs. 8, 21). This is suggested by isopach data though individual units of the basal Trinity sands cannot be correlated to this western margin.

Isopachs of the Hosston Sand and Pearsall Formation suggest that by late Hosston—early Pearsall time a sandy-mud facies of “Pearsall type” sediments was beginning to accumulate along the eastern margin of the Texas craton and northwestward along the axis of the Twin Mountain Valley (figs. 21, 22).

Contemporaneous deposition of the Pearsall facies possibly indicates a decrease in availability of clastic material by late Hosston time.

In southeastern McLennan County and Falls County, the Sligo Limestone of the East Texas Basin was being deposited on the margin of the Texas craton (fig. 21). The Sligo Limestone extends as far west as the central part of McLennan County. West of Waco the Sligo grades into the Hosston Sand.

In the vicinity of McGregor, McLennan County, there was nondeposition throughout Hosston time. This area remained as a persistent high on the McGregor Divide (fig. 21).

In the southwestern part of the area, the Sycamore Sand continued to build out from the Llano area as a broad fluvial plain (figs. 21, 22).

MIDDLE PEARSALL TIME

During Pearsall deposition, there was a decrease in the amount of coarse clastic material being delivered to the area. Over much of the present area of the Texas craton, the Pearsall is a sandy mud, but downdip, along the hinge line between the Texas craton and the East Texas Basin, gray marine shale with some limestone beds of the Hammett Shale Member and limestone of the Cow Creek Member were deposited (figs. 24, 25).

In the southwestern part of the study area, the amount of material available from the Llano area decreased and the broad fluvial plain of Sycamore sediments was undergoing weathering and extensive soil development (figs. 24, 25).
Fig. 27. Late Pearsall-Early Hensel paleogeologic map.

Fig. 28. Cross section, Late Pearsall-Early Hensel time.
Fig. 29. Late Hensel paleogeologic map.

Fig. 30. Cross section, Late Hensel time.
Fig. 31. Extent of Hensel Formation and areas and axes of thickest accumulation.
LATE PEARSSALL—EARLY HENSEL TIME

Rejuvenation of the source area during the latter part of Pearsall deposition with an increased velocity of streams entering the depositional area and/or regression of the Comanchean sea to the southeast made available coarse clastic material to the area. Sandstone and conglomerate of the lower sand unit of the Antlers Sand and Hensel Sand extended out from the Callahan Valley into the central part of the study area (figs. 27, 28).

Isopachs of both the Pearsall Formation and Hensel Sand (figs. 9, 10) show a thinning of the Pearsall and a corresponding thickening of the Hensel in the central part of the area off the mouth of the Callahan Valley. The lower part of the lower sand unit of the Antlers Sand contains conglomerates and conglomeratic sandstone indicating a rejuvenation of the source area and deposition of coarse material near the strand line.

Deposition of the Pearsall facies was restricted to the Hamilton Valley and the eastern margin of the craton in Bosque and Somervell counties (figs. 27, 28).

Sand of the Hensel facies was also deposited along the McGregor Divide (figs. 27, 28). Deposition of sand here was probably due to the winnowing of the fines along the high with the shallowing of the Comanchean sea.

Rejuvenation also occurred in the Llano area to the southwest. Following the long period of soil formation during Pearsall time streams from the Llano area once again brought conglomeratic material into Mills County (idem).

LATE HENSEL TIME

After the influx of coarser material and/or the slight regression of the Comanchean sea during the early part of Hensel deposition, the sea once again transgressed to the northwest. This was the beginning of the major Trinity transgression which culminated with the deposition of the limestones of Rodgers’ (1965) Unit II in the type area of the Glen Rose Formation.

Sand deposition occurred over a large part of the region (figs. 29, 30). Hensel Sand deposition along the eastern margin of the Texas craton was contemporaneous with deposition of the laterally equivalent lower sand unit of the Antlers Sand to the west (fig. 14).

In the southwest the Sycamore Sand deposition continued (figs. 29, 30). Following the Sycamore buildup that accompanied regression during early Hensel time the Comanchean sea began to transgress over the fluvial plain deposits of early Sycamore time. Rocks of the upper part of the Sycamore Sand are more marine in character than any of the lower Sycamore beds (fig. 14).

In the southeastern part of the area deposition of the Glen Rose Limestone was beginning to occur on the margin of the Texas craton (fig. 29).

EARLY GLEN ROSE TIME

Availability of coarse clastic material decreased in the eastern part of the area as the sea continued its northwestward transgression. As the sea moved farther to the northwest, deposition of the Glen Rose Limestone occurred over progressively larger areas.

Limestone deposition occurred over a large portion of the southeastern part of the study area, reaching as far west as the central part of Hamilton County (fig. 32).

North and northwest of the area of limestone deposition, contemporaneous deposition of the Bluff Dale Sand occurred (figs. 32, 33). The probable source of these sands and muds was north of the study area, for they interfinger to the south with the Glen Rose Limestone and to the west with the Hensel Sand facies (figs. 32, 33).

The Hensel Sand was overlapped from the southeast by limestone and from the northeast by Bluff Dale Sand (figs. 32, 33). Hensel Sand deposition continued along a belt running through eastern Eastland, western Hamilton, and western Coryell counties.

In Callahan and Taylor counties deposition of the lower sand unit of the Antlers Sand continued (fig. 32). In Mills County Sycamore deposition continued to be influenced by near-shore marine conditions (figs. 32, 33).
Fig. 32. Early Glen Rose paleogeologic map.

Fig. 33. Cross section, Early Glen Rose time.
Fig. 34. Extent of Bluff Dale Sand and areas and axes of thickest accumulation.
Fig. 35. Middle Glen Rose paleogeologic map.

Fig. 36. Cross section, Middle Glen Rose time.
Fig. 37. Late Glen Rose paleogeologic map.

Fig. 38. Cross section, Late Glen Rose time.
Fig. 39. Paluxy paleogeologic map.

Fig. 40. Cross section, Paluxy time.
MIDDLE GLEN ROSE TIME

Availability of clastic material to the area was greatly decreased by this time, allowing limestone deposition to reach its maximum areal distribution. The Thorp Spring Limestone Member in the type area of the Glen Rose Limestone and the time equivalent limestone bed near the base of the Glen Rose in the southwestern part of the area were deposited (figs. 35, 36). Both were deposited in shallow water not far from shore.

Updip and to the west of limestone deposition, the red-bed unit of the Antlers Sand was deposited. Down-dip along the eastern edge of the Texas craton in McLennan County, deposition of the "massive anhydrite" occurred (figs. 35, 36).

The Sycamore Sand in the southwestern part of the area was overlapped by deposition of Glen Rose Limestone (figs. 35, 36).

LATE GLEN ROSE TIME

The Comanchean sea, after reaching its maximum extent during middle Glen Rose time, began to regress and/or more clastic material was brought into the depositional area. Limestone deposition was not as extensive as earlier but continued over large portions of the study area (fig. 37). Throughout late Glen Rose time limestone deposition was limited to continuously smaller areas in the southeastern part of the study area.

During late Glen Rose time deposition of the Paluxy Sand began in the northern part of the study area (figs. 37, 38). Throughout this time sand deposition pushed continually southward while deposition of limestone of the upper part of the Glen Rose became more restricted.

In western Comanche and Brown counties, west of the limit of limestone deposition, muds, calcareous mudstone, discontinuous limestone beds, calcareous sands, and sands of upper Glen Rose age were deposited in bay environments (figs. 37, 38). Westward, in Callahan and Taylor counties deposition of the red bed unit of the Antlers Sand continued (fig. 37).

PALUXY TIME

During Paluxy time deposition of the Paluxy Sand reached as far south as Waco (fig. 39). Paluxy deposition was coextensive with the deposition of the upper sand unit of the Antlers Sand in the western part of the area (fig. 39).

Southward the Paluxy Sand thins and is replaced down-dip by the Walnut Clay in southern McLennan County.

The probable source of most of the Paluxy Sand is "reworked and redeposited sand of the basal Trinity group" (Atlee, 1962, p. 18).
REFERENCES


APPENDIX I
MEASURED SECTIONS

1. Basal Trinity sands exposed in road cut on State Highway 36, 5.1 airline miles northwest of Denton, Callahan County (lat 32°18'N, long 99°37'W).
   - Moderately sandy sandstone; immature orthoquartzite and muddy sand; pebbles conglomerate; immature orthoquartzite; rust brown, cross-bedded; sand, 0.06-0.25 mm, median 0.12-0.35 mm, moderately sorted; pebbles, 2.0-15 mm, median 3.5 mm, quartz, and chert, poorly sorted.

2. Sub-Cretaceous relief exposed on Jones Ranch, 1.8 airline miles north of Oyen, Lipscomb County (lat 35°33'N, long 100°05'W). Relief on Wichita paloform (sub-Cretaceous surface) evident. Jones' house located on limepete (Paleocene age) capped hill and to the west and 20 to 30 feet lower, rock tank is dug in basal Trinity sands.
   - Hottest section. Pennsylvanian-Cretaceous contact and Antlers Sand exposed in creek bed on east side of road and uphill on west side of road. Section begins in bank of tributary of Deep Creek between Deep and Brushy creeks. 440 yards east of Farm Road 2228, continues in the creek until reaching road and then along road to the south. Top of pond section offers 220 yards to the north and continues uphill. Total Antlers Sand section 220 feet.

3. West's Hollow section. Pennsylvania-Cretaceous contact and Antlers Sand exposed in creek bed on east side of road and uphill on west side of road. Section begins in bank of tributary of Deep Creek between Deep and Brushy creeks. 440 yards east of Farm Road 2228, continues in the creek until reaching road and then along road to the south. Top of pond section offers 220 yards to the north and continues uphill. Total Antlers Sand section 220 feet.

4. West's Hollow section. Pennsylvania-Cretaceous contact and Antlers Sand exposed in creek bed on east side of road and uphill on west side of road. Section begins in bank of tributary of Deep Creek between Deep and Brushy creeks. 440 yards east of Farm Road 2228, continues in the creek until reaching road and then along road to the south. Top of pond section offers 220 yards to the north and continues uphill. Total Antlers Sand section 220 feet.

5. Walnut Clay Unit: 24 feet.
   - Muddy sandstone, nodular, fossiliferous.

6. Antlers Sand.
   - Upper Sand Unit: 33 feet.
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 21.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 22.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 23.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 24.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 25.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 26.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 27.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 28.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 29.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 30.5
     - Covered: red-brown, sandy soil, with ferruginous sand nodules. 31.5

7. Redbed Unit: 21 feet.
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 4.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 5.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 6.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 7.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 8.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 9.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 10.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 11.0
   - Covered: red-brown, sandy soil, with ferruginous sand nodules. 12.0

8. Lower Sand-unit: 4.5 feet.
   - Fine sandstone: immature orthoquartzite: gray, thin to medium-beded, friable, compact; sand range 0.06-0.50 mm, median 0.12-0.35 mm, moderately sorted.
   - Fine sandstone: immature orthoquartzite: gray, thin to medium-beded, friable, compact; sand range 0.06-0.50 mm, median 0.12-0.35 mm, moderately sorted.
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1 Refer to figure 2 for locations.
| Sandy mud, yellow-brown to gray-green with yellow-brown immature sandstone, generally medium-mudstone, at base and top. | 18.0 |
| Sandy mud, greenish yellow to gray-green, with thin beds of laminated  fine-grained sandstone. | 2.0 |
| Fine sandstone with indurated mudstone near middle, yellow-brown mudstone, yellow-brown, calcite, friable, compact, sorted. | 0.6 |
| Sandy mud, tan to gray-green; mottled gray-green; sand, 61 percent, range 0.06-0.1 mm, median 0.06-0.12 mm, subrounded, moderately sorted. | 15.0 |
| Sandy mud, tan to gray, mottled yellow-brown; sand, 95 percent, range 0.06-0.1 mm, median 0.06-0.12 mm, subrounded, moderately sorted. | 14.0 |
| Sandy mud, gray-green to yellow-brown, medium-bedded, calcite, friable to partly cemented, ferruginous nodules and lenses in lower middle part. | 27.0 |
| Sandy mud, gray; pebbles, range 2-10 mm, median 6 mm, chert and pyrite; sand, 25 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted. | 22.5 |
| Sandy mud, yellow-brown to gray-green with yellow-brown immature sandstone; tan, green and yellow-brown, friable, compact, sand, 84.5 percent, range 0.12-2.0 mm, median 0.21-0.5 mm, subrounded, poorly sorted in lower part, moderately sorted in upper part. | 19.0 |
| Sandy mud, green, mottled yellow-brown and red-brown; sand, 25 percent, range 0.06-1.0 mm, median 0.06-0.12 mm, subrounded, moderately sorted in lower, well sorted in upper; trace of muscovite and chlorite in lower part. | 15.0 |
| Sandy mud, tan to gray-green; mottled gray-green; sand, 95 percent, range 0.06-0.1 mm, median 0.06-0.12 mm, subrounded, moderately sorted in upper part; trace of muscovite and chlorite in lower part. | 15.0 |
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| Sandy mud, yellow-brown to gray-green with yellow-brown immature sandstone; tan, green and yellow-brown, friable, compact, sand, 84.5 percent, range 0.12-2.0 mm, median 0.21-0.5 mm, subrounded, poorly sorted in lower part, moderately sorted in upper part. | 19.0 |
### BASAL TRINITY SANDS

**28. Bluff Dale Sand and Thorp Spring Limestone in west bank of Brazos River southeast of the junction of U. S. Highway 297 and State Highway 144, Hood County (lat 32°02′N; long 98°28′W).**

Bluff Dale Sand, gray to green, fine-grained, burrowed in part, muddy sand, silt, and tan sandstone overlain by massive red-brown-bearing Thorp Spring Limestone; total of 20 feet.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluff Dale Sand</td>
<td>Gray to green, fine-grained, burrowed in part, muddy sand, silt, and tan sandstone overlain by massive red-brown-bearing Thorp Spring Limestone; total of 20 feet.</td>
</tr>
</tbody>
</table>

**29. Bluff Dale Sand and Thorp Spring Limestone 175 yards northeast of the Paluxy River on the north side of Farm Road 240, Hood County (lat 32°16′N; long 97°34′W).**

Sandy, gray to tan sandstone, fine-grained, burrowed in part, muddy sand, and a thin lenticular limestone; Ostracoda found near base; overlie by gray nodular massive-bedded Thorp Spring Limestone; total of 20 feet.

<table>
<thead>
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<tr>
<td>Bluff Dale Sand</td>
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</tr>
</tbody>
</table>

**30. Glen Rose Formation at the foot of hill 0.4 miles south of Armstrong Road on State Highway 297, Comanche County (lat 32°02′N; long 98°22′W).**

Fossiliferous limestone, contains poorly preserved oyster shells, wood fragments, and ironstone concretion; some wood fragments replaced by iron.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glen Rose Formation</td>
<td>Fossiliferous limestone, contains poorly preserved oyster shells, wood fragments, and ironstone concretion; some wood fragments replaced by iron.</td>
</tr>
</tbody>
</table>

**31. Pennsylvanian-Cretaceous contact and basal Trinity Sandps exposed in road cut in the north wall of the Sabine River, 275 yards northeast of the Paluxy River on the north side of Farm Road 240, Hood County (lat 32°02′N; long 98°34′W).**

Total section is 100 feet.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvanian-Cretaceous contact</td>
<td>Basal Trinity Sandps exposed in road cut in the north wall of the Sabine River, 275 yards northeast of the Paluxy River on the north side of Farm Road 240, Hood County (lat 32°02′N; long 98°34′W). Total section is 100 feet.</td>
</tr>
</tbody>
</table>

**32. Basal Trinity sands and Quatary river gravel on south side of State Highway 377 west of the Leon River, Comanche County (lat 31°55′N; long 98°28′W).**

Red-brown sand overlapped from west by mottled gray, green, red-brown and white mud with some sandstone and tan, fine-grained, well sorted, friable, compact sandstone; overlain by reddish brown, medium-grained, well sorted, friable, compact sand; top of Paluxy River gravel.

<table>
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<tbody>
<tr>
<td>Basal Trinity sands</td>
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</tr>
</tbody>
</table>

**33. Basal Trinity sands and Glen Rose Limestone in bar ditch on round mountain section, Comanche County (lat 31°55′N; long 98°25′W).**

Muddy sands, muds, and a thin lenticular Ostrea fragments, and ironstone beds; total of 30.0 feet.

<table>
<thead>
<tr>
<th>Horizon</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Basal Trinity sands</td>
<td>Muddy sands, muds, and a thin lenticular Ostrea fragments, and ironstone beds; total of 30.0 feet.</td>
</tr>
</tbody>
</table>

**34. Interbedded mud, mudstone, sand mud, muddy fine sandstone, at the north end of the Leon River, Comanche County (lat 31°55′N; long 98°20′W).**

Sandstone, yellow-brown, calcitic, indurated, pinches out laterally 1.5 feet; angulat contact with overlying Pearsall Formation.

<table>
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<th>Description</th>
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<tbody>
<tr>
<td>Interbedded mud, mudstone, sand mud, muddy fine sandstone</td>
<td>Sandstone, yellow-brown, calcitic, indurated, pinches out laterally 1.5 feet; angulat contact with overlying Pearsall Formation.</td>
</tr>
</tbody>
</table>

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**35. Round Mountain section, Comanche County (lat 31°55′N; long 98°42′W).**

Elevated along Sweetwater Creek and Farm Road 1699, west and south of Round Mountain. Total basal Trinity sands section is 140.0 feet.

<table>
<thead>
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</tr>
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<tbody>
<tr>
<td>Round Mountain</td>
<td>Elevated along Sweetwater Creek and Farm Road 1699, west and south of Round Mountain. Total basal Trinity sands section is 140.0 feet.</td>
</tr>
</tbody>
</table>

**36. F (lat 31°57′N; long 98°43′W)**

Glen Rose Limestone

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glen Rose Limestone</td>
<td><strong>36. F (lat 31°57′N; long 98°43′W)</strong> Glen Rose Limestone</td>
</tr>
</tbody>
</table>

**37. Middle and lower Trinity sands and clays exposed in cut on U. S. Highway 377, 4.6 air line miles southwest of Comanche, Comanche County (lat 31°55′N; long 98°40′W).**

West Clay

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Clay</td>
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</tr>
</tbody>
</table>

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**38. Paluxy Sand**

**39. Fine sandstone and muddy sandstone: mature orthoquartzite, tan, evenly bedded, cut and fill sand and sandstone...20.0**

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>Paluxy Sand</td>
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</tr>
</tbody>
</table>

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**40. General**

**35-E (lat 31°56′N; long 98°45′W)**

Hensel Sand

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-E (lat 31°56′N; long 98°45′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**41. General**

**35-D (lat 31°56′N; long 98°42′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
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<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-D (lat 31°56′N; long 98°42′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**42. General**

**35-C (lat 31°57′N; long 98°42′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-C (lat 31°57′N; long 98°42′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**43. General**

**35-B (offset from 35-A 100 yards upstream)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-B (offset from 35-A 100 yards upstream)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**44. General**

**35-A (lat 31°57′N; long 98°41′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-A (lat 31°57′N; long 98°41′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**45. General**

**35-B (offset from 35-A 100 yards upstream)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-B (offset from 35-A 100 yards upstream)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**46. General**

**35-C (lat 31°57′N; long 98°42′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
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<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-C (lat 31°57′N; long 98°42′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

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**47. General**

**35-D (lat 31°56′N; long 98°42′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
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<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-D (lat 31°56′N; long 98°42′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

---

**48. General**

**35-E (lat 31°56′N; long 98°45′W)**

Hensel Sand

<table>
<thead>
<tr>
<th>Horizon</th>
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<tbody>
<tr>
<td>Hensel Sand</td>
<td><strong>35-E (lat 31°56′N; long 98°45′W)</strong> Hensel Sand</td>
</tr>
</tbody>
</table>

---

**49. General**

**35-F (lat 31°57′N; long 98°43′W)**

Glen Rose Limestone

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
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<tbody>
<tr>
<td>Glen Rose Limestone</td>
<td><strong>35-F (lat 31°57′N; long 98°43′W)</strong> Glen Rose Limestone</td>
</tr>
</tbody>
</table>

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**50. General**

**36. General**

**37. General**

**38. General**

**39. General**

**40. General**

**41. General**

**42. General**

---

**51. General**

**52. General**

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**53. General**

**54. General**

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**55. General**

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**56. General**

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**57. General**

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**58. General**

---

**59. General**

---
1. Sandy mud and pebbly sandstone (calcite immature orthoquartzite; yellow-brown, indurated, medium-bedded; pebbles range 0.06-0.20 mm, median 0.12-0.25 mm, subrounded, moderately sorted; sand 68.0 percent, range 0.06-1.0 mm, median 0.12-1.0 mm, subrounded, poorly sorted, 49 percent mud.

2. Sandy pebbly conglomerate at base overlain by interbedded muddy pebbly sandstone and sandy pebbly mud; immature orthoquartzite; gray, green and red-brown; sandy pebbly conglomerate, medium-bedded and contain green sand mud beds; muddy pebbly sandstone occurs as irregular lenses in the sandy pebbly mud; pebbles, 23 percent, range 2.0-20 mm, median 6 mm, chart and cross-bedded; sand, 51 percent, range 0.06-0.20 mm, median 0.21-0.25 mm, subrounded, moderately to poorly sorted, mud 24 percent.

3. Sandy pebbly conglomerate:
   - Medium sandstone: orthoquartzite; light tan weathered darker, thin beds medium cross-bedded, subrounded, well sorted, friable, compact, follows by mottled green and red sandy mud; 45.0 to 30.0 feet.
   - Very fine sandstone: orthoquartzite; friable, compact at base overlain by interbedded muddy and indurated fine-grained sandstone; 165.0 feet.
   - Fine sandstone, sandy mud and mud with 1 foot of indurated light yellow-brown calcite: burrowed sandy mud with arenaceous mica mud nodules 10-160 mm in diameter; sand, 0.06-0.10 mm, median 0.12-0.25 mm; pelecypod, gastropod, and vertebrate fossils in upper 2/3 cut; 110 feet of section, approximately 33.0 feet above Pennsylvanian-Cretaceous contact.

4. Sandy pebbly conglomerate and Paluxy Sand (3) exposed in series of road cuts on Farm Road 1467, 3.4 airine miles east of U. S. Highway 183, beginning outer road going south, Brown County (lat 31°15'N; long 98°52'W). Interbedded sandy mud, indurated calcareous sandstone, thin-bedded, friable, and cross-bedded and sandy pebbly mud with reworked fossil zone; calcareous sandstone: calcitic immature orthoquartzite; light green, indurated, thin-bedded, jointed, ripple marks well rounded and frosted, quartzite and vein quartz.

5. Paluxy Sand and Walnut Clay on the north side of Salt Mountain, 173 yards east of where Salt Creek crosses Farm Road 1467, Brown County (lat 31°52'N; long 98°35'W). Total section is 20-4 feet. Walnut Clay: thin irregular-bedded, fossiliferous; base of Walnut Clay thin reworked fossil zone.

6. Medium sandstone: immature orthoquartzite; gray, green and red-brown, massive cross-bedded; some show a bimodal sorting in channel cut m red-brown and gray-green; sandy pebbly sandstone near top; sand, 52.3 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted; muscovite and glauconite.

7. Sandy pebbly conglomerate:
   - Medium sandstone: submature orthoquartzite; lower part, green and red-brown, massive cross-bedded, green sandy mud bleeds and stringers, friable, compact, and cross-bedded; some show a bimodal sorting in channel cut m red-brown and gray-green;
   - sandy pebbly sandstone near top; sand, 52.3 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted; muscovite and glauconite.

8. Sandy pebbly conglomerate:
   - Medium sandstone: orthoquartzite; light tan weathered darker, thin beds medium cross-bedded, subrounded, well sorted, friable, compact, follows by mottled green and red sandy mud; 45.0 to 30.0 feet.
   - Very fine sandstone: orthoquartzite; friable, compact at base overlain by interbedded muddy and indurated fine-grained sandstone; 165.0 feet.
   - Fine sandstone, sandy mud and mud with 1 foot of indurated light yellow-brown calcite: burrowed sandy mud with arenaceous mica mud nodules 10-160 mm in diameter; sand, 0.06-0.10 mm, median 0.12-0.25 mm; pelecypod, gastropod, and vertebrate fossils in upper 2/3 cut; 110 feet of section, approximately 33.0 feet above Pennsylvanian-Cretaceous contact.

9. Paluxy Sand and Walnut Clay on the north side of Salt Mountain, 173 yards east of where Salt Creek crosses Farm Road 1467, Brown County (lat 31°52'N; long 98°35'W). Total section is 20-4 feet. Walnut Clay: thin irregular-bedded, fossiliferous; base of Walnut Clay thin reworked fossil zone.

10. Medium sandstone: immature orthoquartzite; gray, green and red-brown, massive cross-bedded; some show a bimodal sorting in channel cut m red-brown and gray-green; sandy pebbly sandstone near top; sand, 52.3 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted; muscovite and glauconite.

11. Sandy pebbly conglomerate:
   - Medium sandstone: submature orthoquartzite; lower part, green and red-brown, massive cross-bedded, green sandy mud bleeds and stringers, friable, compact, and cross-bedded; some show a bimodal sorting in channel cut m red-brown and gray-green;
   - sandy pebbly sandstone near top; sand, 52.3 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted; muscovite and glauconite.

12. Sandy pebbly conglomerate:
   - Medium sandstone: orthoquartzite; light tan weathered darker, thin beds medium cross-bedded, subrounded, well sorted, friable, compact, follows by mottled green and red sandy mud; 45.0 to 30.0 feet.
   - Very fine sandstone: orthoquartzite; friable, compact at base overlain by interbedded muddy and indurated fine-grained sandstone; 165.0 feet.
   - Fine sandstone, sandy mud and mud with 1 foot of indurated light yellow-brown calcite: burrowed sandy mud with arenaceous mica mud nodules 10-160 mm in diameter; sand, 0.06-0.10 mm, median 0.12-0.25 mm; pelecypod, gastropod, and vertebrate fossils in upper 2/3 cut; 110 feet of section, approximately 33.0 feet above Pennsylvanian-Cretaceous contact.
Pennsylvaniaian

Mudstone brown calcite, fossiliferous (brachiopods, bryozoa, fusulinids), indurated, light-gray to dark-gray, east of U. S. Highway 29, Mills County (lat 31°41'N; long 98°47'W).

Limestone; gray, thin to medium, wavy bedded; about 1/4 feet thick, overlain by interbeds of irregular-bedded, indurated gray (white) calcareous sandstone and calcite; fossils include normal echinoids and brachiopods; 12 yards south of the road.

50. Glen Rose Sandstone on north side of U. S. Highway 29, 6.4 miles west of its junction with State Highway 20, Mills County (lat 31°40'N; long 98°57'W).

Sandy conglomerate, light brown, calcite (white) pebbles, range 0.5-1.5 inches, median 0.7 inches; sand fraction containing fine to medium, well-sorted, rounded pebbles, range 0.5-1.5 inches, median 0.7 inches; surface cemented by calcite, yellow-brown; base of pebble layer may be weathered, light-brown, calcite stringers; channel 4 inches wide, inch deep; total about 4.0 feet.

51. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

52. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

53. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

54. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

55. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

56. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

57. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

58. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

59. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

60. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

61. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

62. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

63. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.

64. Sycamore Sandstone on west side of road 29, 6.4 miles south of its junction with U. S. Highway 29, Mills County (lat 31°38'N; long 98°57'W).

Muddy sandstone and mottled pink sandstone; calcite stringers; angular, medium to thick irregular-bedded; contains small nodules of hard limestone and mottled yellow-brown, sandy pebble conglomerate; stringers, relic pebble structures (?) 1-5 inches diameter; total about 4.0 feet.
4 Muddy fine sandstone; immature orthoquartzite; yellow-brown, friable, compact to poorly cemented, burrowed, thin-to-medium-bedded, found as float; sand 0.06-0.50 mm, medium 0.12-0.25 mm, subround; well sorted ........................................ 4.0
3 Sandy mud, gray mottled-yellow-brown; sand 41.1 percent, range 0.06-0.50 mm, medium 0.06-0.12 mm, subround, well sorted .................................................... 7.0
2 Covered, probably sand with sandy mud ................................. 15.5
1 Muddy fine sandstone grading upward into fine sandstone; immature orthoquartzite; gray-green mottled red-brown in lower part, white weathered green in upper part, abundant calcite in lower part, upper part friable, compact; sand 85 percent; range 0.06-1.0 mm, median 0.12-0.25 mm, subrounded, moderately sorted in lower part, well sorted in upper ................................. 6.0

Redbed Unit
Sandy mud with interbedded muddy fine sandstone; red-brown, gray and red-brown, and purple, mottled with some calcite in lower part; sand 53.8 percent, range 0.06-1.0 mm, medium 0.06-0.12 mm with 0.12-0.25 mm in middle part, subround, moderately sorted ........................................... 0.0

Lower Sand Unit
Muddy pebble conglomerate becoming muddy sandy pebble conglomerate; immature orthoquartzite; gray with purplish red-brown and purple, pebbly lenses and mud blebs in lower part, scattered pebbles in middle and muddy lenses in upper part; pebbles 71.1 percent, range 2-6 mm, median 4 mm, chert and quartz, quartz predominant; sand 25.3 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, moderately sorted, mud 16 percent ................................... 2.5

Medium sandstone with muddy pebble conglomerate and sandy pebble conglomerate in lower part; immature orthoquartzite; gray with purplish red-brown and red-brown, thick-bedded with cross-bedding in upper part, pebbles concentrated in lenses and stringers in lower part, upper part superimposed; medium sandstone with few pebbles randomly scattered throughout; pebbles, 25.3 percent, range 2-18 mm, median 4 mm, becoming smaller upward, subrounded, chert predominant; sand 69.6 percent, range 0.06-2.0 mm, median 0.25-0.50 mm with 0.12-0.25 mm in lower part, subrounded, moderately to well sorted; mud 5.1 percent .................................... 23.5

5 Slightly pebbly fine sandstone with muddy pebbly sandstone in lower part and pebbly sandstone in upper part; immature orthoquartzite; gray, purplish red, rust red and purplish gray, medium- to massive-bedded with cross-bedding in upper part; pebbles, 16.8 percent, range 2-22 mm, median 5 mm, subangular to subrounded, chert and quartz, chert predominating; sand 77 percent; range 0.06-2.0 mm, median 0.12-0.25 mm, with 0.25-0.50 mm in lower part and 0.50-1.0 mm in upper part, subrounded, moderately sorted; mud 6 percent ................................... 19.0
4 Covered ............................................................................. 4.5
3 Pebbly muddy medium sandstone; immature orthoquartzite; rust brown, massive-bedded; pebbles, 28 percent, range 2-12 mm, median 5 mm, subrounded, chert and quartz, chert predominant; sand 52.5 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subrounded, moderately sorted, mud 20 percent .................. 5.0
2 Covered ............................................................................. 2.5
1 Muddy pebble conglomerate becoming sandy pebble conglomerate; immature orthoquartzite; red-brown mottled yellow-brown in lower part, gray, weathered light brown in upper part, pebbles concentrated in stringers in upper part, green sandy mud blebs in upper part; muddy pebble conglomerate, pebbles, 10 percent, range 2-32 mm, median 6 mm, subrounded, chert and quartz, chert predominant, mud 40.5 percent, muddy sandy pebble conglomerate; pebbles 71.1 percent, range 2-17 mm, median 4 mm, subrounded, quartz and chert, quartz predominant; sand, 20.8 percent, range 0.25-2.0 mm, median 0.5-1.0 mm, round; mud 8.1 percent .................................. 6.5

Total ..................................................................................... 70.5

Pennsylvaniaian
Mud, dark red-brown, with thin indurated sandstone beds.
67. Cut on north side of road on lower part of hill, 0.6 mile east of
intersection with U. S. Highway 83-84. County road turns off U. S.
Highway 83-84 1.0 mile north of the junction of U. S. Highway 83
and 84, Taylor County (lat 32°14'N; long 99°45'W).
Muddy medium sandstone and muddy sandy pebble conglomerate;
immature orthoquartzite; brown to tan, gravel, range 2-64 mm,
median 6 mm, quartz and chert, quartz predominant; sand, range
0.06-2.0 mm, median 0.25-0.50 mm; 10.0 feet.

*Sections correlated by elevation.

Middle Pennsylvanian
### APPENDIX II

#### SUBSURFACE LOCATIONS

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Company and Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>101.</td>
<td>Mid-Continent Petroleum Co., #1 Squaw Creek Cattle Company, Hood County. (lat 32°22'N; long 97°45'W).</td>
</tr>
<tr>
<td>102.</td>
<td>B. W. Fitzgerald, #1 Van Morrison, Hood County. (lat 32°22'N; long 97°45'W).</td>
</tr>
<tr>
<td>103.</td>
<td>K-I Oil Company, #1, M. M. Bunt, Somervell County. (lat 32°48'N; long 97°42'W).</td>
</tr>
<tr>
<td>104.</td>
<td>Jess Hicken Oil Corp., #1 Bush, Bosque County. (lat 32°16'N; long 97°35'W).</td>
</tr>
<tr>
<td>105.</td>
<td>American Liberty Oil Co., #1 Elmer Smith, Bosque County. (lat 32°20'N; long 97°45'W).</td>
</tr>
<tr>
<td>106.</td>
<td>C. M. Stoner, #1, Cedar Valley Ranch, Somervell County. (lat 32°11'N; long 97°55'W).</td>
</tr>
<tr>
<td>107.</td>
<td>Roy Bogue, #1, W. W. Roberson, Erath County. (lat 32°07'N; long 98°02'W).</td>
</tr>
<tr>
<td>108.</td>
<td>Texas Water Wells, #15 City of Stephenville, Erath County. (lat 32°14'N; long 98°12'W).</td>
</tr>
<tr>
<td>109.</td>
<td>W. H. Woods, #1 R. J. Sikes, Erath County. (lat 32°19'N; long 98°13'W).</td>
</tr>
<tr>
<td>110.</td>
<td>Dale Smith and Louisiana Machine Co., #1 Kiker, Erath County. (lat 32°11'N; long 98°17'W).</td>
</tr>
<tr>
<td>111.</td>
<td>Frank Burtram, #2 Withfield, Erath County. (lat 32°16'N; long 98°21'W).</td>
</tr>
<tr>
<td>112.</td>
<td>H. B. Cowboy Drilling Co., #1 R. C. Crouch, Erath County. (lat 32°05'N; long 98°24'W).</td>
</tr>
<tr>
<td>113.</td>
<td>John W. Bartlett, #1 D. E. Steel, Comanche County. (lat 31°57'N; long 98°45'W).</td>
</tr>
<tr>
<td>114.</td>
<td>Coastal States Gas Producing Co., #1 S. L. Rankin, Brown County. (lat 31°43'N; long 98°52'W).</td>
</tr>
<tr>
<td>115.</td>
<td>Humble Oil and Refining Co., #1 J. M. Foreman, Comanche County. (lat 31°57'N; long 98°47'W).</td>
</tr>
<tr>
<td>116.</td>
<td>United North and South Development Co., #1 Fred Johnson, Mills County. (lat 31°42'N; long 98°49'W).</td>
</tr>
<tr>
<td>117.</td>
<td>R. K. Stoker, #1 Fletcher, Mills County. (lat 31°28'N; long 98°31'W).</td>
</tr>
<tr>
<td>118.</td>
<td>Byron Hoffman, #1 J. S. Owens, Mills County. (lat 31°28'N; long 98°22'W).</td>
</tr>
<tr>
<td>119.</td>
<td>American Manufacturing Co., #1 T. W. Winters, Hamilton County. (lat 31°30'N; long 98°04'W).</td>
</tr>
<tr>
<td>120.</td>
<td>J. L. Myers &amp; Sons, #2 City of Hamilton, Hamilton County. (lat 31°29'N; long 98°07'W).</td>
</tr>
<tr>
<td>121.</td>
<td>Amerada Petroleum Corp., #1 L. S. Burney, Hamilton County. (lat 31°50'N; long 98°15'W).</td>
</tr>
<tr>
<td>122.</td>
<td>Jones Brothers, #1 D. M. Profitt, Hamilton County. (lat 31°55'N; long 98°18'W).</td>
</tr>
<tr>
<td>123.</td>
<td>Amerada Petroleum Corp., #1 John Briscoe, Hamilton County. (lat 31°42'N; long 98°20'W).</td>
</tr>
<tr>
<td>124.</td>
<td>C. M. Stoner, #1 City of Meridian, Bosque County. (lat 31°58'N; long 97°52'W).</td>
</tr>
<tr>
<td>125.</td>
<td>American Liberty Oil Co., #1 Reichert, Bosque County. (lat 31°45'N; long 97°52'W).</td>
</tr>
<tr>
<td>126.</td>
<td>O. C. Proctor, #1 J. W. Henry, Bosque County. (lat 31°38'N; long 97°56'W).</td>
</tr>
<tr>
<td>127.</td>
<td>C. M. Stoner, #4 George Adams, Bosque County. (lat 31°43'N; long 97°45'W).</td>
</tr>
<tr>
<td>128.</td>
<td>J. L. Myers &amp; Sons, #1 City of Stephenville, Coryell County. (lat 31°29'N; long 97°44'W).</td>
</tr>
<tr>
<td>129.</td>
<td>C. M. Stoner, #1 Jonesboro Water Supply Corp., Coryell County. (lat 31°33'N; long 97°52'W).</td>
</tr>
<tr>
<td>130.</td>
<td>Amerada Petroleum Corp., #1 N. F. Tate, Coryell County. (lat 31°24'N; long 97°50'W).</td>
</tr>
<tr>
<td>131.</td>
<td>J. L. Myers &amp; Sons, #3 Gatesville School for Boys, Coryell County. (lat 31°29'N; long 97°45'W).</td>
</tr>
<tr>
<td>132.</td>
<td>General Crude Oil Company, #1 Ernest Day, Coryell County. (lat 31°20'N; long 98°26'W).</td>
</tr>
<tr>
<td>133.</td>
<td>J. L. Myers &amp; Sons, #2 City of Moody, McLennan County. (lat 31°19'N; long 99°14'W).</td>
</tr>
<tr>
<td>134.</td>
<td>C. M. Stoner, #1 Spring Valley, McLennan County. (lat 31°23'N; long 99°18'W).</td>
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<tr>
<td>135.</td>
<td>J. L. Myers &amp; Sons, #3 City of McGregor, McLennan County. (lat 31°28'N; long 99°25'W).</td>
</tr>
<tr>
<td>136.</td>
<td>Falcon Oil Company, #1, Henry Mattlage Jr., McLennan County. (lat 31°34'N; long 99°22'W).</td>
</tr>
<tr>
<td>137.</td>
<td>H. W. Bass &amp; Sons, #1 Delmar Ranch, McLennan County. (lat 31°38'N; long 97°23'W).</td>
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<td>138.</td>
<td>Hervie Meadows &amp; Sons, #1 S. F. Foster, McLennan County. (lat 31°40'N; long 97°18'W).</td>
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<tr>
<td>139.</td>
<td>R. C. Smith and Falcon Oil Corp., #1 H. C. McKethan, McLennan County. (lat 31°29'N; long 97°17'W).</td>
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<tr>
<td>140.</td>
<td>J. L. Myers &amp; Sons, #1 Dr. Barnes, McLennan County. (lat 31°30'N; long 97°18'W).</td>
</tr>
<tr>
<td>141.</td>
<td>J. L. Myers &amp; Sons, #1 Youngblood, McLennan County. (lat 31°29'N; long 97°16'W).</td>
</tr>
<tr>
<td>142.</td>
<td>Golinda Co-op, #1 Water well, Falls County. (lat 31°22'N; long 97°00'W).</td>
</tr>
<tr>
<td>143.</td>
<td>Layne Texas Company, #1 City of Dublin Test Hole, Erath County. (lat 32°03'N; long 98°26'W).</td>
</tr>
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1. Refer to figure 2 for well locations.
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Urban geology of Greater Waco, A series on urban geology in cooperation with Cooper Foundation of Waco.

*Publications available from Baylor Geological Society or Baylor Geological Studies, Baylor University, Waco, Texas, 76703.