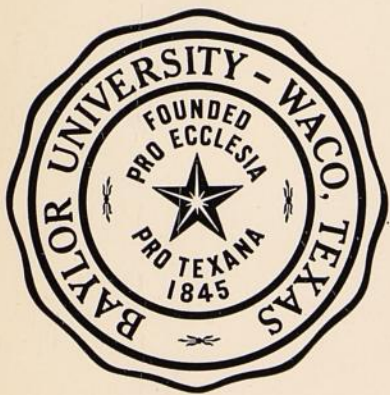


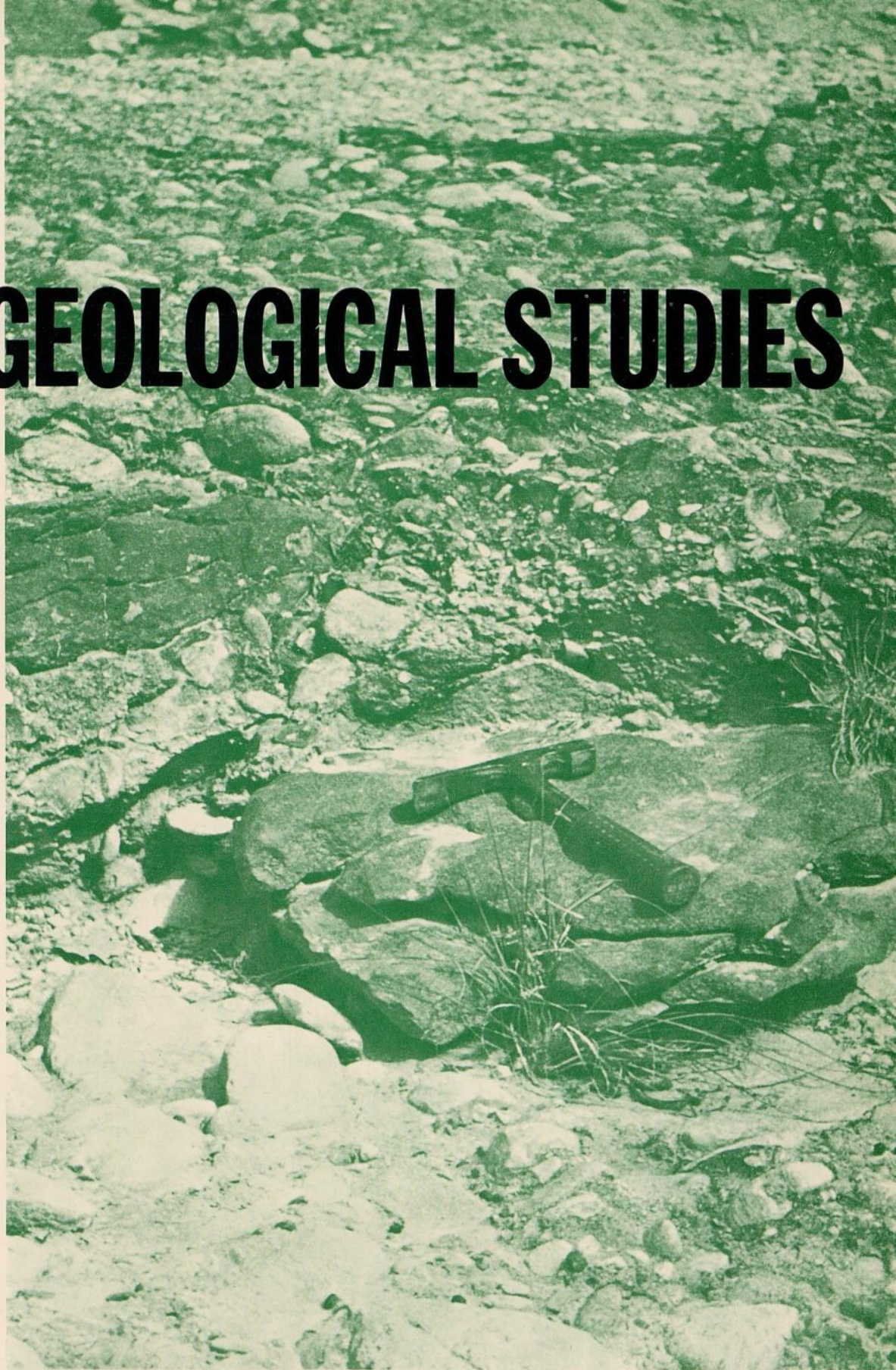
BAYLOR GEOLOGICAL STUDIES

FALL 1968
Bulletin No. 15



*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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BAYLOR GEOLOGICAL STUDIES

BULLETIN NO. 15

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

PETER A. BOONE

BAYLOR UNIVERSITY
Department of Geology
Waco, Texas
Fall, 1968

Baylor Geological Studies

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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 Hosston 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 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 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 two 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.

INTRODUCTION¹

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 Co-

manchean 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.

¹A thesis submitted in partial fulfillment of the requirements for the M.A. degree in Geology, Baylor University, 1966.

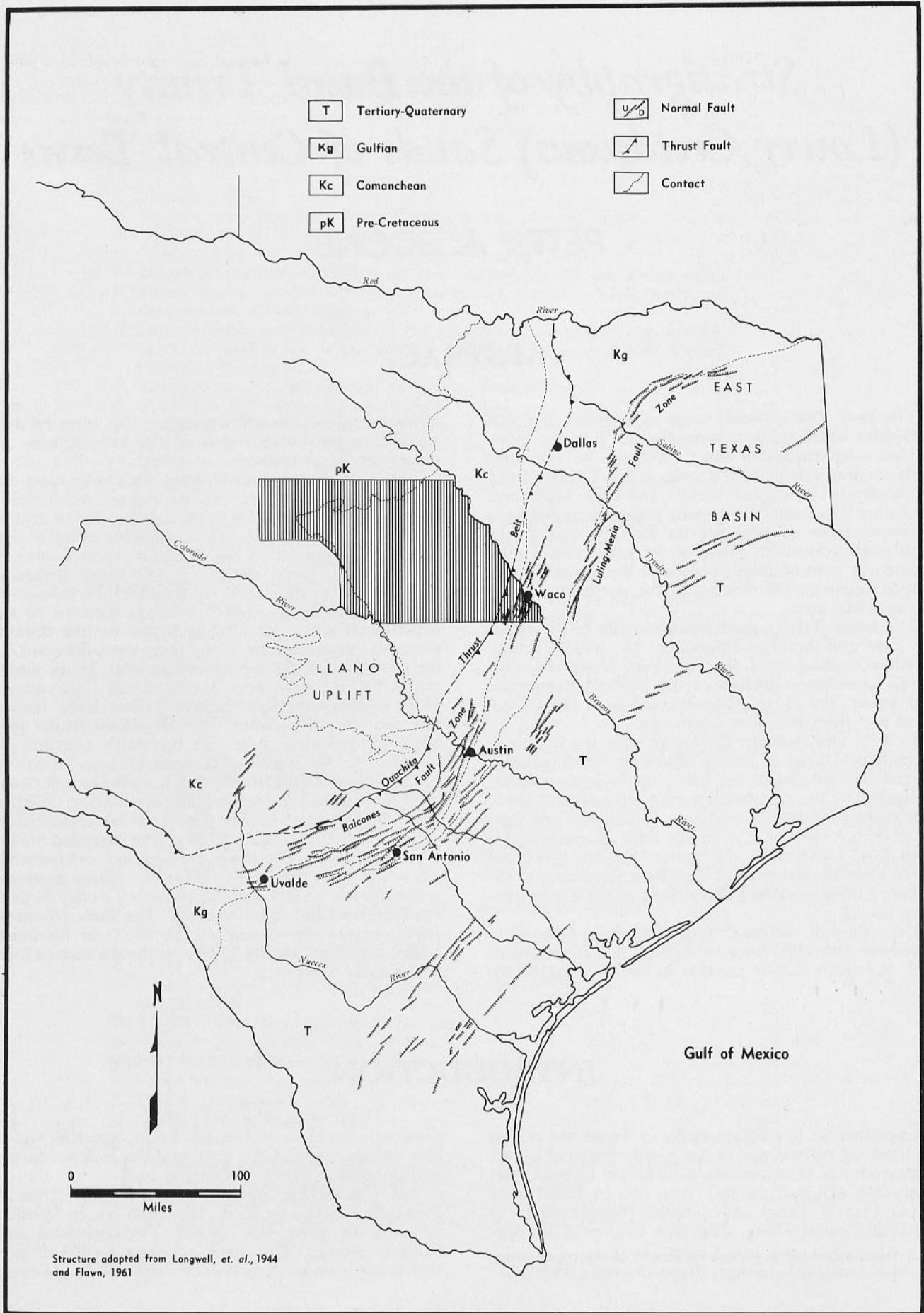


Fig. 1. Location Map.

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 thickens and grades into carbonate units downdip. Lozo and Stricklin (1956, 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 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. 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 of the Trinity Group and the Paluxy Sand and Walnut Clay of the Fredericksburg Group receive consideration because they intergrade with the lower sand units. 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 Comanche 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 formational names in the series.

Considerable geologic interest in the region continues today, and numerous workers (see References) have contributed to our knowledge of the Comanche 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.

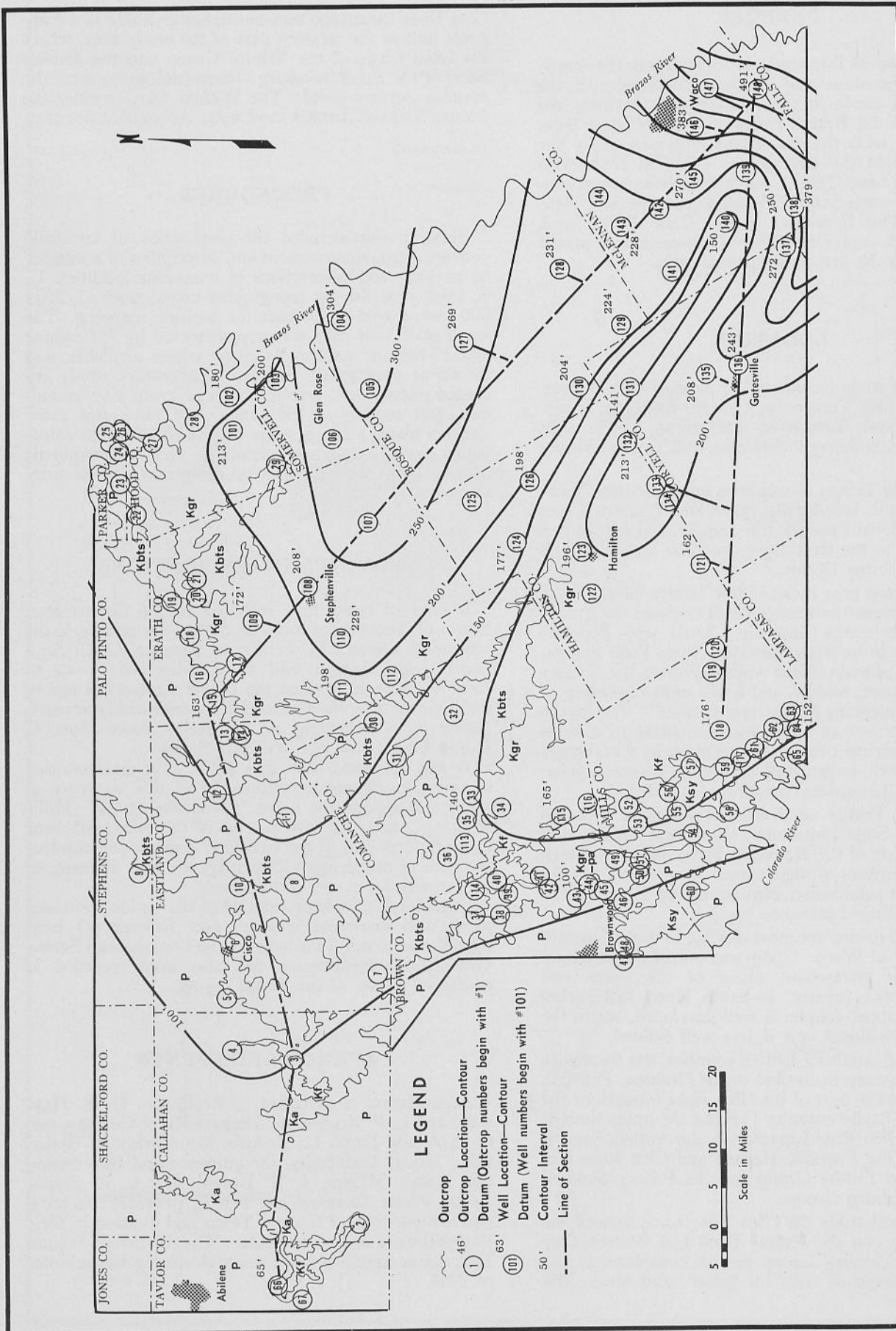


Fig. 2. Outcrop and thickness, basal Trinity sands, Central Texas. Kf undifferentiated Walnut Clay, Comanche Peak Limestone, and Edwards Limestone; Kgr-pa undifferentiated Glen Rose Limestone and Faluzy Sand; Kgr Glen Rose Limestone; Kbits undifferentiated Hosston Sand, Pearsall Formation, Hensel Sand and Bluff Dale Sand; Ka Antlers Sand; Ksy 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 Einschlüsse" 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 into the area 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 strata along the tributaries of the Washita River to the Neocomian Stage. This is the section which G. G. Shumard described at Fort Washita and that Hill (1887c, pp. 73-74) reported "has many paleontologic similarities with that described by Roemer from . . . New Braunfels, but that their lithologic features vary greatly."

In 1860, Benjamin F. Shumard, brother of G. G. Shumard and director of the Texas Geological Survey, published a stratigraphic section of the Cretaceous of

Texas which he compiled from the works of earlier authors. In this section he incorporated strata of G. G. Shumard's "Comanche Peak group" with Roemer's "Fredericksburg group." The Austin Limestone was equated with Roemer's "Kreidebildungen am Fusse des Hochlandes." Shumard, like Roemer, placed the Fredericksburg Group above the Gulfian Series believing that the Gulfian Series represented the oldest Cretaceous rocks present and that rocks of Lower Cretaceous age were absent.

Marcou (1861, p. 93) disagreed with Shumard's interpretation and published his own section in which he rearranged Shumard's units with the knowledge gained by his own observations. Hill (1887c, p. 81) believed Marcou's section "is more in accordance with the actual relations of the strata than any other published and especially those of Roemer and Shumard."

Although Shumard's section of the Cretaceous was in error, he made several important contributions to the Cretaceous geology of the state. He was first to prove conclusively that the Cretaceous of the other Gulf states was represented in Texas when he correlated the Ripley Group of Mississippi with rocks in Navarro County. He also was the first to describe an equivalent of the Dakota Sandstone in Grayson County (Hill, 1887c, p. 82).

In 1886, Hill privately published a broadside sheet entitled "Geological Section of the Cretaceous Strata of the State of Texas, As Seen Along the Line of the Texas Pacific Railroad, from Elmo, Kaufman County, to Millsap, Parker County, and, with Local Variation of Thickness, As It Occurs throughout the State; Based upon Personal Observation" (Jones, 1963, p. 36). This was a structural dip section across North Texas and with it Hill showed, for the first time, the correct sequence of the strata comprising the Texas Cretaceous.

In detailing his section with written reports the following year, Hill named the rocks of the Lower Cross Timbers (the more eastern of the Cross Timbers of Texas) the "Gulf series" for their resemblance to the basal Cretaceous groups of the Mississippi region (1887a, p. 300). At the same time, he showed that the Gulfian Series "rests upon four hundred feet of a second, and lower series of limestone strata" which he named the "'Texas' group of the American Cretaceous," or the "Comanche series" for the town of Comanche, where as a boy he first studied these rocks.

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). 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

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 Marcou 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 sands" or "Upper Cross Timbers") which "are the shore detritus of the Mesozoic sea when it bordered upon the Carboniferous continent" and "may prove [to have] Jurassic affinities" (1887b, pp. 305-306).

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 (Wilmarth, 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'" (1889b, 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 (*idem*, pp. 120-121).

Continued study led Hill (1891, p. 505) to redefine the Trinity Group to "include two stratigraphic subdivisions," the "Trinity" or basal sands and the Glen Rose or "Alternating beds." With this, the base of the Fredericksburg Group 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 "Thorp Spring limestone subdivision." The Thorp 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 "Bosque 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. 192).

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).

As 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 northwestern 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 coquina 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 Sligo 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.



Fig. 3. Western Cross Timbers (on right) and Glen Rose Prairie (on left).

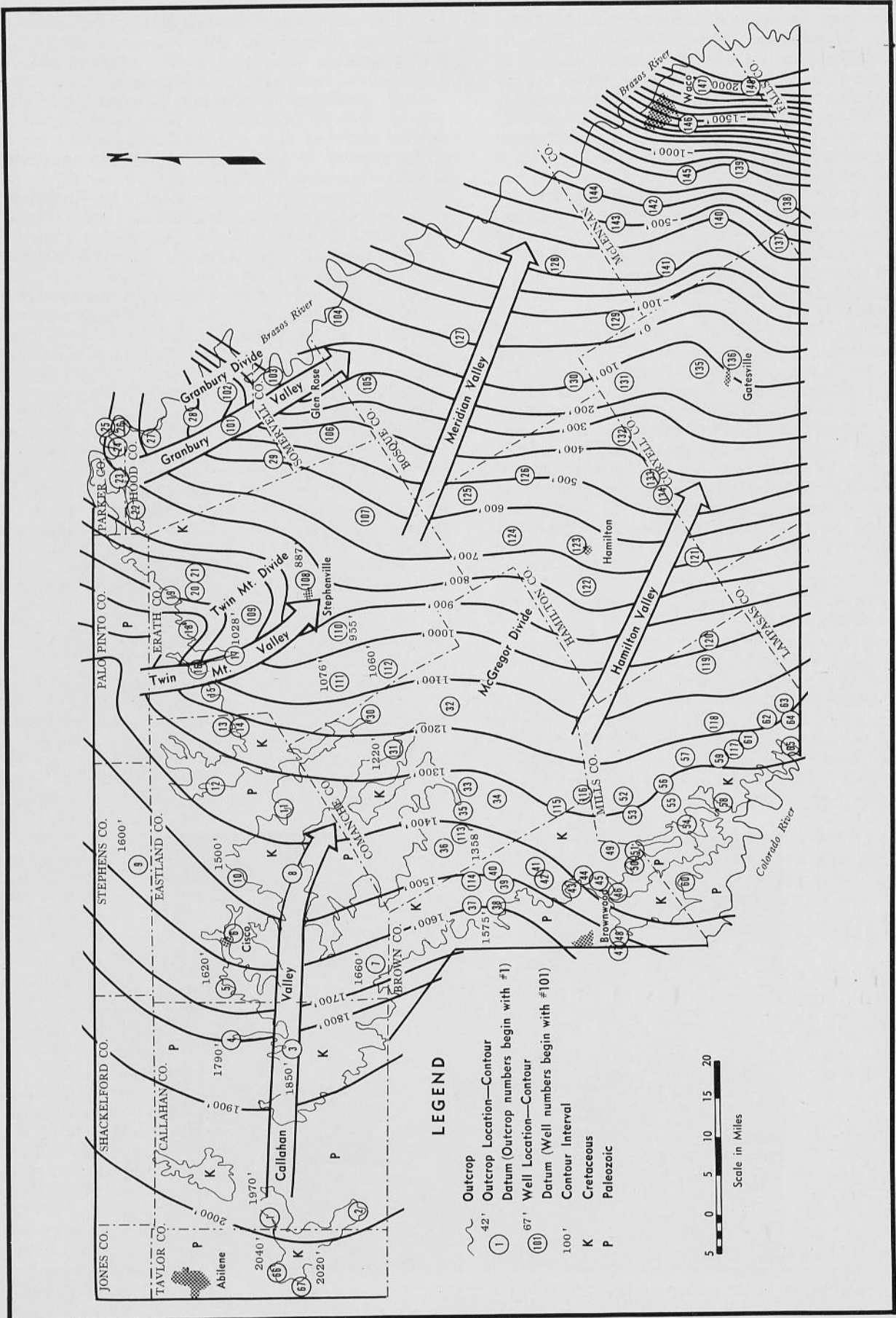


Fig. 4. "Topography" of Wichita paleoplain, Central Texas.

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 channeled 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 Permian 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

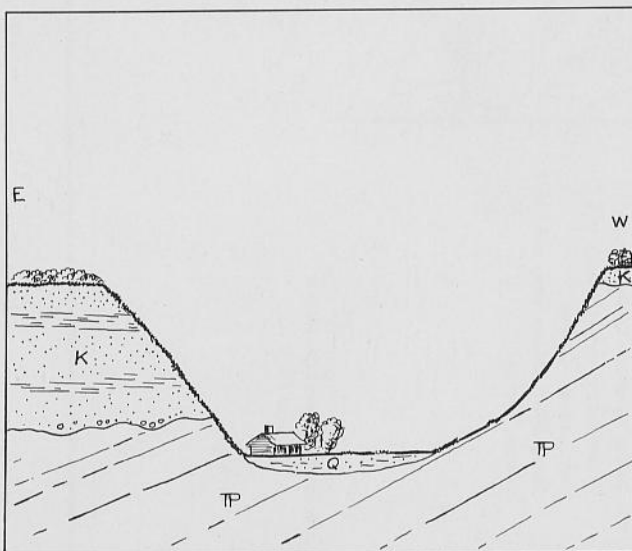


Fig. 5. Diagrammatic representation of the relationship of the Cretaceous-Pennsylvanian contact at the Brownwood Country Club south of Brownwood, Brown County.

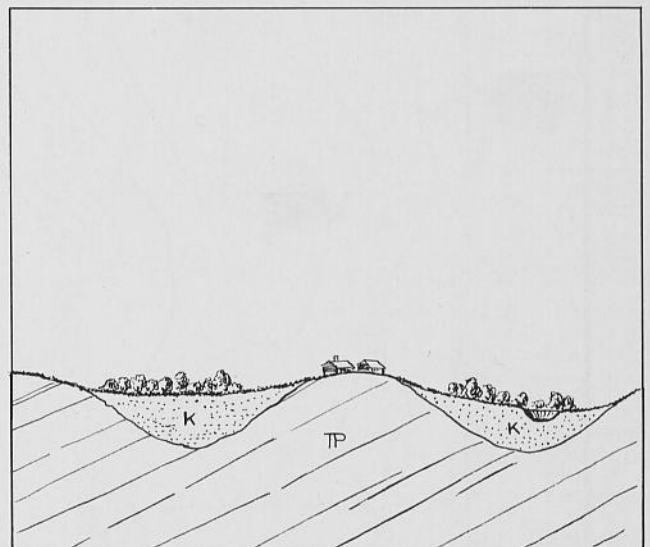


Fig. 6. Diagrammatic representation of the relationship of present topography to buried topography of the Wichita paleoplain at Jones Ranch, Oplin, Callahan County.

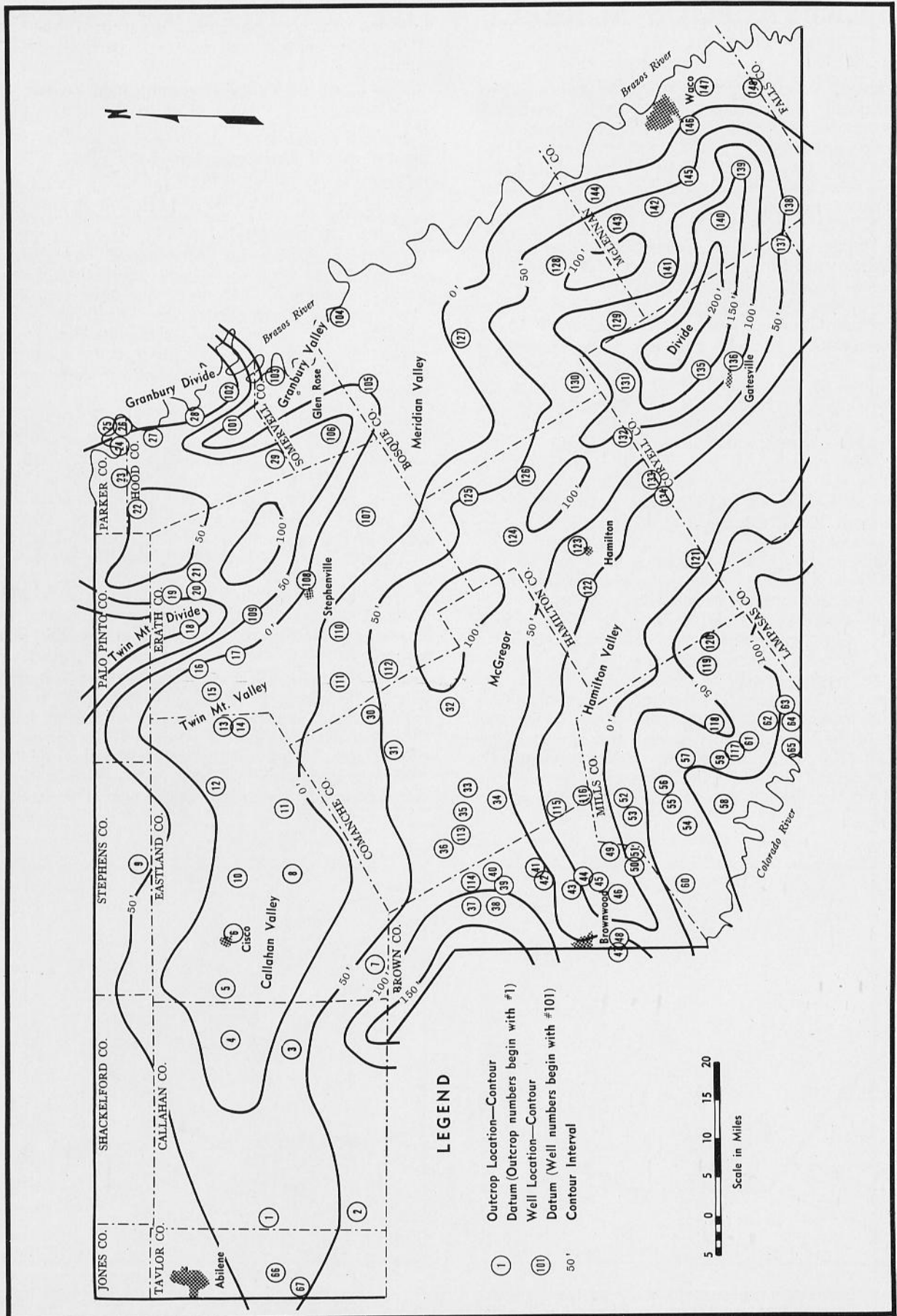


Fig. 7. Residual topography, Wichita paleoplain, Central Texas.

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. Farther 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.



Fig. A. Pennsylvanian-basal Trinity sands contact (locality 18)

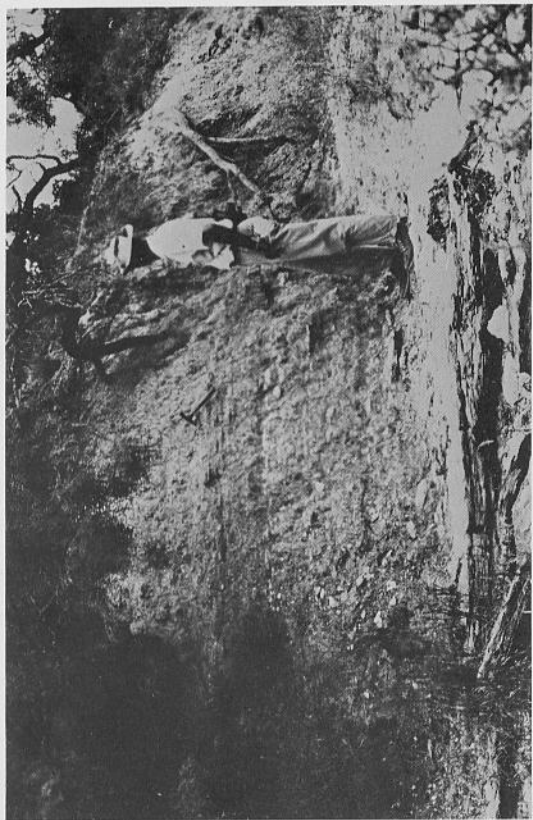


Fig. B. Pennsylvanian-Antlers Sand contact (locality 3)

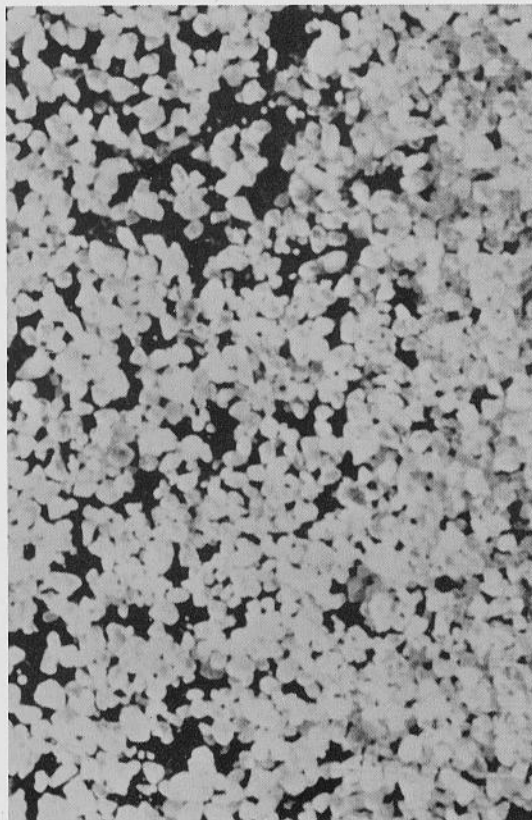


Fig. C. Hosston Sand (10X).

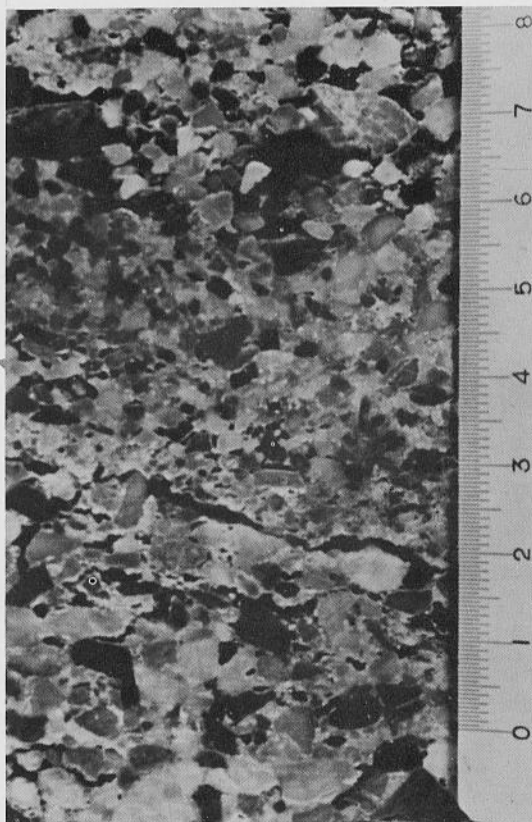


Fig. D. Opaline conglomerate, basal Trinity sands, polished slab.

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 de-

scribed 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 Sligo 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 Permian 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. I) 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.

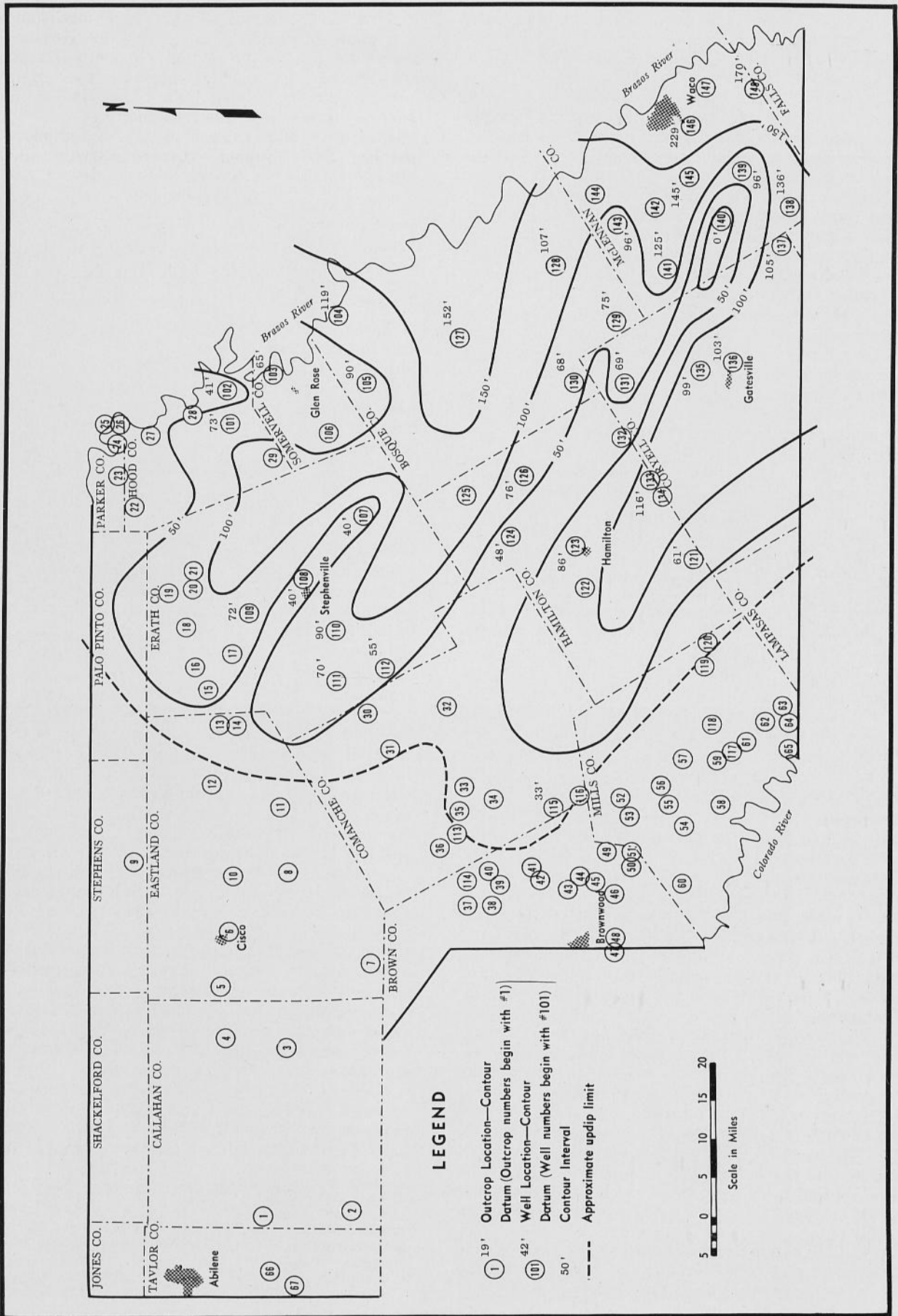


Fig. 8. Thickness of Hosston Sand, Central Texas.

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-

bedded sandstone and siltstone of Pennsylvanian age. At Round Mountain (locality 35), the Hosston Sand, consisting of gray to red-brown sandy conglomerate interbedded with muddy sandstone and sandy mud, overlies steeply dipping light green, indurated, thin-bedded 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 (Imlay, 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 sub-mature, 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 subround 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 ion 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

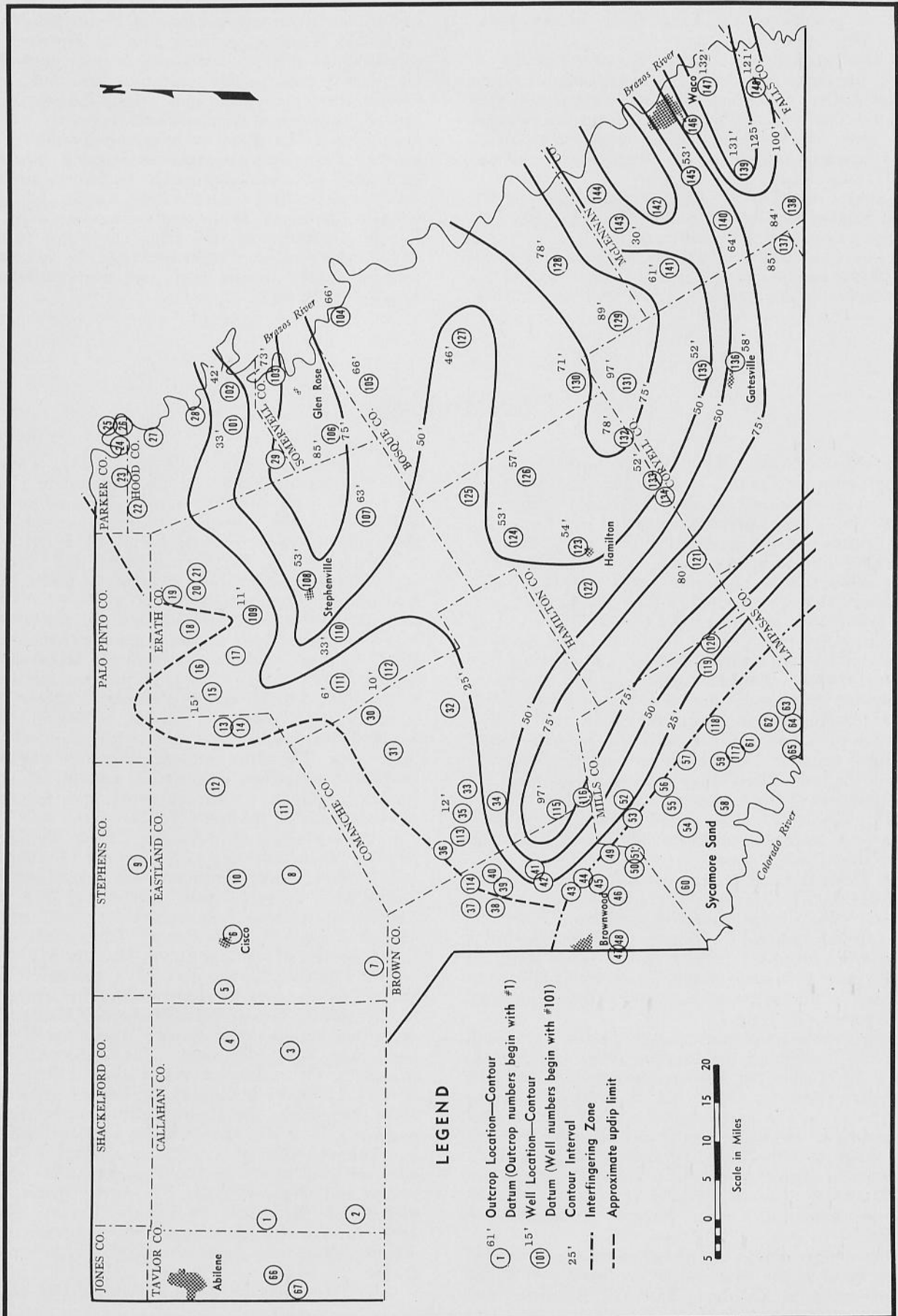


Fig. 9. Thickness of Pearsall Formation, Central Texas.

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 sands 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, oölitic to finely sucrosic, slightly porous limestone" (Holloway, 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 22 feet in the C. M. Stoner #1 Spring Valley well (locality 139) and is absent in the Hervie Meadows & Sons #2 City of McGregor well (locality 140). Northwest of the Golinda Co-op #1 well 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 buff-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 oölitic crystalline limestone beds which become sandy westward" (Holloway, 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 Steppe 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

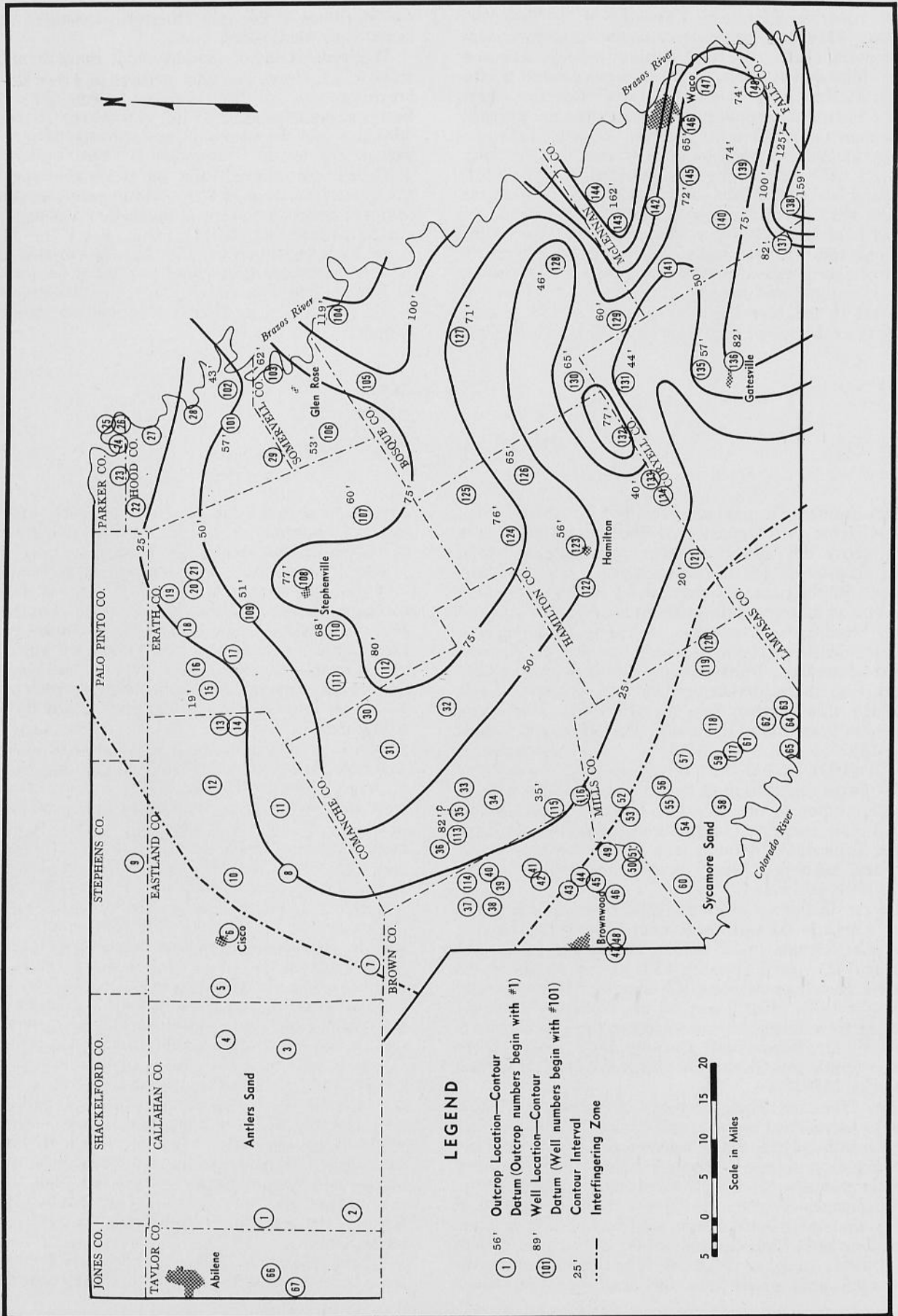


Fig. 10. Thickness of Hensel Sand, Central Texas.

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

Frank Buttram #2 Withfield well (locality 111) in western Erath County.

At Twin Mountain (locality 15), the Pearsall Formation is 15 feet thick and consists of green and red-brown sandy mud. The sandy mud contains 25 percent fine, subround, moderately to well sorted quartz sand with a trace of muscovite and chlorite in the lower part of the unit.

Eleven and one-half feet of red-brown and green sandy mud exposed at Round Mountain (locality 35) may belong to the Pearsall Formation although direct correlation to the Twin Mountain section (locality 15) or to the area of nearest well control (western Erath County) was not determined.

HENSEL SAND

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-round, 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 coarse-grained, sub-round 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-round 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-E, 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 varia-

tions 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 Buie well (locality 104). West and northwest of Bosque County the Hensel Sand thins before interfingering 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).

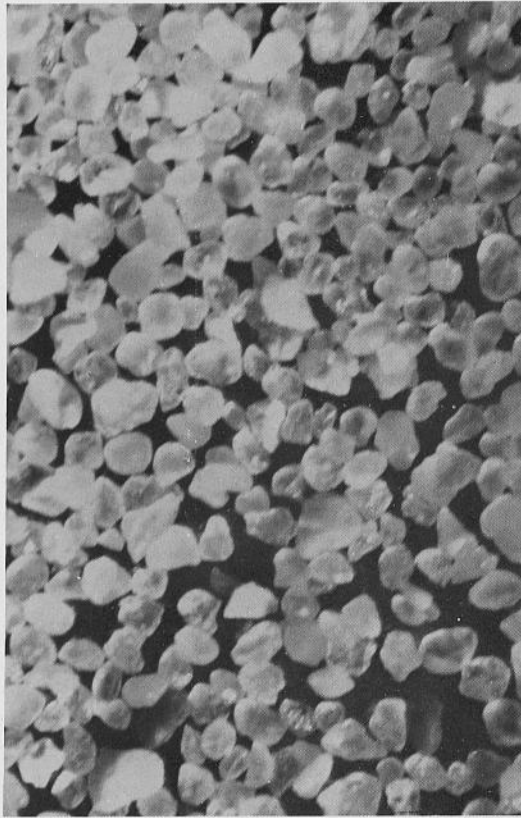


Fig. B. Hensel Sand (10X).

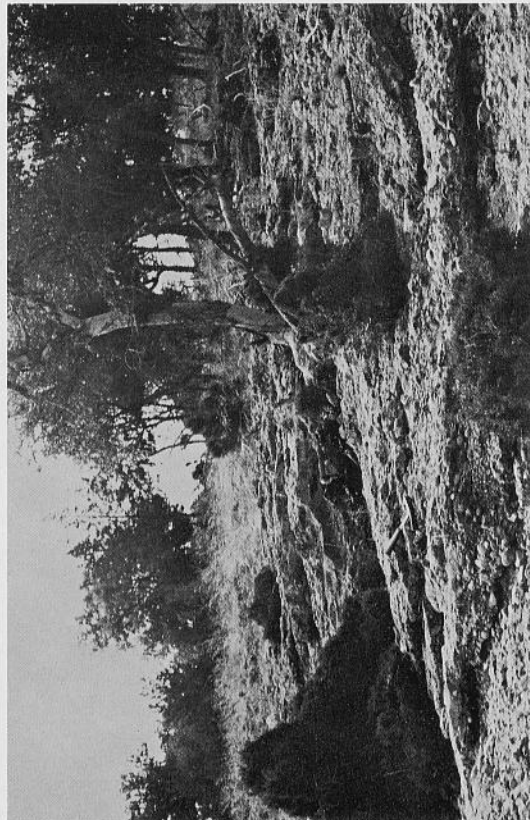


Fig. C. Sycamore Sand, cross-bedding in basal conglomerate (locality 65-A, unit 1).

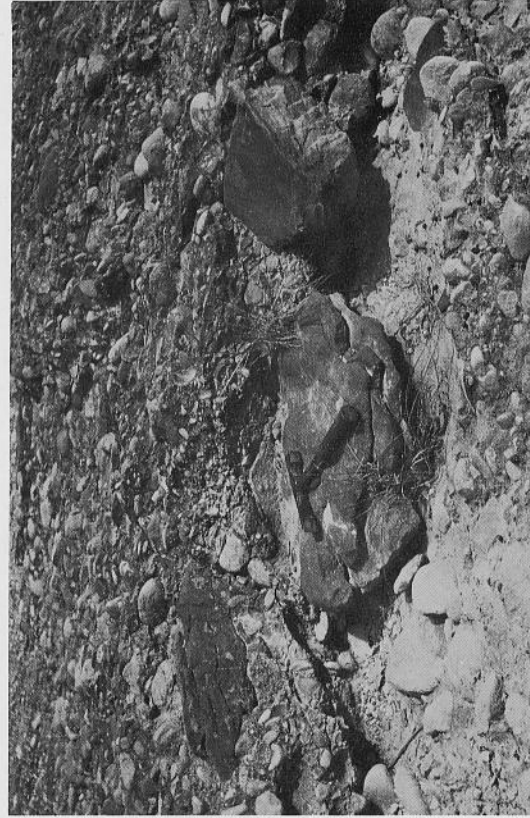


Fig. D. Sycamore Sand, pebbles and boulders in basal conglomerate (locality 65-A, unit 1).

winnowing of the mud portion of the sediments by wave and current action produced a sand facies that is indistinguishable from the overlying Hensel Sand and contemporaneous with the deposition of the sandy mud facies of the Pearsall Formation to the east.

Throughout the study area the Hensel Sand consists of massive friable sandstone with interbedded muds. At Twin Mountain (locality 15), the Hensel Sand is 19 feet thick and consists of immature muddy medium-grained sandstone and medium-grained sandstone with muddy 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 con-

taining 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 fluvial to near-shore facies consisting of interbedded sandy pebble to very large pebble conglomerate, arenaceous limestone, and paleosoils (locality 65); and a more marine near-shore facies containing more sandstone and sandy mud. The fluvial facies occurs throughout Mills County. Near the Mills-Brown county line the fluvial 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 fluvial 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 paleosoils 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 subround 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

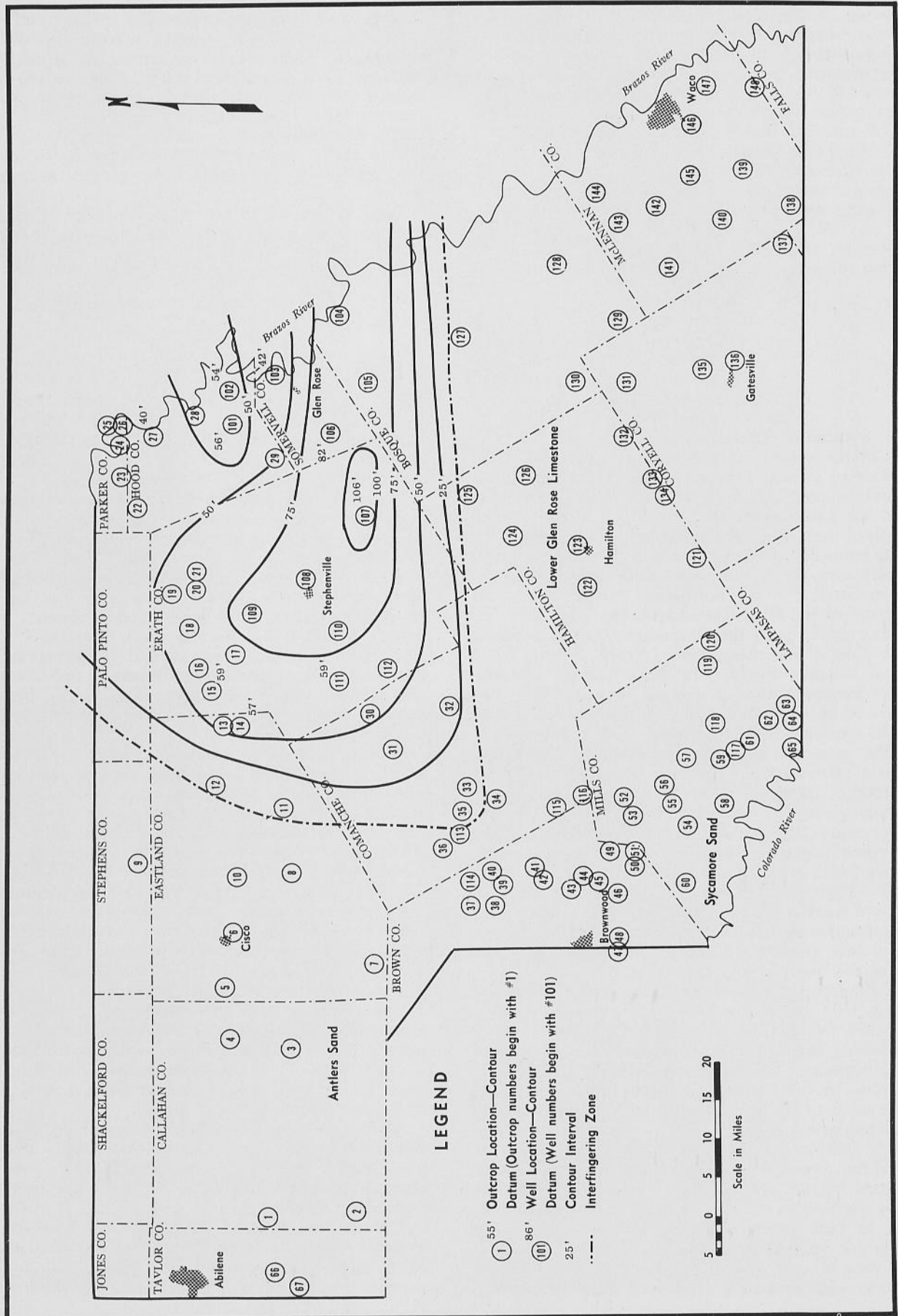


Fig. 11. Thickness of Bluff Dale Sand, Central Texas.

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" (*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; Pl. III) 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.

— (1968) Cross-section of the Trinity sands: Unpublished student report no. 517, Geology Department, Baylor University.



Fig. A. Sycamore Sand, paleosoil (locality 65-A, unit 3).

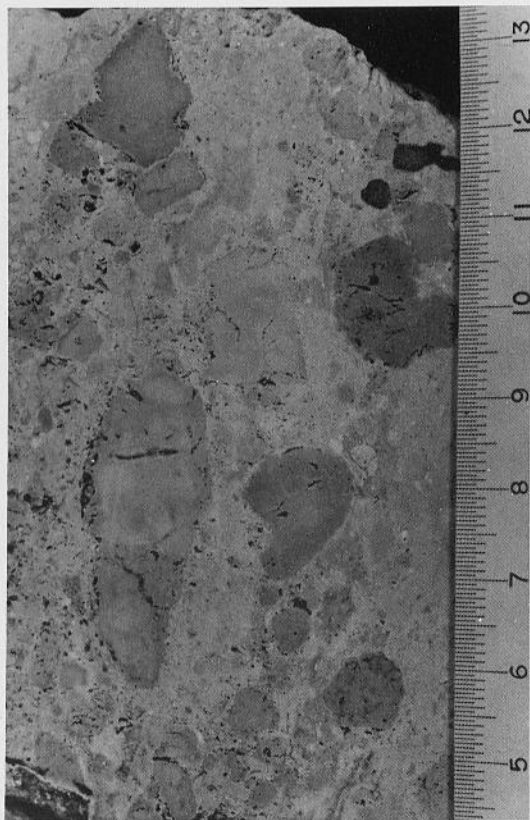


Fig. B. Sycamore Sand, polished slab of conglomeratic limestone paleosoil (?) (locality 65-A, unit 5).

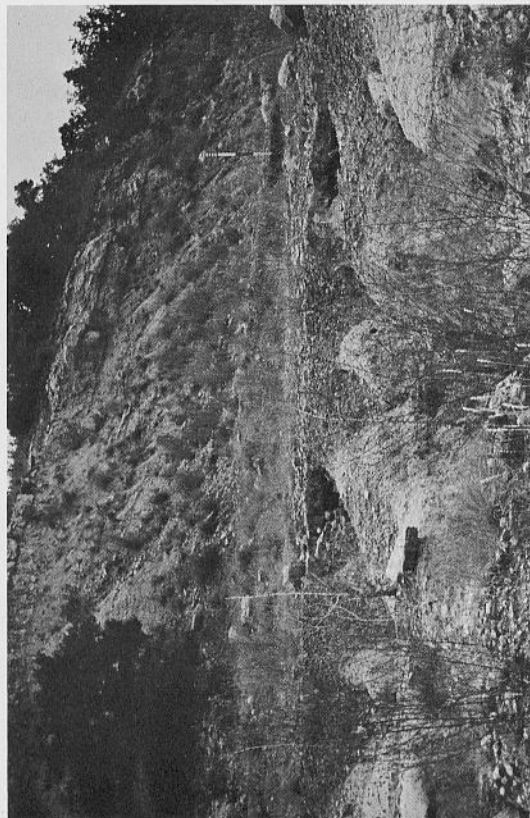


Fig. C. Bluff Dale Sand (locality 29).

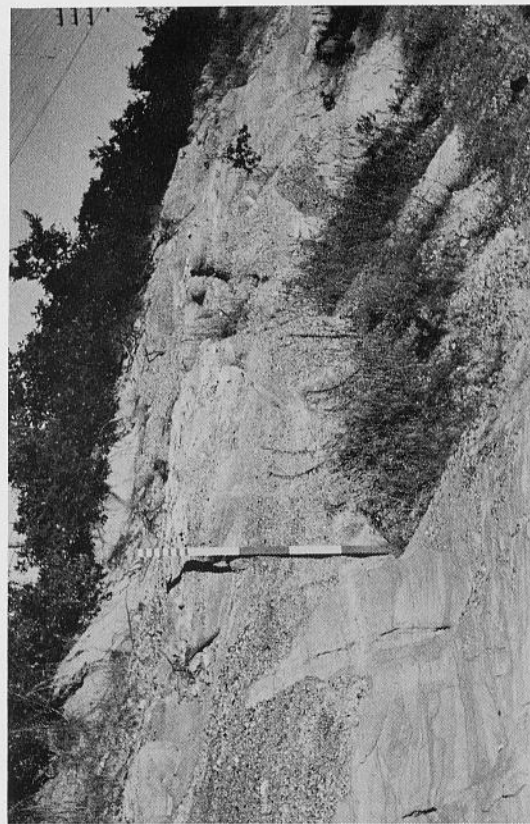


Fig. D. Antlers Sand, conglomerate and sandstone of lower sand unit (locality 1).

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 subround quartz and chert with a range of 2 to 64 mm and a median diameter of 5 to 6 mm (fig. 12).

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 subround 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. Subround 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 IN THE BASAL TRINITY SANDS

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,



Fig. A. Glen Rose Formation (locality 38).



Fig. B. Glen Rose Formation overlain by Paluxy Sand (locality 39).

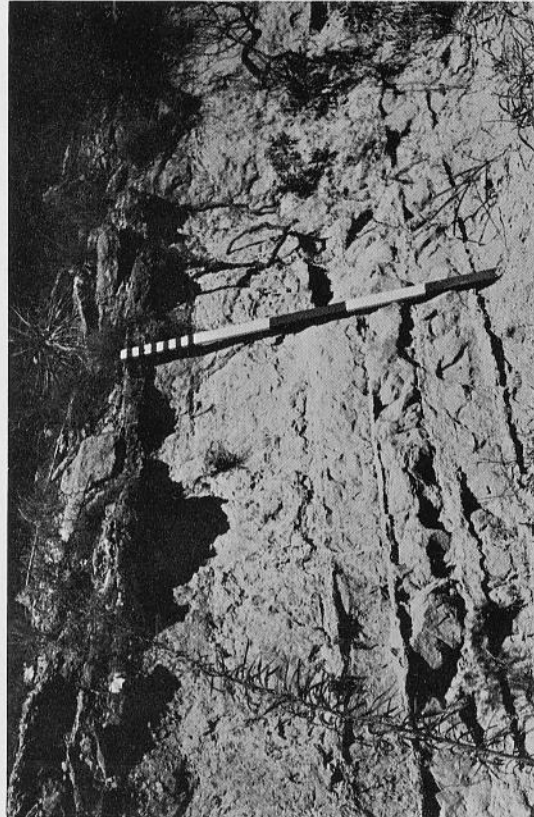


Fig. C. Paluxy Sand overlain by limestone of the Walnut Formation (locality 61).



Fig. D. Cut and fill channel at top of Paluxy Sand overlain by relatively horizontal limestone of the Walnut Formation.

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.



Fig. 12. Pebbles in conglomerate of Lower Sand unit Antlers Sand (locality 3, unit 3).

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 Spring 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 (?). Eight miles north (locality 61), the basal unit of the Glen Rose Formation is 4 to 5 feet of thin-bedded fossiliferous 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 coquinoid 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.

Farther 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 Spring 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 Spring 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 coquinoid placers of pelecypod 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 back-bay 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 interfingering 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 basal Trinity sands and the Paluxy Sand coalesce 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 "wavy 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.

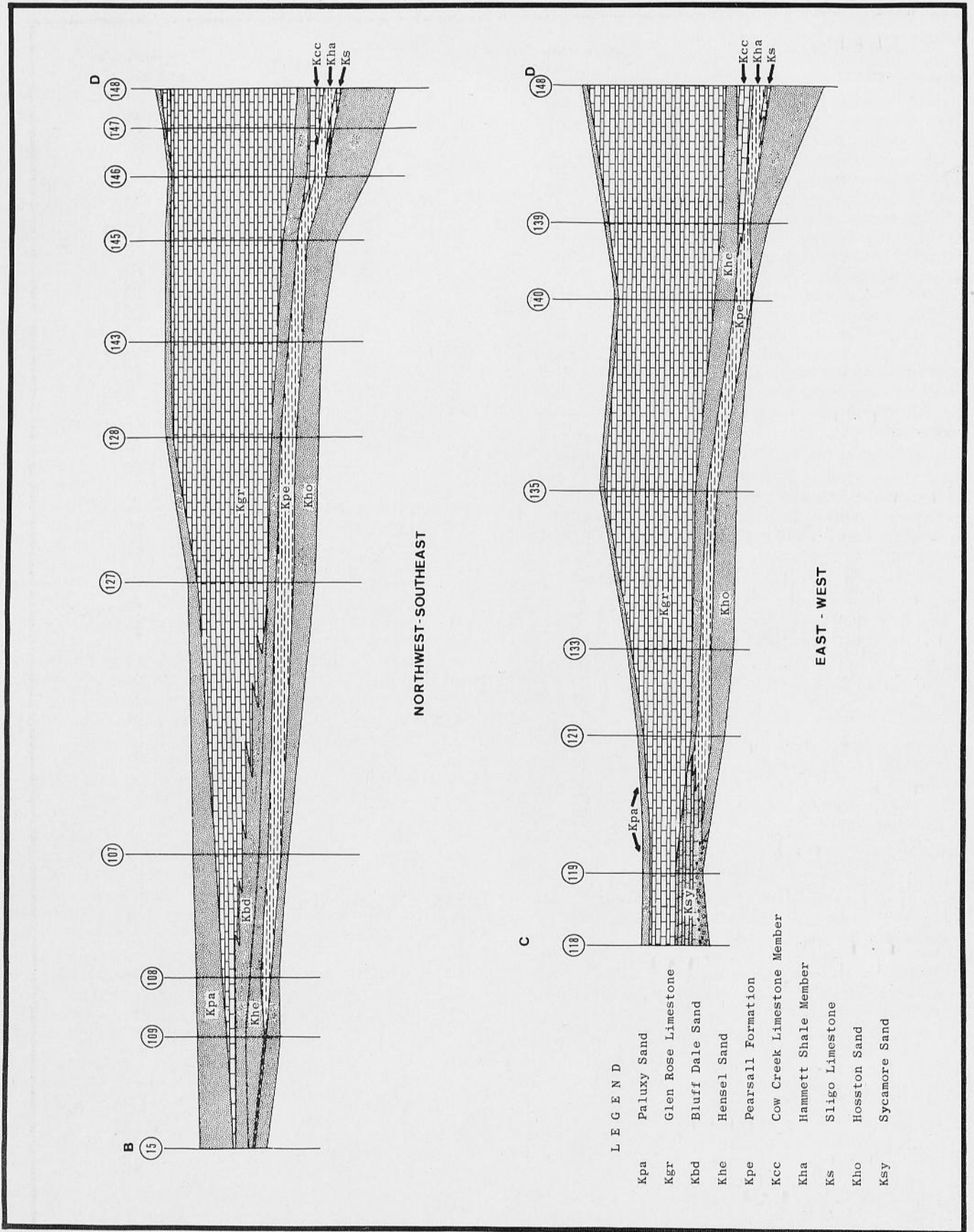


Fig. 13. Stratigraphic cross section, basal Trinity sands, Central Texas.

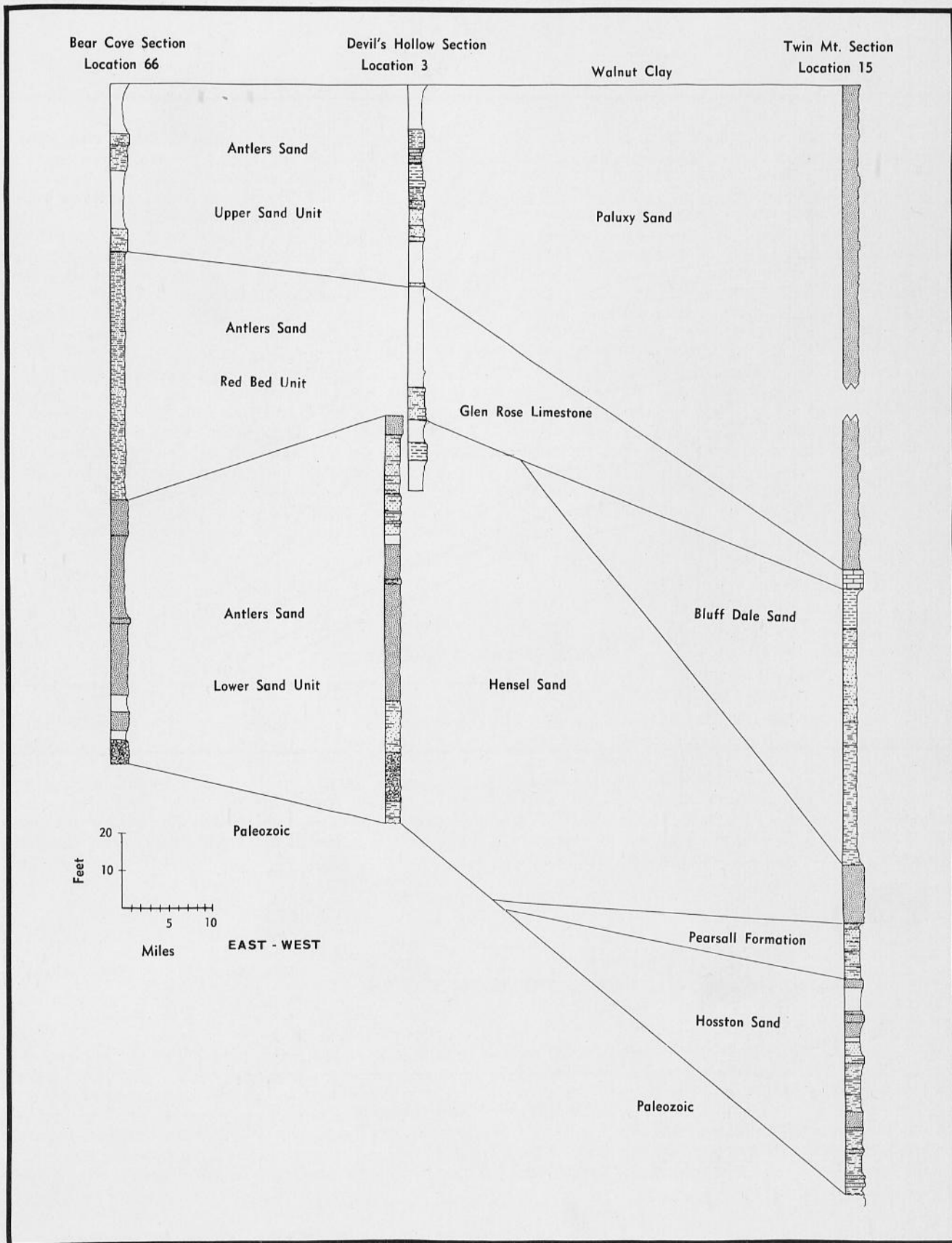


Fig. 14. Correlation section, basal Trinity sands, Central Texas.

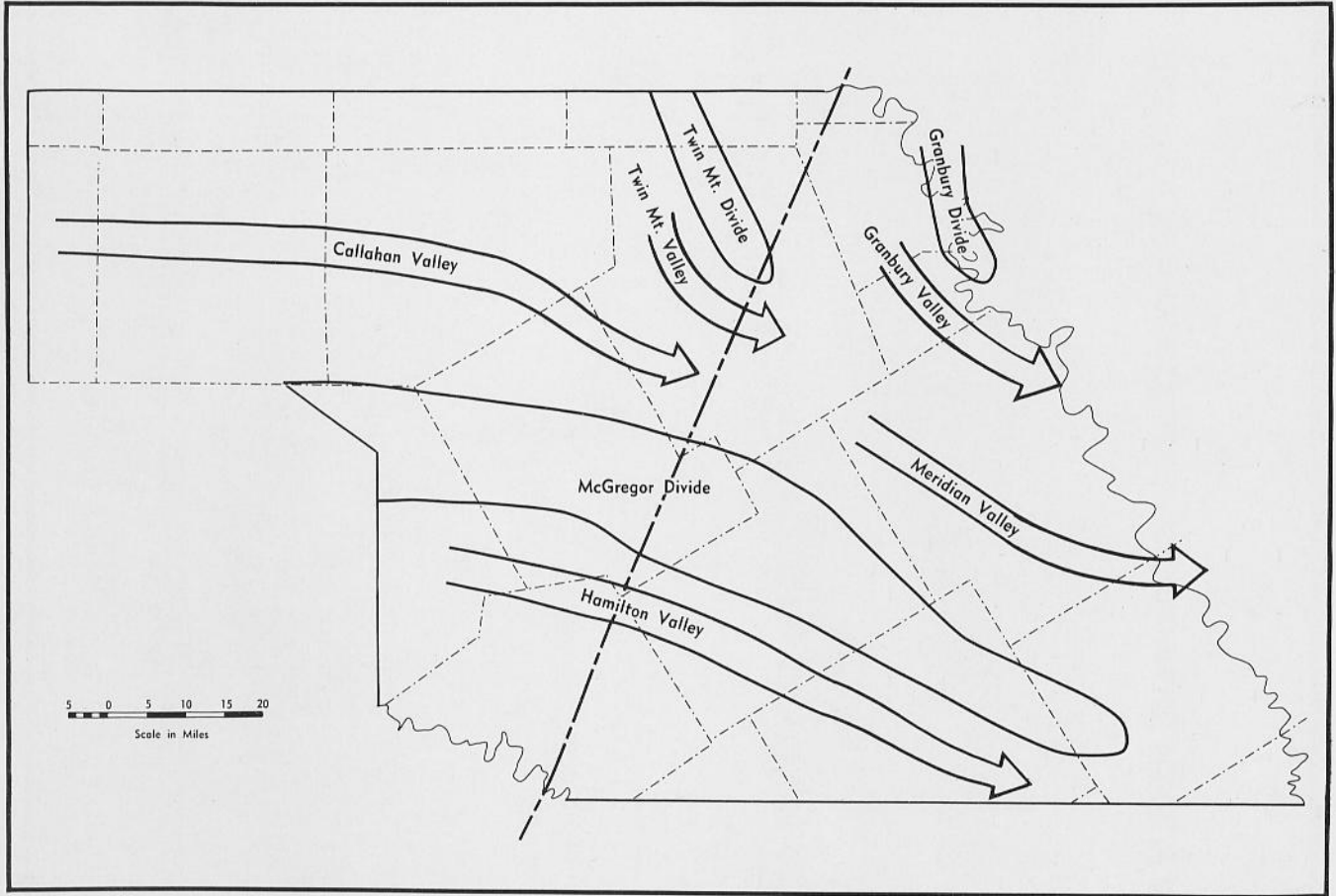


Fig. 15. Wichita paleotopographic map.

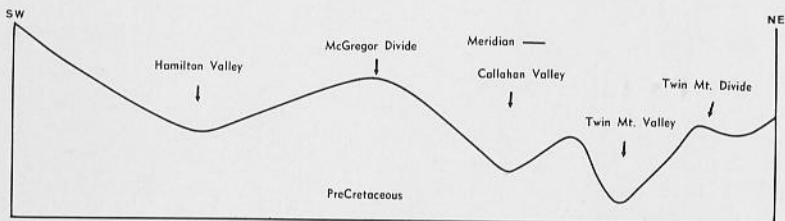


Fig. 16. Profile, Wichita paleoplain.

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 Sligo Limestone; the second by the Pearsall Formation; 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).

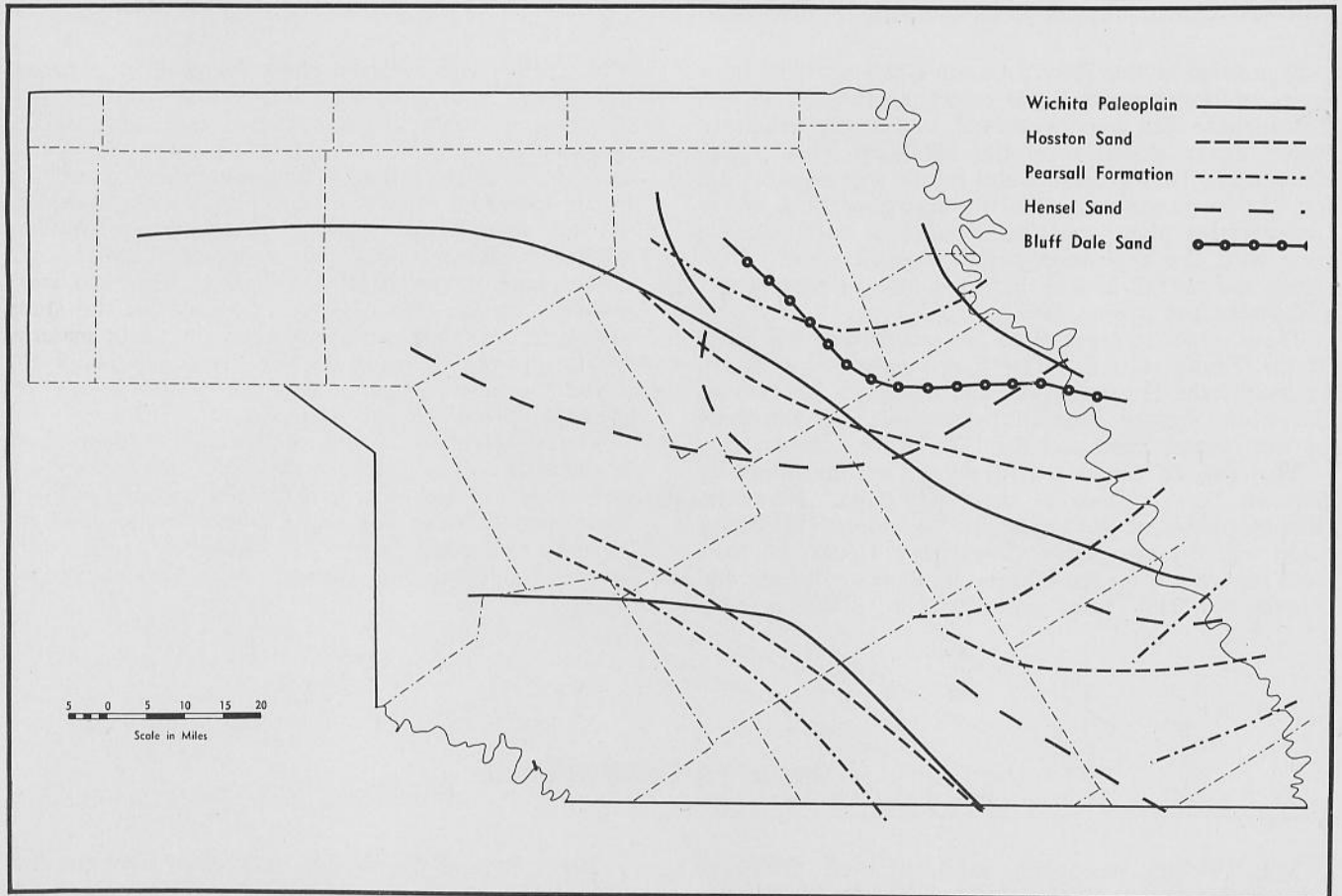


Fig. 17. Relationship of the axes of thickness of the Hosston, Pearsall, Hensel, and Bluff Dale formations with the axes of the Hamilton and Callahan-Meridian valleys.

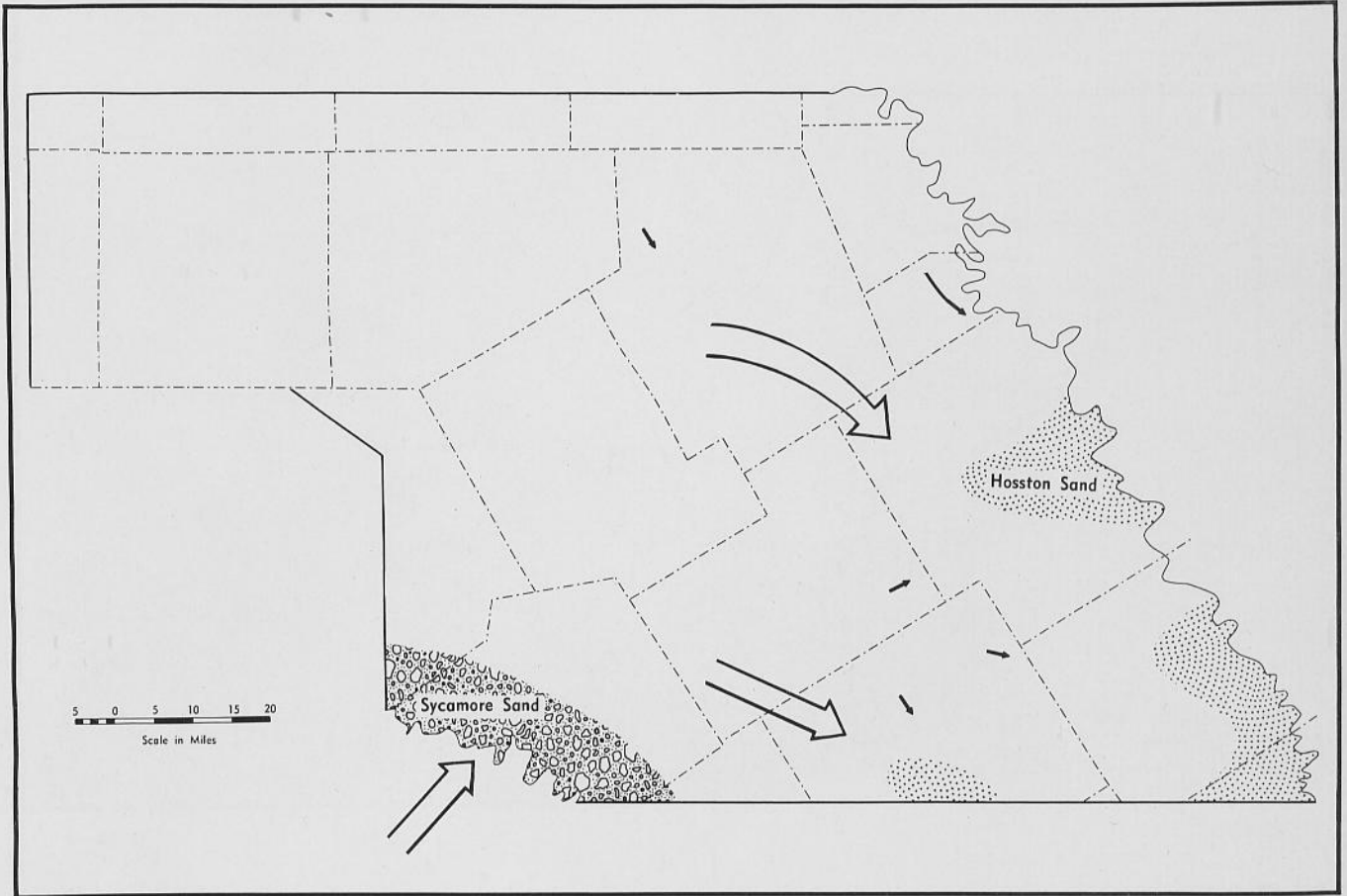


Fig. 18. Early Hosston paleogeologic map.

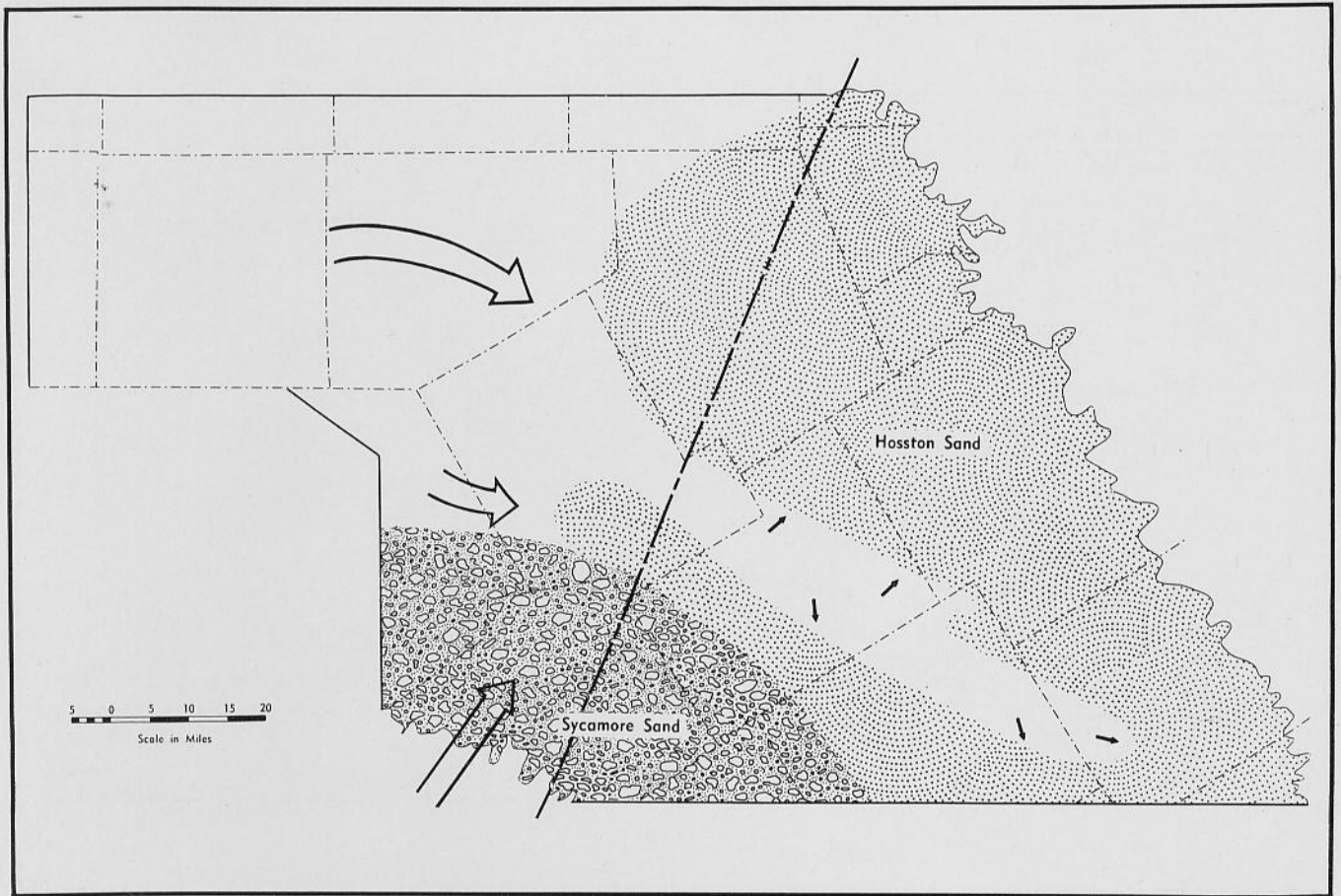


Fig. 19. Middle Hosston paleogeologic map.

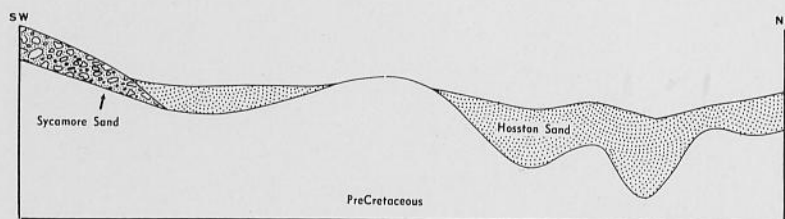


Fig. 20. Cross section, Middle Hosston time.

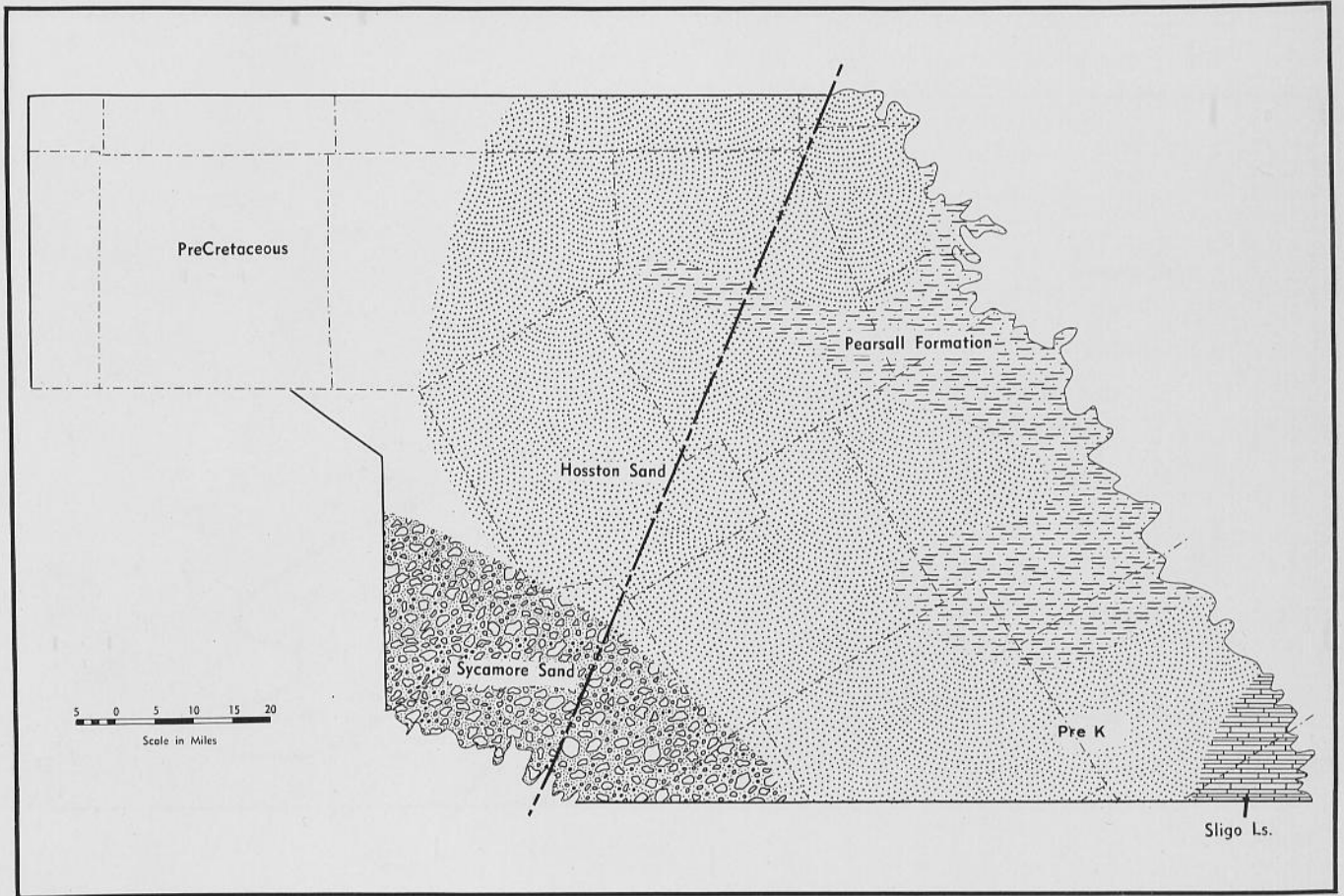


Fig. 21. Late Hosston-Early Pearsall paleogeologic map.

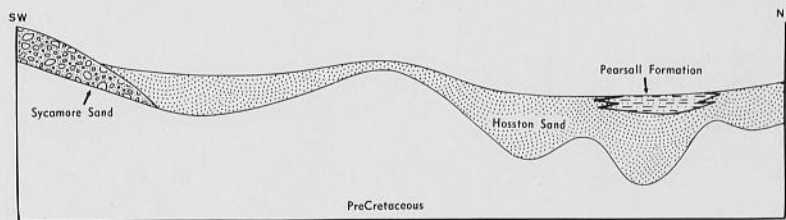


Fig. 22. Cross section, Late Hosston-Early Pearsall time.

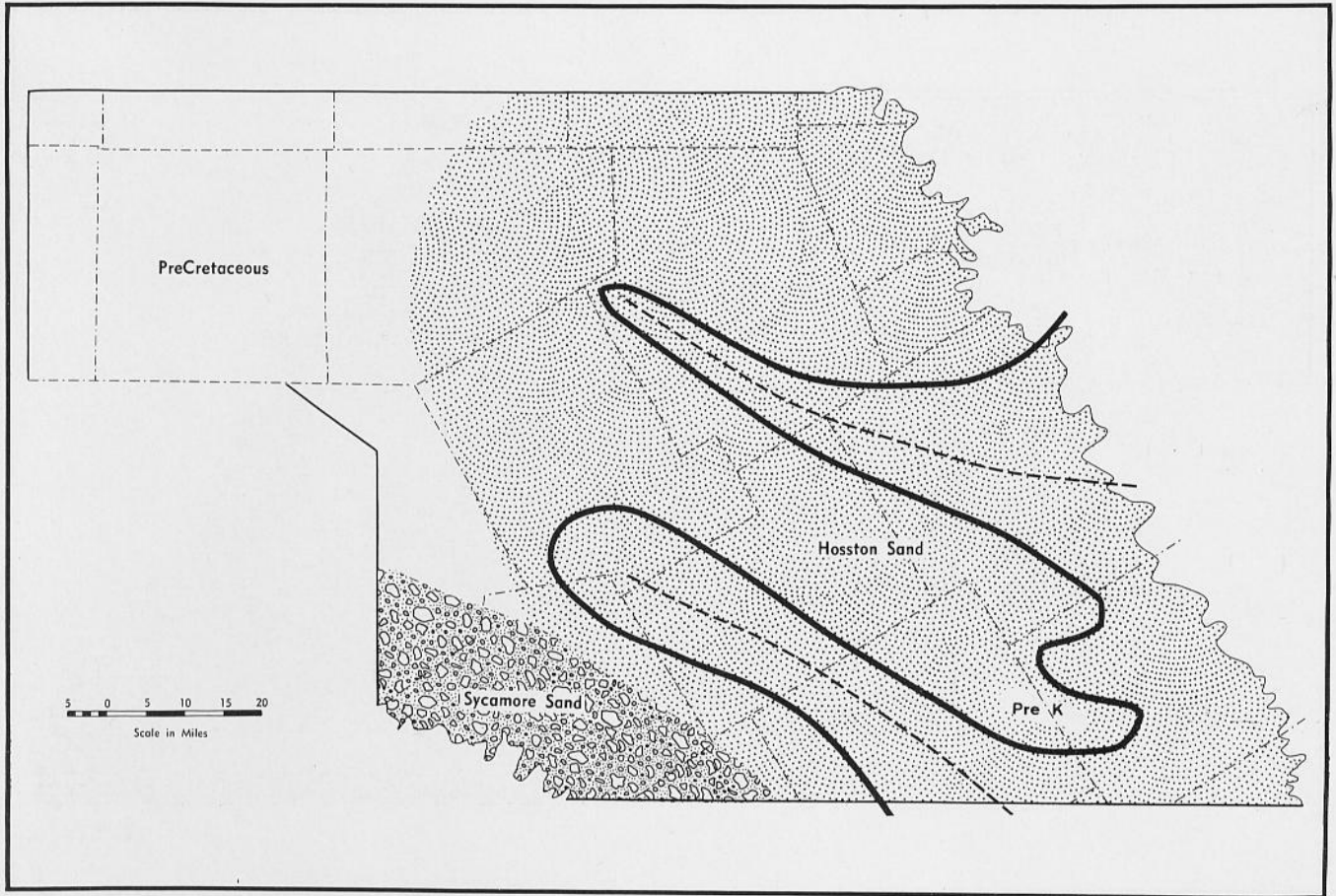


Fig. 23. Extent of Hosston Sand and areas and axes of thickest accumulation.

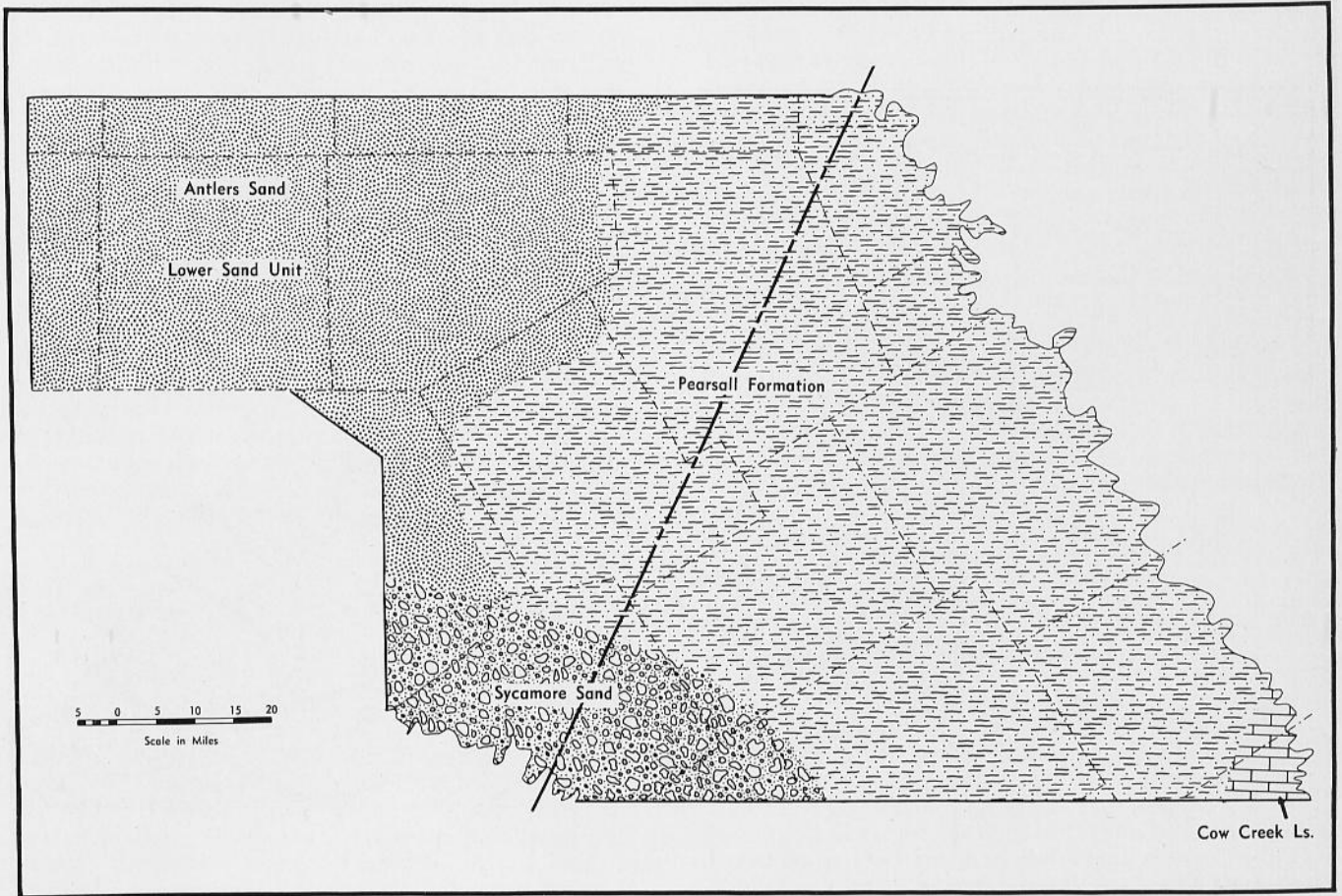


Fig. 24. Middle Pearsall paleogeologic map.

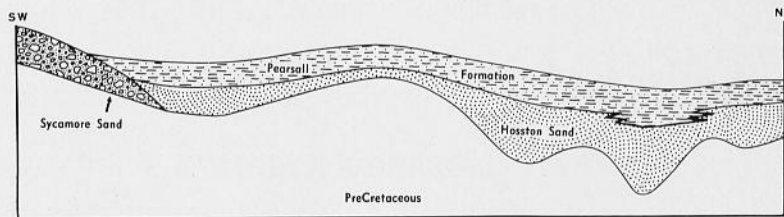


Fig. 25. Cross section, Middle Pearsall time.

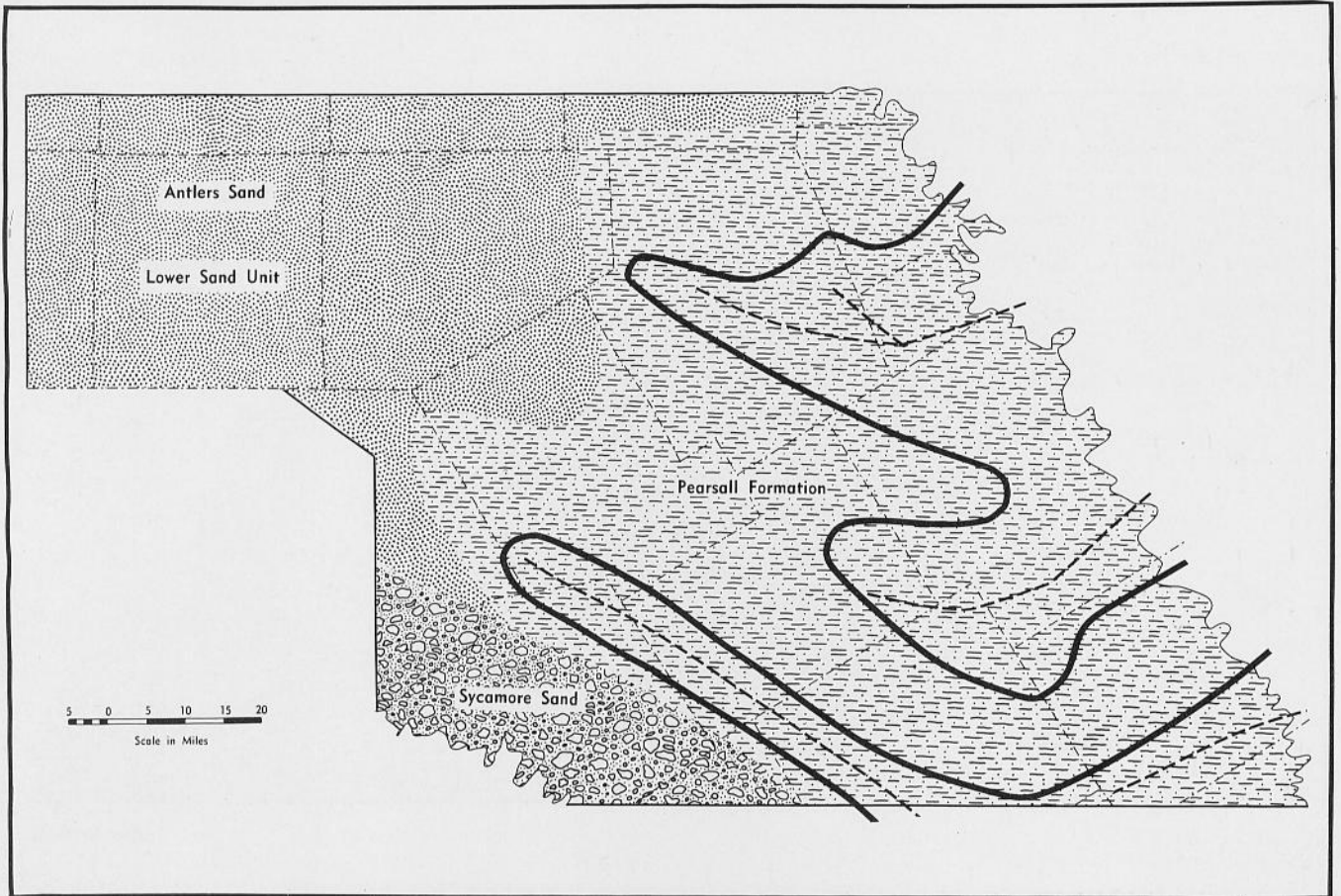


Fig. 26. Areas of thickness, Pearsall Formation.

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 microcross-bedded. 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 HOSSTON—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).

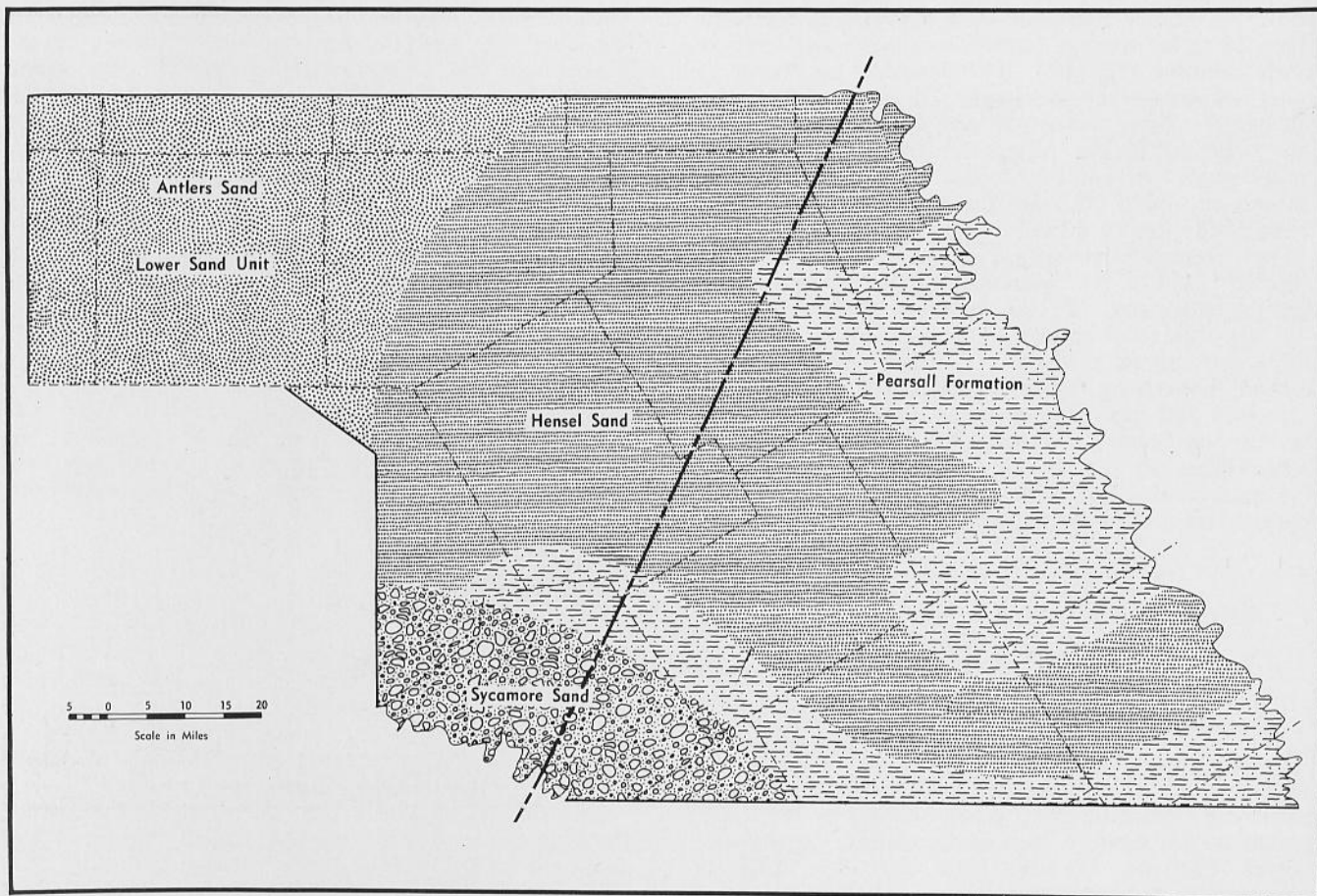


Fig. 27. Late Pearsall-Early Hensel paleogeologic map.

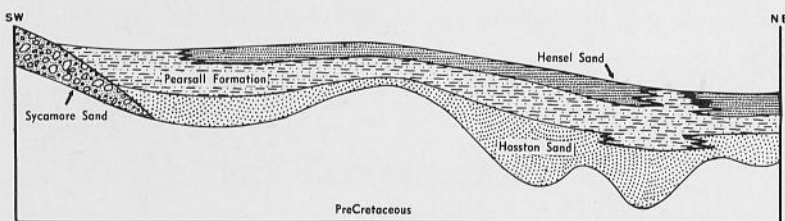


Fig. 28. Cross section, Late Pearsall-Early Hensel time.

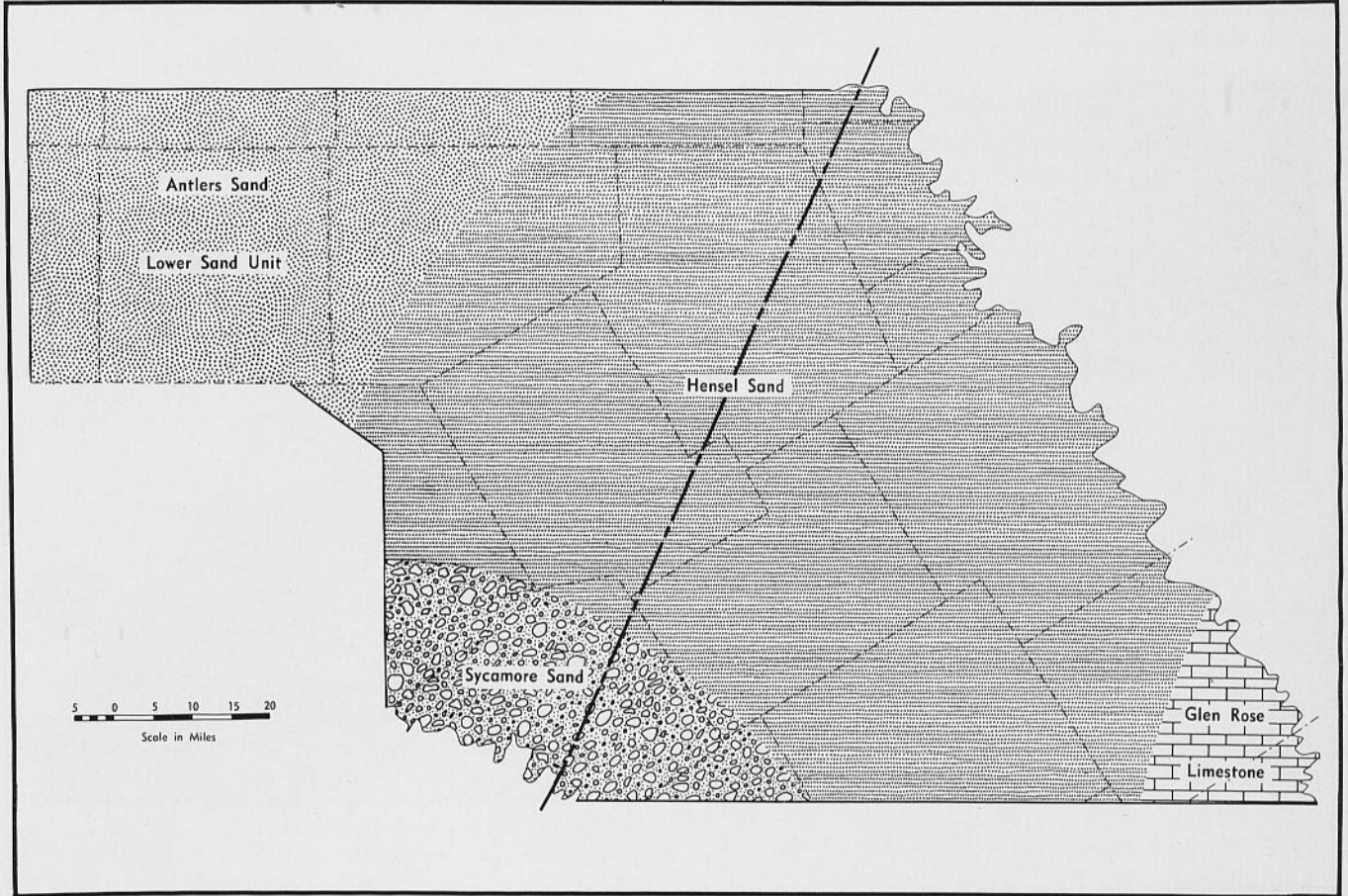


Fig. 29. Late Hensel paleogeologic map.

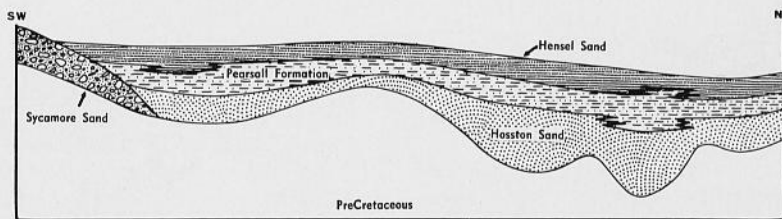


Fig. 30. Cross section, Late Hensel time.

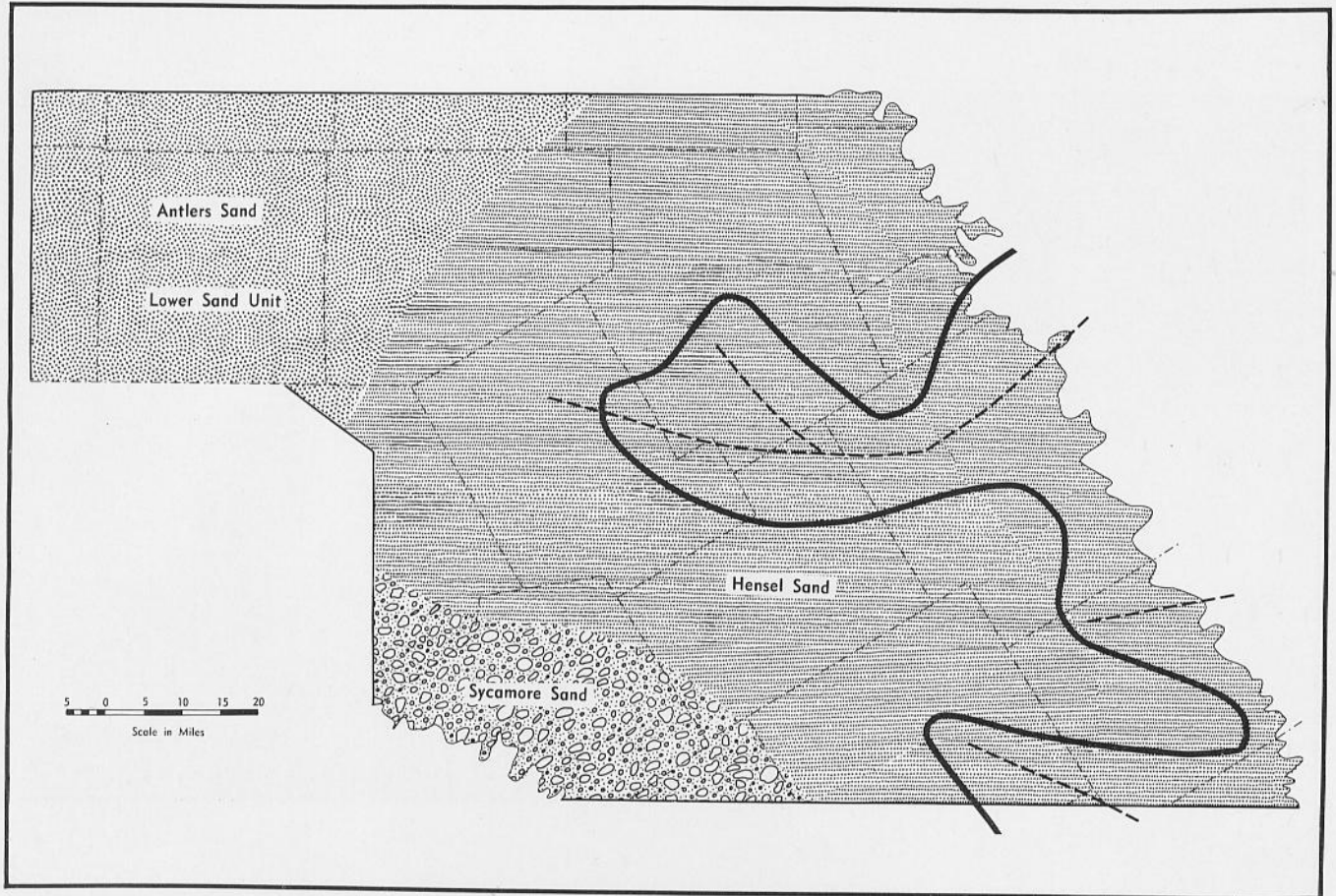


Fig. 31. Extent of Hensel Formation and areas and axes of thickest accumulation.

LATE PEARSALL—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).

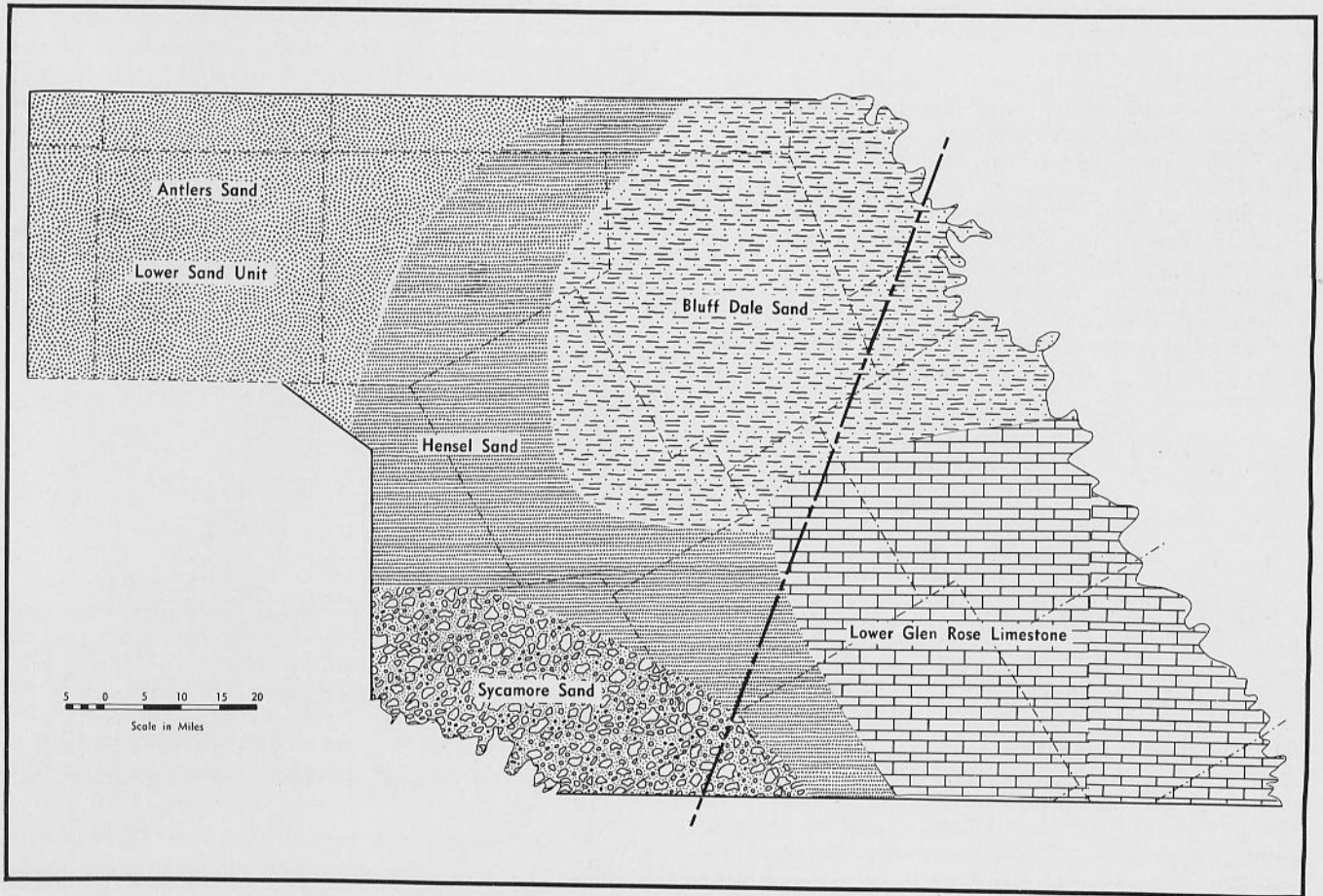


Fig. 32. Early Glen Rose paleogeologic map.

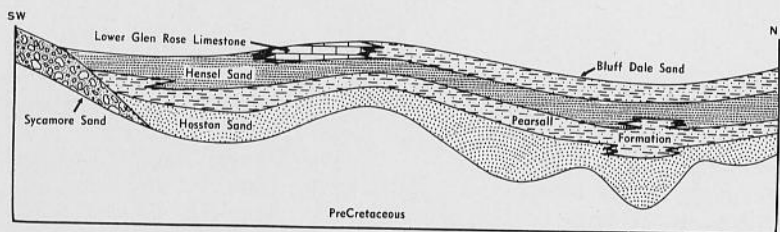


Fig. 33. Cross section, Early Glen Rose time.

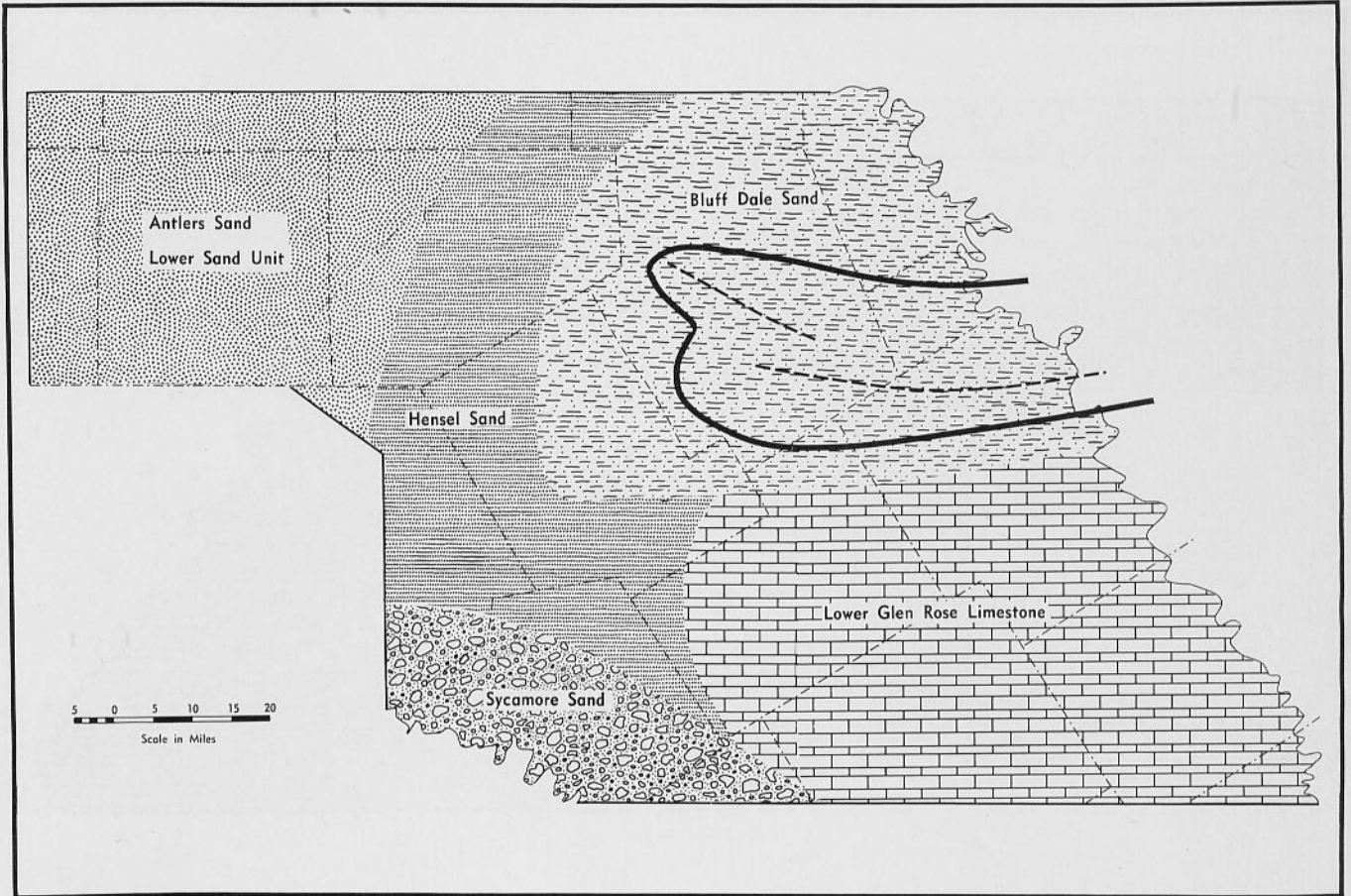


Fig. 34. Extent of Bluff Dale Sand and areas and axes of thickest accumulation.

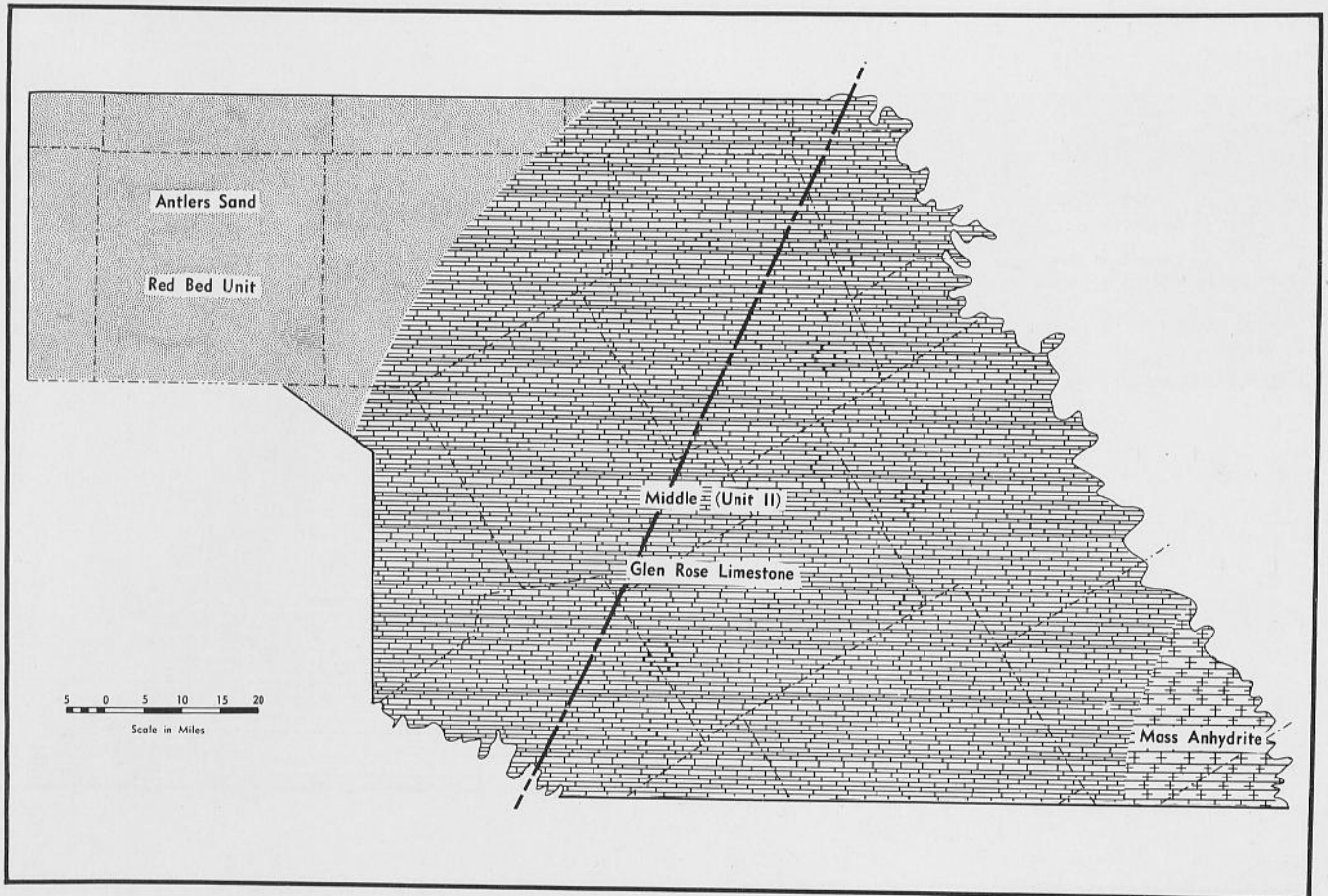


Fig. 35. Middle Glen Rose paleogeologic map.

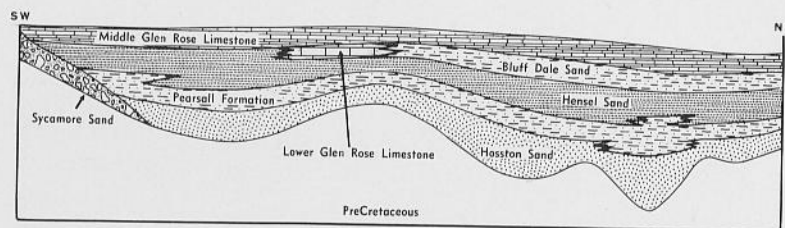


Fig. 36. Cross section, Middle Glen Rose time.

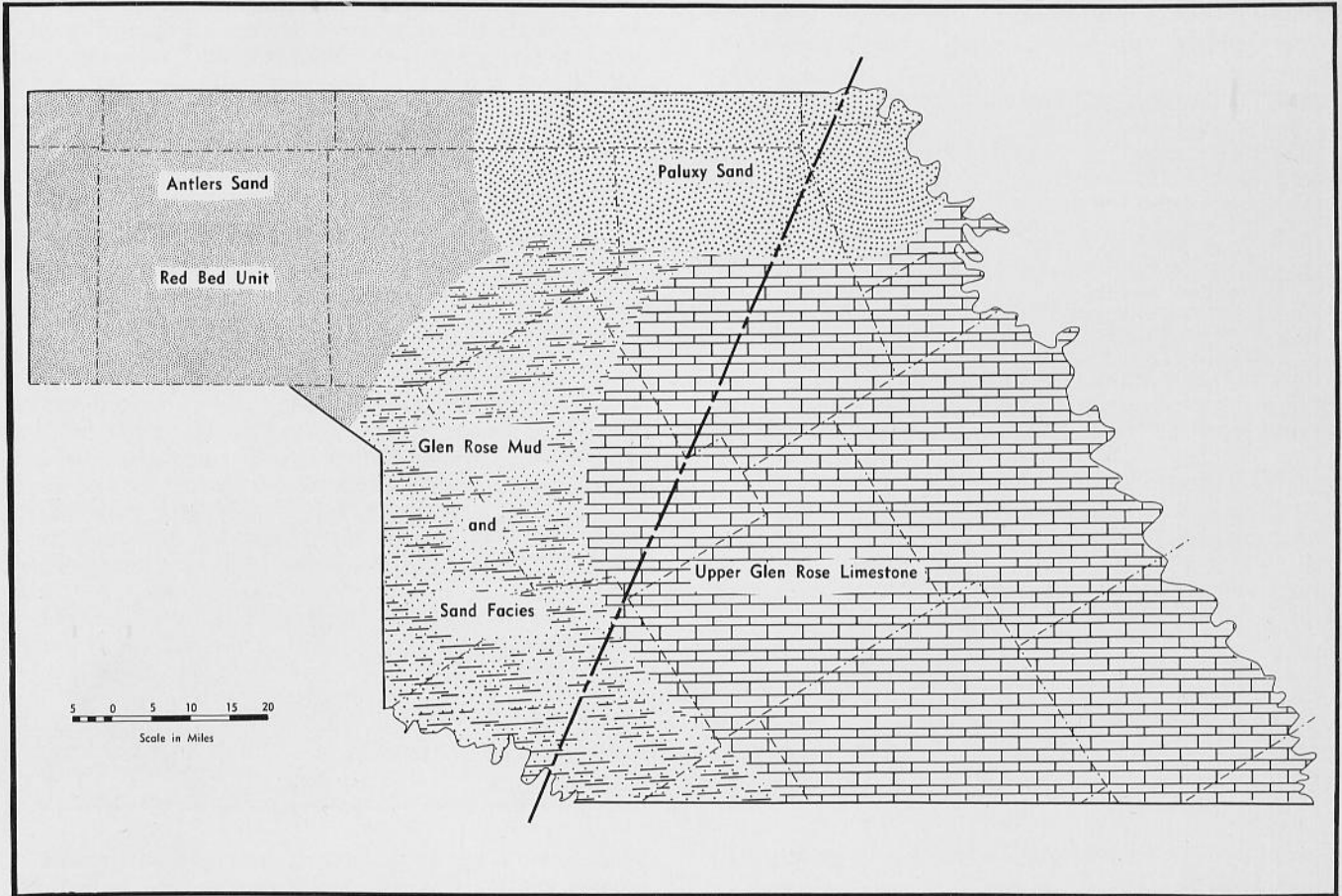


Fig. 37. Late Glen Rose paleogeologic map.

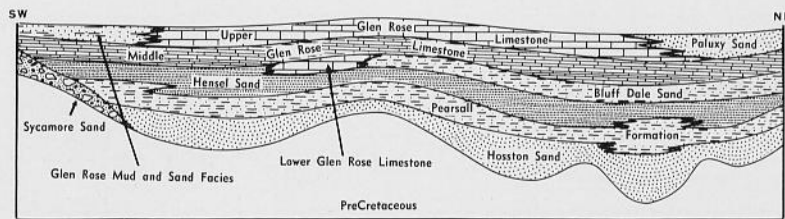


Fig. 38. Cross section, Late Glen Rose time.

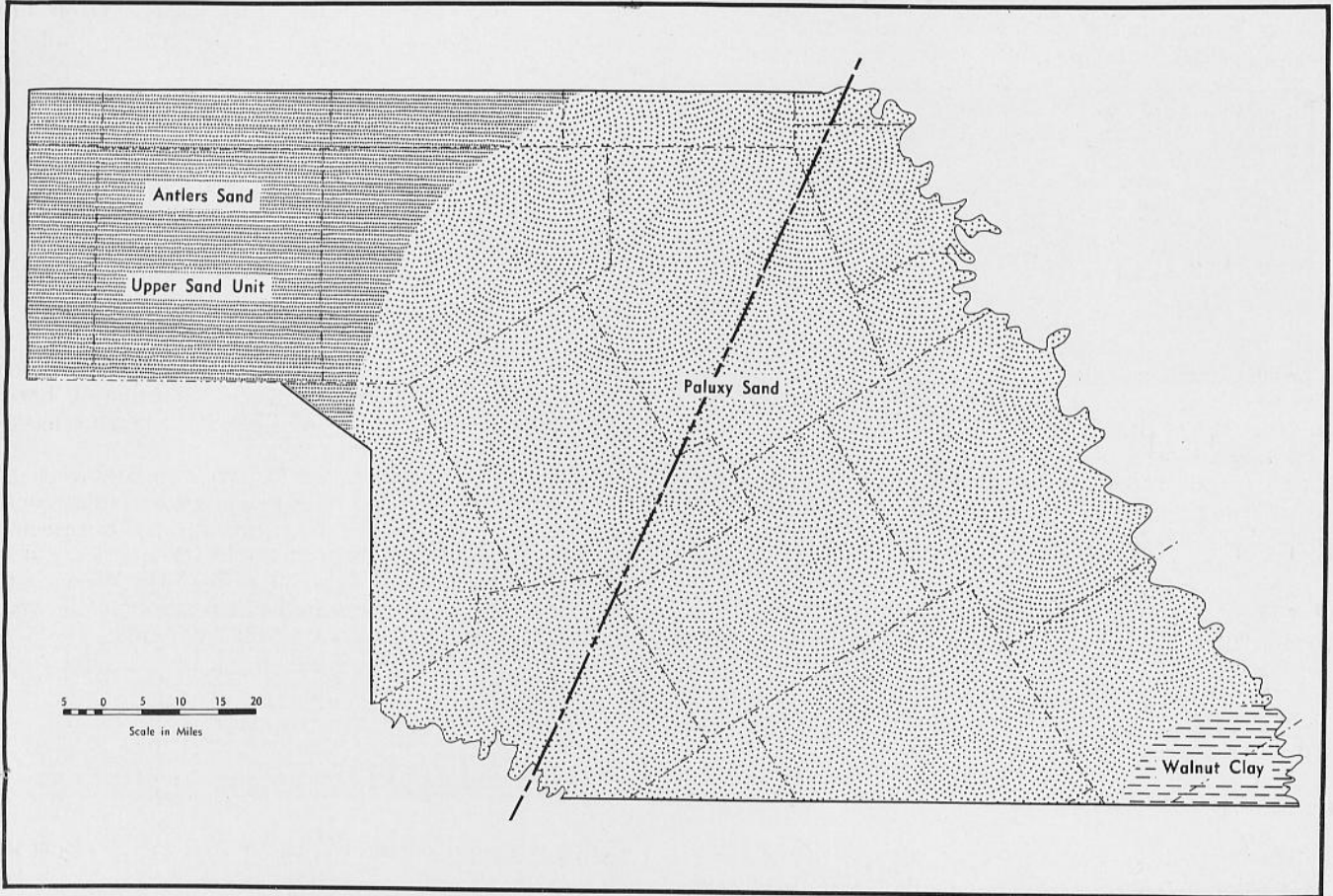


Fig. 39. Paluxy paleogeologic map.

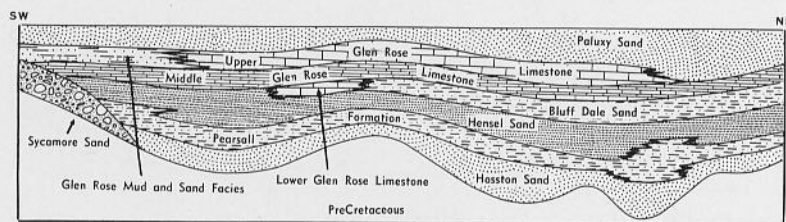


Fig. 40. Cross section, Paluxy time.

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 Comanche 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).

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APPENDIX I

MEASURED SECTIONS¹

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).
Muddy medium sandstone; immature orthoquartzite and muddy sandy pebble conglomerate; immature orthoquartzite; rust brown, cross-bedded; sand, 0.06-2.0 mm, median 0.25-0.50 mm, subround, poorly sorted; pebbles, 2-20 mm, median 6 mm, quartz and chert, quartz predominant, subround; 15 feet.
2. Sub-Cretaceous relief exposed on Jones Ranch 1.8 airline miles west of Oplin, Callahan County (lat 32°05'N; long 99°36'W). Relief on Wichita paleoplain (sub-Cretaceous surface) evident. Jones' house located on limestone (Paleozoic age) capped hill and to the west and 20 to 30 feet lower, stock tank is dug in basal Trinity sands.
3. Devil's Hollow 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 up the creek until reaching road and then along road to the south. From top of roadcut section offset 220 yards to the north and continues uphill. Total Antlers Sand section 201 feet.
Walnut Clay
Limestone, nodular, fossiliferous -----
Antlers Sand
Upper Sand Unit
12 Covered -----12.0
11 Sandy mud, red-brown to purple-red -----5.0
10 Argillaceous limestone, light gray weathers dark, indistinctly bedded, weathers blocky -----4.0
9 Mud, red-brown to purple-red -----4.5
8 Mudstone, yellow-brown, calcitic, indurated, medium to regular-bedded -----2.0
7 Sandy mud, gray-green to red-brown; sand 28.3 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted -----3.2
6 Muddy fine sandstone: immature orthoquartzite; yellow-brown, friable, compact, highly burrowed, burrows cemented; sand 52.6 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted -----3.5
5 Mud grading upward to sandy mud, red-brown and green, caliche present -----4.0
4 Muddy fine sandstone: immature orthoquartzite; gray, friable, compact; sand 53.1 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted -----3.0
3 Muddy very fine sandstone: immature orthoquartzite; yellow-brown to orange-brown, friable, compact; sand, 75 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted -----1.5
2 Covered; red sandy soil with blocks of thin-bedded, brown, calcitic, indurated mudstone -----13.0
1 Muddy fine sandstone: immature orthoquartzite; tan, massive-bedded, calcitic, indurated; sand range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted -----1.0
Total -----56.7
Redbed Unit
7 Covered; red-brown sandy soil with ferruginous sand nodules -----22.5
6 Muddy fine sandstone: immature orthoquartzite; red-brown weathers brown, thin-bedded, calcitic, indurated; sand range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted -----0.5
5 Covered -----4.0
4 Sandy mud with muddy fine sandstone (immature orthoquartzite) at base and capped by thin mudstone, with gray-green and pink, medium to massive-bedded; mudstone, calcitic, indurated, micro-cross-bedded; sand 40.6 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, moderately sorted; lower part finer sand and well sorted -----9.0
3 Covered -----6.0
2 Mudstone, pinkish purple weathers brown, calcitic, indurated, weathers blocky -----4.0
1 Covered; brownish pink sandy soil -----8.5
Total -----54.5
Lower Sand Unit
10 Fine sandstone: immature orthoquartzite; gray, thin- to medium-bedded, friable, compact; sand range 0.06-0.50 mm, median 0.12-0.25 mm, subround -----4.9
9 Muddy fine sandstone and interbedded muddy medium sandstone and sandy mud: immature orthoquartzite; red-brown, yellow-brown and green, thin- to medium-bedded, friable, compact; indurated, calcitic, muddy medium sandstone in lower part; sand 50.3 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately to poorly sorted -----26.5
8 Covered -----3.0
7 Fine sandstone: immature orthoquartzite; tan and light red-brown, friable, compact; sand 90 percent, range 0.06-0.25 mm, median 0.12-0.25 mm, subround, well sorted -----9.0
6 Muddy sandy pebble conglomerate: immature orthoquartzite; red-brown and brown; pebbles 32.8 percent, range 2-10 mm, median 5 mm, chert and quartz, chert predominate; sand 58.3 percent, range 0.06-2.0 mm, median 0.12-0.25 mm, subround, moderately sorted -----2.0
5 Fine sandstone with some slightly pebbly muddy sandstone: immature orthoquartzite; gray to tan, massive-bedded in lower parts becoming massively cross-bedded in upper parts, friable compact, pebbles occur as lenses or thin stringers, cross-beds in upper part consist of laminae of clay blebs and pebbles separating thin sands, cross-bedded medium occurs in lower third of unit; pebbles 2.5 percent, range 2-15 mm, median 4 mm, quartz and chert; sand 92.8 percent, range 0.06-2.0 mm, median 0.12-0.25 mm, subround, moderately sorted -----31.0
4 Muddy fine sandstone becoming sandy mud with pebbly muddy sandstone upward: immature orthoquartzite; gray, gray-green and red-brown, massive-bedded becoming medium-bedded and laminated in upper part, friable, compact, pebbly muddy sand occurs as lenses; pebbles, 10.8 percent, range 2-132 mm, median 5 mm, quartz and chert, quartz predominant; sand 49 percent, range 0.06-2 mm, median 0.12-0.25 mm, subround, moderately sorted; mud 51 percent -----14.0
3 Muddy sandy pebble conglomerate with interbedded slightly pebbly muddy medium sandstone: immature orthoquartzite; gray and brown, friable, compact with mud stringers at top; pebbles, 51.5 percent, range 2-64 mm, median 6 mm, quartz and chert, more quartz in lower part with more chert in upper; sand 40.5 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, moderately sorted; mud 8 percent -----13.0
2 Sandy mud, mottled yellow-brown and red-brown -----4.0
1 Sandy mud, reworked Pennsylvanian mud, mudstone absent -----2.0
Total -----109.4
Pennsylvanian
2 Sandy mud, mottled purple, yellow-brown and red-brown, thin-bedded, indurated mudstone -----4.0
1 Fine sandstone; calcitic, purplish gray, indurated, thin-bedded rib and furrow structure -----2.0
Total -----6.0
4. Basal Trinity sands exposed on top of hill south of Putnam and west of Farm Road 880, Callahan County (lat 32°22'N; long 99°12'W).
Sandy pebble conglomerate: opaline orthoquartzite; pebbles, range 2-75 mm, median 8 mm, chert and quartz, chert predominant.
5. Basal Trinity sands exposed on hilltop north of U. S. Highway 80, 6.7 airline miles west of Cisco, Eastland County (lat 32°22'N; long 99°05'W).
Pebble conglomerate: ferruginous orthoquartzite; pebbles, range 2-30 mm, median 5 mm, chert and quartz, chert predominant, sub-round.
6. Lake Cisco Conglomerate (Pennsylvanian) on west side of U. S. Highway 183, 2.1 miles south of Cisco, Eastland County (lat 32°21'N; long 98°58'W).
Medium sandstone; rust brown, cross-bedded, subround to sub-angular, about 10 feet thick; overlain by pebbly medium sandstone, cross-bedded, ferruginous, pebbles, median 16 mm, subround, chert, mud, and quartz.
7. Basal Trinity sands in cut on north side of State Highway 36 across from junction with Farm Road 583, Eastland County (lat 32°06'N; long 99°02'W).
Sandy mud, mottled tan and red-brown with thin, irregular, discontinuous, indurated, calcareous stringers of mudstone; total 8.0 feet.
8. Reworked basal Trinity sands on west side of State Highway 6, ¼ mile south of the Missouri-Kansas-Texas Railroad, Carbon, Eastland County (lat 32°16'N; long 98°49'W).
Fine sand, brown, cross-bedded, colian; 8.0 feet.
9. Basal Trinity sands exposed on east side of Farm Road 1852, 4.9 airline miles north-northwest of Morton Valley, Eastland County (lat 32°32'N; long 98°47'W).
Muddy fine sandstone and sandy muds with muddy pebbly sandstone: orthoquartzite; red-brown, green and yellow-brown, massive-bedded and cross-bedded, possible channeling; 60.0 feet.
10. Basal Trinity sands on east side of State Highway 6, 1.8 miles north of Punkin Center, Eastland County (lat 32°20'N; long 98°49'W).
Medium sandstone, sandy mud and sandy pebble conglomerate overlain by medium-bedded pebble conglomerate: opaline orthoquartzite; well-cemented; pebbles, range 2-35 mm, median 6 mm, chert and quartz; 10.0 feet.
11. Basal Trinity sands in cut of Farm Road 2689, ¼ mile south of Natches Creek, Eastland County (lat 32°16'N; long 98°41'W).
Interbedded pebble conglomerate, pebbly sandstone, sandy mud and sandstone: orthoquartzite; gray-green, purple, reddish tan and red-brown, sandstone and conglomerate, friable, compact; pebbles, range 6-102 mm, median 12 mm, chert with some quartzite.
12. Basal Trinity sands exposed in valley wall of Jim Neal Creek where county road descends, 5.4 airline miles south-southeast of Ranger, Eastland County (lat 32°24'N; long 98°39'W).
Valley wall capped by opal-cemented chert pebble conglomerate: orthoquartzite about 60.0 feet above creek bed; intervening interval consists of Pennsylvanian limestone followed by a covered interval and Cretaceous gray to dark red-brown sandstone, pebbly sandstone, sandy muds and muds.
13. Basal Trinity sands in creek bed north of county road between Desdemona and Davidson Cemetery, 0.6 miles northeast of Rattlesnake Mountain, Eastland County (lat 32°28'N; long 98°30'W).
Interbedded muddy sandstone and muddy granular sandstone: orthoquartzite; cross-bedded, friable, compact; pebbles, range 2-6 mm, median 2 mm, quartz and chert; sand, range 0.06-2.0 mm, subround.
14. Glen Rose Limestone, Bluff Dale Sand, and Hensel Sand exposed uphill along county road, 0.8 miles south of Rattlesnake Mountain and 6.3 airline miles north-northeast of Desdemona, Eastland County (lat 32°21'N; long 98°31'W).
Glen Rose Limestone
Limestone, light gray fossiliferous, separated by thin sand and mud -----5.5
Bluff Dale Sand
6 Mudstone, calcitic, yellow-brown, interbedded with gray-green mottled yellow-brown sandy mud becoming laminated upward -----7.0
5 Muddy fine sandstone, yellow-brown weathered light brown, friable, compact, becoming more muddy upward -----10.5
4 Arenaceous limestone, light brown, nodularly bedded, burrowed -----5.5

¹Refer to figure 2 for locations.

3	Sandy mud, yellow-brown to gray-green with yellow-brown indurated thin- to medium-bedded mudstone at base and top	21.0
2	Muddy fine sandstone, gray-green mottled yellow-brown	9.0
1	Muddy fine sandstone, calcitic, yellow-brown, irregularly thin- to medium-bedded, burrowed; sand, range 0.06-0.50 mm, median 0.12-0.25 mm.	4.0
	Total	57.0
Hensel Sand		
3	Sandy mud, greenish yellow to gray-green, with thin beds of laminated muddy fine-grained sandstone	2.0
2	Covered	19.0
1	Fine sandstone, gray weathers light brown, thin- to medium-bedded becoming massive upward, friable, compact; sand, range 0.06-0.5 mm, median 0.12-0.25 mm, subround, moderately sorted	18.0
	Total	39.0
15.	Twin Mountain section, Erath County (lat 32°23'N; long 98°26'W). Section measured on northeast side of Twin Mountain beginning in tributary of Salt Creek and continues up the bar ditch and hill on the north side of the road.	
	Thorp Spring Limestone	
	Limestone, gray fossiliferous	5.0
	Bluff Dale Sand	
5	Mud with indurated mudstone near middle, yellow-brown mottled gray, calcitic; mudstone, irregularly bedded	11.0
4	Sandy mud, gray to gray-green mottled yellow-brown; sand 15 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, well sorted	5.0
3	Muddy fine sandstone: immature orthoquartzite; mottled tan and brown, friable; sand 61 percent, range 0.06-0.50 mm, median 0.12-0.25 mm in lower part, 0.06-0.12 mm in upper part, subround, well sorted in lower part, moderately sorted in upper	20.0
2	Sandy mud, gray, sand 38.8 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted	6.0
1	Sandy mud with mud at top, gray-green, mottled gray-green and purplish red-brown, and reddish purple; sand 20 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted	28.0
	Total	70.0
Hensel Sand		
2	Sandy mud becoming mud upward, green and gray-green; sand 25 percent, range 0.06-2.0 mm, median 0.25-0.50 mm in lower sandy mud, 0.06-0.12 mm in upper mud, subround, moderately sorted in lower, well sorted in upper; muscovite in upper part	4.0
1	Muddy medium sandstone and medium sandstone with muddy sandy pebble conglomerate lenses at base: immature orthoquartzite; granular medium sand in middle part; gray weathers tan, cross-bedded, green sandy mud blebs and stringers concentrated in lower part; pebbles, range 2-20 mm, median 6 mm, chert and quartz, chert predominant; sand 83.4 percent, range 0.12-2.0 mm, median 0.25-0.50 mm, subround, poorly sorted in lower part, moderately sorted in upper	15.0
	Total	19.0
Pearsall Formation		
	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, well sorted in lower part, moderately to well sorted in upper part; trace of muscovite and chlorite in lower part	15.0
Hosston Sand		
11	Slightly pebbly muddy medium sand: immature orthoquartzite; tan, green and yellow-brown, friable, compact, interbedded sandstone and sandy mud; sand, 77.7 percent, range 0.12-1.0 mm, median 0.25-0.50 mm, subround, moderately sorted	2.3
10	Covered	6.0
9	Medium sandstone: siliceous submature orthoquartzite; with sandy mud at base, light brown; cross-bedded in upper half; sand 96 percent, range 0.06-1.0 mm, median 0.25-0.50 mm, subround, moderately to well sorted	7.0
8	Covered	1.5
7	Muddy fine sandstone: immature orthoquartzite; with interbedded calcitic, indurated thin-bedded gray and green mottled yellow-brown sandstone, efflorescent, lower part contains siliceous sandstone bodies similar to underlying sandstone; sand 68 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately to well sorted, sandstone ledges poorly sorted	3.5
6	Slightly pebbly muddy medium sandstone: siliceous immature orthoquartzite; gray weathers light brown; flow cast trend easterly; micro-cross-bedded, pyrite nodules	2.0
5	Sandy mud becoming slightly pebbly fine sand upward, green mottled yellow-brown and gray, friable, compact; sand 66.3 percent, range 0.12-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted; calcite rhombs in lower part	4.5
4	Sandy mud, red-brown mottled yellow-brown, calcite and calcitic indurated sand nodules; sand 19 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted; calcite rhombs	4.0
3	Sandy mud, green mottled yellow-brown and red-brown, lower part very sandy and ferruginous, upper part contains calcite nodules and pyrite; sand 15.2 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted; trace muscovite in lower part	4.5
2	Fine sandstone becoming muddy fine sandstone at top: immature orthoquartzite; tan, laminated in middle part, ferruginous nodules and lenses in lower and middle parts, green sandy mud laminae, lenses and blebs in middle and upper parts, calcitic sand nodules in middle part; sand 92.3 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted; muscovite in lower part	15.0
1	Muddy fine sandstone, fine sandstone and sandy mud interbedded, brown, yellow-brown, gray and green, thin- to medium-bedded, calcitic, friable to partly cemented, ferruginous nodules and lenses in lower sandstone, green sandy mud blebs and pyrite nodules in upper sandstone; sand 61.4 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted, muscovite in lower part	7.0
	Total	57.3
Pennsylvanian		
	Sandstone, brownish-green, thin-bedded, ripple marks overlain by thin- to medium-bedded gray conglomerate limestone; pebbles, range 2-5 mm, median 2 mm, limestone and calcareous mudstone, green clay blebs.	
16.	Pennsylvanian-Cretaceous contact exposed on county road just west of Barton Creek and 3.8 airline miles north-northwest of Hannibal, Erath County (lat 32°25'N; long 98°22'W).	
	Pennsylvanian-Cretaceous contact; thick-bedded Pennsylvanian sandstone overlain by micro-cross-bedded Trinity sandstone.	
17.	Basal Trinity sands in bank of Hannibal Creek 0.5 miles west of Hannibal, Erath County (lat 32°22'N; long 98°20'W). Chert pebble conglomerate and gravelly medium- to coarse-grained sand; orthoquartzite; tan to red-brown, friable, compact; 10.0 to 15.0 feet thick.	
18.	Pennsylvanian-Cretaceous contact on south side of Farm Road 1715, 200 yards west of Lost Creek, Erath County (lat 32°26'N; long 98°17'W).	
	Pennsylvanian, red-brown mud, 15.0 feet thick; overlain by Trinity, muddy sandstone and sandstone, gray-green and tan weathered rust brown; calcitic, friable, compact, sandstone lenticular with micro-cross-bedding.	
19.	Pennsylvanian-Cretaceous contact about ¼ the way up the hill on both sides of the road; 2.4 airline miles west-southwest of Patilo and 7.1 airline miles north-northwest of Morgan Mill, Erath County (lat 32°29'N; long 98°13'W).	
	Pennsylvanian red-brown muds and thin-bedded mudstone overlain by Trinity pebbly sandstone and muds, pebbles mainly chert.	
20.	Bluff Dale Sand and Thorp Spring Limestone in cut on Farm Road 1715, 3.0 airline miles northwest of Morgan Mill, Erath County (lat 32°25'N; long 98°12'W).	
	Sandstone and muddy sandstone: orthoquartzite; tan to gray overlain by fossiliferous, thin-bedded limestone, total 10.0 feet thick.	
21.	Basal Trinity sands between Bee Dee Creek and county road, 2.8 airline miles north of Morgan Mill, Erath County (lat 32°26'N; long 98°10'W).	
	Chert pebble conglomerate overlain by medium-grained sand; orthoquartzite; sandy mud and mud, white and red-brown; sand contains fossilized wood and iron concretions; 55.0 feet.	
22.	Pennsylvanian-Cretaceous contact on south side of county road, 1.5 airline miles northwest of the junction of State Highway 4 and Farm Road 1543, Hood County (lat 32°32'N; long 98°00'W).	
	Dark red-brown Pennsylvanian mud overlain by gray and gray-green Trinity muds and muddy sandstone.	
23.	Pennsylvanian-Cretaceous contact and lower 20 feet of Hosston Sand exposed in bluff on east side of Walter's Branch 50 yards south of Farm Road 1543 and 1.1 airline miles northeast of Allison Cemetery, Hood County (lat 32°33'N; long 97°57'W).	
	Hosston Sand	
5	Muddy sandy conglomerate: immature orthoquartzite; rust brown; gravel, 2-20 mm, median 6 mm, quartz and chert, quartz predominant, subround; sand, 0.12-2.0 mm, median 0.25-0.50 mm, subround	3.0
4	Fine sandstone: mature orthoquartzite; light brown weathered rust brown; sand, range 0.62-1.0 mm, median 0.12-0.25 mm, subround, well sorted	5.0
3	Fine sandstone and pebbly medium sandstone: submature orthoquartzite; tan, indistinct bedding, friable, compact; fine sandstone; sand, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted; pebbly medium sandstone; pebbles, range 2-10 mm, median 6 mm, chert and quartz, chert predominant; sand, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, poorly sorted	2.5
2	Sandy mud; green, with nodular calcite zone 2 feet above conglomerate, becoming muddy sandstone at top	4.5
1	Clay pebble conglomerate; red-brown, indurated; clay pebble conglomerate probably due to reworking of underlying Pennsylvanian mud by transgressing Cretaceous sea	1.5
	Total	16.5
Pennsylvanian		
	Mud, red-brown	18.0
24.	Basal Trinity sands exposed at Conway Bluff on the Brazos River, Parker County (lat 32°34'N; long 97°52'W). Red-brown sandy mud, gray mud and white fine-grained, friable, compact sandstone: orthoquartzite; fossiliferous logs up to 1½ feet in diameter and several feet long found throughout; about 50 feet below the Thorp Spring Limestone.	
25.	Bluff Dale Sand on west side of county road, 0.15 miles south of Hightower Bridge across the Brazos River, Parker County (lat 32°34'N; long 97°49'W). Varicolored to buff muds and red-brown thin-bedded, burrowed sandstone.	
26.	Thorp Spring Limestone on east side of county road, 0.45 miles south of Hightower Bridge across the Brazos River, Parker County (lat 32°34'N; long 97°49'W). Thick-bedded fossiliferous limestone; abundant rudistids and pelecypods; 8.0 feet thick.	
27.	Thorp Spring Limestone, Bluff Dale Sand, and Hensel Sand exposed along Farm Road for 0.5 miles south of Robinson Creek, Hood County (lat 32°30'N; long 97°51'W).	
	Thorp Spring Limestone	5.0
	Limestone, gray, fossiliferous massive	5.0
	Bluff Dale Sand	
	Alternating thin beds of sandstone and sandy mud, yellow-brown to gray, fossiliferous in part	40.0
	Hensel Sand	
	Interbedded sandstone and sandy mud, gray-green to yellow-brown, cross-bedded in part	50.0

28. Bluff Dale Sand and Thorp Spring Limestone in west bank of Brazos River southeast of the junction of U. S. Highway 377 and State Highway 144, Hood County (lat 32°26'N; long 97°48'W). Bluff Dale Sand, gray-green to gray muds and tan sandstone overlain by massive rudistid-bearing Thorp Spring Limestone; total of 40.0 feet.	7 Covered -----	18.5
29. Bluff Dale Sand and Thorp Spring Limestone 175 yards northeast of the Paluxy River on the north side of Farm Road 204, Hood County (lat 32°16'N; long 97°54'W). Sandstone, gray to yellow-brown, fine-grained, burrowed in part, muddy sands, muds, and a thin lenticular limestone; <i>Ostrea</i> fragments found near base; overlain by gray nodular to massive-bedded Thorp Spring Limestone; total of 30.0 feet.	6 Fine sandstone: immature orthoquartzite; gray and orange-brown, irregular-bedded, friable, compact, green sandy mud blebs; sand 92.8 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted -----	3.5
30. Glen Rose Formation at top of hill 0.4 miles south of Armstrong Creek on State Highway 6, Comanche County (lat 32°06'N; long 98°28'W). Fossiliferous limestone, contains poorly preserved oyster shells, wood fragments, and iron stone concretion; some wood fragments replaced by iron.	5 Covered -----	27.5
31. Pennsylvanian-Cretaceous contact and basal Trinity sands exposed in road cut in the north wall of the Sabana River, 175 yards northeast of the river and 4.5 airline miles south-southwest of DeLeon, Comanche County (lat 32°02'N; long 98°34'W). Total section is 30+ feet.	4 Fine sandstone: supermature orthoquartzite; gray weathers brown, thick-bedded, calcitic, friable, compact; sand 98 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, well sorted -----	4.0
Hensel Sand	3 Medium sandstone becoming sandy mud upward: immature orthoquartzite; gray, cross-bedded, thin sandy mud stringers and blebs, medium-grained sand and coarse-grained sand laminated, sand 68.1 percent, range 0.06-2.0 mm, median 0.25-0.50 mm in medium sandstone with 0.06-2.0 mm in sandy mud, round in medium sandstone, subround in sandy mud, moderately sorted -----	4.7
2 Muddy sandstone, red-brown, range 0.06-1.0 mm, median 0.25-0.50 mm, subround, moderately sorted, with some fine-grained micro-cross-bedded sandstone.	2 Covered -----	4.5
1 Sandy pebble conglomerate, overlying the red-brown sandy mud laterally from the channel (?), pebbles, 2-24 mm, median 4 mm, limestone, quartz and chert with some green clay blebs, limestone predominant.	1 Muddy fine sandstone becoming very fine sandstone in upper part: immature orthoquartzite; light brown weathers brown and gray, irregular thin- to medium-bedded becoming thin-bedded in upper part, calcitic, friable, compact, partly cemented, green sandy mud blebs in lower part; sand 91 percent, range 0.06-0.50 mm, median 0.12-0.25 mm becoming 0.06-0.12 mm, in upper part, subround, moderately sorted; glauconite and chlorite in minor amounts -----	11.5
Pearsall Formation	Total -----	86.2
Sandy mud, red-brown, part of sandy mud replaced by cut and fill sand channel (?). Channel (?); pebbly sandstone, yellow-brown weathered brown, cross-bedded; pebbles, 2-8 mm, median 4 mm, quartz and chert with some green clay blebs, quartz predominant.	35-E (lat 31°56'N; long 98°43'W)	
Hosston Sand	Hensel Sand	
Sandy pebble conglomerate, calcitic, gray; pebbles 2-300 mm, median 8 mm, sand, 0.12-2.0 mm, median 0.25-0.50 mm, subround, moderately sorted.	5 Fine sandstone: submature orthoquartzite; gray, medium- to thick-bedded; lower part coarse-grained and calcitic; sand 98.2 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted -----	11.0
Pennsylvanian	4 Muddy fine sandstone: immature orthoquartzite; yellow-brown, irregular, indurated, weathers honeycombed; sand, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted -----	2.0
Sandstone and siltstone, multicolored (maroon, light green and brown) thin-bedded; angular contact with overlying Cretaceous.	3 Muddy fine sandstone: immature orthoquartzite; gray, massive-bedded small calcitic, indurated sandy mudstone nodules; yellow-brown muddy sand blebs at top; sand 74.1 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, poorly sorted; fossiliferous fragments, chlorite and glauconite -----	3.0
32. Basal Trinity sands and Quarternary river gravel on south side of State Highway 377 west of the Leon River, Comanche County (lat 31°57'N; long 98°28'W). Red-brown mud overlapped from west by mottled gray-green, red-brown and white mud with some sandstone and tan, fine-grained, well sorted, subround, friable, compact sandstone; overlain by reddish brown, medium-grained, well sorted, friable, compact, sand; top of cut Quarternary gravel.	2 Covered -----	10.0
33. Basal Trinity sands and Glen Rose Limestone in bar ditch on southeast side of Duncan Creek, 2.6 airline miles northwest of junction of State Highway 36 and Farm Road 1689 and 5.5 airline miles east-southeast of Sidney, Comanche County (lat 31°55'N; long 98°39'W). Sandy mud, dark red-brown and green-gray, overlain by Glen Rose yellow-brown, calcareous mudstone and thin-bedded fossiliferous limestone; 30.0 to 35.0 feet.	1 Muddy fine sandstone: immature orthoquartzite; gray weathers brown, thick-bedded; lenses of green sandy mud at top; sand 88.8 percent, range 0.06-0.25 mm, median 0.12-0.25 mm, subround, well sorted; muscovite and chlorite -----	4.0
34. Paluxy Sand and Walnut Clay exposed in cut on U. S. Highway 377, 4.6 airline miles southwest of Comanche, Comanche County (lat 31°53'N; long 98°40'W). Walnut Clay	Total -----	30.0
Limestone, thin-bedded, nodular, fossiliferous with a 6 inch bed of fossil hash at base -----	35-D (lat 31°56'N; long 98°42'W)	
Paluxy Sand	Hensel Sand	
Fine sandstone and muddy sandstone: mature orthoquartzite; tan, evenly-bedded, cut by cut and fill sand channels -----	4 Medium sandstone: submature orthoquartzite; brown, medium irregular-bedded, calcitic, partly indurated; sand 96.9 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, poorly sorted -----	2.5
Total -----	3 Muddy fine sandstone: immature orthoquartzite; green mottled yellow-brown; calcitic, indurated mudstone nodules; caliche; sand 75 percent, range 0.12-0.50 mm, median 0.12-0.25 mm, subround, well sorted; glauconite rare -----	3.7
35.* Round Mountain section, Comanche County (lat 31°56'N; long 98°42'W). Measured along Sweetwater Creek and Farm Road 1689, west and south of Round Mountain. Total basal Trinity sands section is 140.0 feet.	2 Sandy mudstone, yellow-brown, thick irregular-bedded, calcitic, indurated, crystalline calcite fills small vugs, at base 6 inches green sandy mud -----	6.0
35-F (lat 31°57'N; long 98°43'W)	1 Sandstone: submature orthoquartzite; tan to gray weathers tan, massive cross-bedded, friable, compact, green sandy mud stringers and blebs concentrated along cross-beds; sand 96.8 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately to well sorted; muscovite occurs in lower part -----	7.0
Glen Rose Limestone	Total -----	19.2
4 Interbedded mud, mudstone, sand mud, muddy sandstone, sandstone, calcareous sandstone, arenaceous limestone biomicrite and biosparite, gray, green, yellow-brown and olive drab -----	35-C (lat 31°57'N; long 98°42'W)	
3 Biomicrite, overlain by biosparite, gray, thin-bedded in lower part, medium-bedded in upper part -----	Hensel Sand	
2 Mud, gray and yellow-brown, fossiliferous, caliche -----	4 Sandstone, yellow-brown, calcitic, indurated, pinches out laterally -----	1.5
1 Mudstone, yellow-brown, calcitic, indurated fossiliferous -----	3 Fine sandstone: immature orthoquartzite; gray to tan, massive, friable, compact, green sandy mud stringers and blebs; sand, median 0.12-0.25 mm, subround, moderately sorted -----	20.5
Total -----	2 Sandy mud, green -----	2.0
87.8	1 Sandy mud, red-brown -----	4.0
Bluff Dale Sand	Total -----	28.0
Sandy mud with muddy medium sandstone at top: immature orthoquartzite; gray, olive drab, and yellow-brown, calcitic, indurated calcitic nodules in lower part, caliche in upper part; sand 48.8 percent, range 0.06-1.0 mm, median 0.06-0.12 mm in sandy mud, 0.25-0.50 mm in muddy sand, subround, moderately sorted -----	35-B (offset from 35-A 100 yards upstream)	
Hensel Sand	Hensel Sand (?)	
8 Fine sandstone with interbedded sandy mud and muddy fine sandstone: immature orthoquartzite; gray and green, thin irregular-bedded in lower part, massive indistinct cross-bedded upward, calcitic, friable, compact, pyrite nodules and crystals, burrowed, efflorescent, caliche in sandy mud, ferruginous calcitic nodules in upper part; sand 81 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, well sorted; muscovite in middle part -----	Muddy sandy pebble conglomerate: immature orthoquartzite; gray, calcitic, indurated, channel; pebbles, range 2-20 mm, median 6 mm, chert and quartz, subround; sand, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted -----	7.0
Total -----	35-A (lat 31°57'N; long 98°41'W)	
12.0	Hensel Sand	
	5 Sandy pebble conglomerate: immature orthoquartzite; yellow-brown, calcitic; pebbles, range 4-32 mm, median 16-32 mm, limestone -----	5.0
	4 Muddy medium sandstone: immature orthoquartzite; with trace of pebbles, yellow-brown, calcitic, friable to partly cemented, caliche nodules, sand 68.6 percent, range 0.06-1.0 mm, median 0.25-0.50 mm, subround, moderately sorted; pebbles, range 8-12 mm, weathered chert -----	0.5
	3 Fine sandstone: submature to mature orthoquartzite; gray weathers light brown, massive cross-bedded, friable, compact, green sandy mud blebs concentrated in middle part, sand 95 percent range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted becoming well sorted upward -----	6.0

- 2 Muddy very fine sandstone: immature orthoquartzite; yellow-brown, green, red-brown, indurated calcitic mudstone nodules (3 in.) in lower part; sand 52.3 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted; trace chlorite -----1.5
- 1 Fine sandstone: immature orthoquartzite; gray weathers light brown, massive cross-bedded, green sandy mud blebs and stringers, friable, compact; sand, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, moderately sorted, muscovite rare -----3.0
- Total -----16.0
- Pearsall Formation -----6.0
- 2 Covered -----6.0
- 1 Sandy mud with pebbly mud at top; dark red-brown mottled green and gray with green at top, becomes more sandy upward, sandy mud, sand, 39.5 percent, range 0.06-1.0 mm, median 0.25-0.50 mm, subround, poorly sorted; pebbly mud, 19.5 percent pebbles, range 2-8 mm, median 4 mm, quartz and chert, quartz predominant, 31.5 percent sand, range 0.06-1.0 mm, median 0.25-0.50 mm, subround, poorly sorted, 49 percent mud -----11.5
- Total -----17.5
- Hosston Sand
- Sandy pebble conglomerate at base overlain by interbedded muddy pebbly sandstone and sandy pebbly mud: immature orthoquartzite; gray, green, and red-brown, sandy pebble conglomerate and muddy pebbly sandstone are micro-cross-bedded and contain green sandy mud blebs; muddy pebbly sandstone occurs as irregular lenses in the sandy pebbly mud; pebbles, 23 percent, range 2-20 mm, median 6 mm, chert and quartz, chert predominant; sand, 53 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, moderately to poorly sorted, mud 24 percent -----5.5
- Pennsylvanian
- Sandstone, light green, indurated, thin-bedded, jointed, ripple marks from angular unconformity with overlying Cretaceous.
36. Hensel Sand in bed of Stagg Creek south of Farm Road 1689 and in cut on each side of the road to the southeast; 3.7 airline miles northwest of Sidney, Comanche County (lat 31°58'N; long 98°47'W).
- Medium sandstone: orthoquartzite; light tan weathered darker, thin to medium cross-bedded, subround to subangular, well sorted, friable, compact, followed by mottled green and red sandy mud; 45.0 to 50.0 feet.
37. Glen Rose Formation in south bank of Pleasant Creek east of U. S. Highway 183, 3.9 miles south of May, Brown County (lat 31°55'N; long 98°55'W).
- Very fine sandstone: orthoquartzite; friable, compact at base overlain by interbedded muds and indurated fine-grained sandstone; burrowed and both sandstone and muds fossiliferous; total of 30 feet.
38. Glen Rose Limestone road cut on Farm Road 1467, 250 yards east of its intersection with U. S. Highway 183, Brown County (lat 31°52'N; long 98°55'W).
- Fine sandstone, sandy mud and mud with 1 foot of indurated light yellow-brown calcitic burrowed sandy mud with arenaceous micrite nodules 50-140 mm in diameter; sand, 0.06-1.0 mm, median 0.12-0.25 mm; pelecypod, gastropod, and vertebrate fossils in upper 2/3 of cut; 11.0 feet of section, approximately 35.0 feet above Pennsylvanian-Cretaceous contact.
39. Glen Rose Limestone and Paluxy Sand (?) exposed in series of road cuts on Farm Road 1467, 3.4 airline miles east of U. S. Highway 183, beginning at county road going south, Brown County (lat 31°52'N; long 98°52'W).
- Interbedded sandy mud, indurated calcareous mudstone, thin-bedded calcareous sandstone, and friable sandstone, yellow-brown, gray and green-gray; sting ray and turtle remains, pelecypods and gastropods occur in lower and upper thirds; friable, compact, fine-grained sandstone occurs in the middle third of the section, apparently interfingering with the more calcareous parts of the section, base of section 10.0 feet above sandy mud with arenaceous micrite nodules at locality 38.
40. Paluxy Sand and Walnut Clay on the north side of Salt Mountain, 175 yards east of where Salt Creek crosses Farm Road 1467, Brown County (lat 31°52'N; long 98°50'W). Total section is 20+ feet.
- Walnut Clay
- Limestone, thin irregular-bedded, fossiliferous; base of Walnut Clay thin reworked fossil zone.
- Paluxy Sand
- Medium sandstone: mature orthoquartzite; white, cross-bedded, friable, compact sandstone with gray-green mud and sandstone near top; sand, median 0.25-0.50 mm, subround, well sorted.
41. Paluxy Sand and Walnut Clay on south side of U. S. Highway 377, 8.1 miles northeast of Early, Brown County (lat 31°48'N; long 98°49'W). Total section is 20+ feet.
- Walnut Clay
- Limestone, thin-bedded Walnut limestone with reworked fossil zone at base.
- Paluxy Sand
- Medium sandstone: submature orthoquartzite; lower part of exposure is channel trending south-southwest; sands fine to medium-grained, light gray to brown, subround, friable, compact, and cross-bedded; some show a bimodal sorting in very fine- and medium-grained ranges; pyrite concretions with wood fragments as center present; above the channel relatively horizontal sandstone.
42. Glen Rose Formation on south side of U. S. Highway 377, 6.1 miles northeast of Early, Brown County (lat 31°47'N; long 98°51'W).
- Biomirite, gray, thin-bedded, with placers (coquina) of pelecypod fragments; biomirite contains fecal pellets (?) and filled burrows; both above and below limestone occur gray-green to yellow-brown fossiliferous and non-fossiliferous muds and mudstones; total of 20.0 to 25.0 feet.
43. Watkin's Ranch section, Brown County (lat 31°44'N; long 98°52'W). Section begins in wall of stock tank 0.2 mile north of barn and continues uphill 0.1 mile northeast of barn.
- Sycamore Sand
- 15 Slightly pebbly arenaceous limestone, gray, massive-bedded becoming irregularly medium-bedded toward top, pebbles concentrated in upper part; pebbles range 2-10 mm, median 6 mm, round limestone -----16.0
- 14 Coarse sandstone: immature orthoquartzite; brown, calcitic, poorly cemented; sand 93.9 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, moderately sorted; quartzite and vein quartz fragments -----1.0
- 13 Covered -----8.0
- 12 Sandy mud becoming fine sandstone (calcitic immature orthoquartzite) upward; yellow-brown; sand 43.8 percent near base to 52.8 percent near top, range 0.06-1.0 mm, median 0.12-0.25 mm; calcite rhombs and glauconite; few gastropods in upper part; quartzite and vein quartz fragments in lower part -----21.5
- 11 Sandy mud, red-brown mottled yellow-brown, calcitic; sand 33.7 percent near base to 22.7 percent near top, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, some coarse sand grains well rounded and frosted, quartzite and vein quartz fragments found near top; calcitic rhombs and glauconite; forams rare -----16.0
- 10 Pebble arenaceous limestone, gray irregular-bedded; pebbles, range 2-64 mm, median 6 mm, chert, limestone, and calcareous mudstone -----4.5
- 9 Slightly granular muddy fine sandstone: calcitic immature orthoquartzite; yellow-brown, indurated, medium-bedded; pebbles range 2-8 mm, median 4 mm, chert, subround; sand, range 0.06-2.0 mm, median 0.12-0.25 mm, subround; calcite rhombs and glauconite -----2.0
- 8 Slightly pebbly muddy fine sandstone: immature orthoquartzite; light brown mottled gray-green and red-brown, indistinct-bedded weathers blocky, pebbles concentrated near top; pebbles, range 2-40 mm, median 6 mm, chert; sand range 0.06-0.50 mm, median 0.12-0.25 mm; calcite rhombs and glauconite -----2.0
- 7 Sandy mud, red-brown becoming mottled upward, calcitic; sand, 35.9 percent, range 0.06-0.5 mm, median 0.12-0.25 mm, subround; calcareous rhombs and glauconite -----3.0
- 6 Muddy fine sandstone: immature orthoquartzite; red-brown, calcitic, friable, compact to poorly cemented, poorly bedded weathers blocky, upward alternates between indurated and non-indurated beds; indurated beds more sandy; sand, range 0.06-0.50 mm, median 0.12-0.25 mm, subround, calcite rhombs and glauconite -----8.0
- 5 Muddy fine sandstone: calcitic immature orthoquartzite; yellow-brown weathers dark green to red-brown, friable, compact, irregular-bedded; sand 89 percent, range 0.06-0.50 mm, median 0.12-0.25 mm, subround; calcite rhombs and glauconite -----6.0
- 4 Covered -----6.0
- 3 Sandy mud; red-brown, calcitic -----2.0
- 2 Muddy fine sandstone: calcitic immature orthoquartzite; light red-brown mottled gray-green; sand, 65.4 percent, range 0.06-0.50 mm, median 0.06-0.12 mm, subround, moderately sorted; muscovite and glauconite in minor amounts -----2.0
- 1 Sandy mud, yellow-brown mottled gray-green and red-brown, calcitic; sand, 32.8 percent, range 0.06-1.0 mm, median 0.06-0.12 mm subround; muscovite and glauconite in minor amounts -----1.0
- Total -----99.0
- Pennsylvanian
- Mud, purple -----5.0
44. Sycamore sand and Glen Rose Formation (?) in bluff on south side of Gulf Colorado and Santa Fe Railway, 2.0 airline miles east-south-east of the junction of the Gulf Colorado and Santa Fe Railway overpass of U. S. Highway 183, Brown County (lat 31°43'N; long 98°56'W).
- Sandy calcareous mudstone, mottled reddish brown and yellowish tan, weathered gray, followed by arenaceous (Cretaceous Glen Rose ?) limestone; total about 30.0 feet.
45. Glen Rose Formation (?) on county road 4.0 miles west of Zephyr and 6.1 miles southeast of the junction of U. S. Highway 377 and U. S. Highway 84 in Early, Brown County (lat 31°42'N; long 98°51'W).
- Micrite with sparite and pisolitic-filled crevice; believed to be Glen Rose altered by subaerial weathering.
46. Upper part of Sycamore Sand exposed in gully and up the hill, 0.22 miles southeast of stock tank on Lamkin's Ranch. Tank southwest of Williams Ranch Road, 21.1 airline miles due west of Zephyr, Brown County (lat 31°41'N; long 98°53'W).
- Red-brown sandy mud in lower part, green and red-brown fine sandstone with some pebbly sandstone in upper part, hill capped by arenaceous limestone; 50.0 feet.
47. Pennsylvanian-Cretaceous contact and basal Trinity sands along U. S. Highway 377, 0.5 to 1.2 miles southwest from its junction with Farm Road 45, Brown County (lat 31°59'N; long 99°00'W).
- Muds, sandy muds and sandstone: immature orthoquartzite; red-brown and gray-green with caliche zone at base overlying Pennsylvanian Winchell (?) limestone. South about 0.6 mile and on east side of road is a sand-filled channel cut in red-brown and gray-green sandstone and muds.
48. Pennsylvanian-Cretaceous contact and Sycamore Sand exposed on north face of Cretaceous outlier 0.8 mile south-southwest of Brownwood Country Club, Brown County (lat 31°38'N; long 98°49'W).
- Sycamore Sand
- Interbedded muddy fine to medium sandstone: immature orthoquartzite; sandy mud, with some muddy pebbly sandstone, calcitic, friable, red-brown with yellow-brown and green; pebbles 4-150 mm, median 8-32 mm, quartzite, quartz, limestone, calcareous sandstone and calcareous mudstone; caliche nodules occur at several horizons -----75.0

- Pennsylvanian
Mudstone brown calcitic, fossiliferous (brachiopods, bryozoa, fusulinids, and crinoids).
49. Glen Rose Formation (?) on west side of road 5 yards south of creek and 0.7 mile south of Zephyr, Brown County (lat 31°40'N; long 98°47'W).
Limestone; gray, thin to medium wavy-bedded; about 1½ feet thick; overlain by alternating irregular-bedded, indurated gray calcareous sandstone and friable, compact, greenish sandstone.
 50. Sycamore Sand exposed north of county road, 1 mile west of locality 51 (lat 31°37'N; long 98°49'W).
Muddy sandy conglomerate: calcitic immature orthoquartzite; pebbles; range 2-20 mm, median 5 mm, subround to round; quartz and chert with minor amounts of limestone; overlain by cross-bedded sandstone.
 51. Sycamore Sand on east side of county road, 5.1 airline miles south of Zephyr and 10.3 airline miles southeast of the junction of Farm Road 2126 with Farm Road 2525, Brown County (lat 31°36'N; 98°45'W).
Sandstone: immature orthoquartzite; red-brown mottled gray and tan; fine- to medium-grained, subangular to subround, poorly sorted, indurated, calcareous; surface weathered irregularly; upper part sandy mud and burrowed; overlain by mudstone, light gray weathered dark, thin (1½ to 6 in.), irregular-bedded, indurated, slightly calcareous; undulate contact with underlying sandy mud.
 52. Glen Rose Formation exposed along Pompey Creek, 5.7 airline miles north of Mullin and 0.5 to 1.5 miles west of Farm Road 573, Mills County (lat 31°38'N; long 98°40'W).
Glen Rose consists of fossiliferous muds, mudstones and limestone; selenite geodes and nodules found in lower part; 80.0 to 90.0 feet.
 53. Channel in Sycamore Sand exposed in bed of Pompey Creek at U. S. Highway 84, 4.75 miles northwest of Mullin, Mills County (lat 31°37'N; long 98°42'W).
Muddy sandstone and muddy pebbly sandstone: calcitic immature orthoquartzite; cross-bedded, friable; pebbles, range 4-20 mm, median 6 mm, chert, subround; sand, range 0.06-2.0 mm, median 0.5-1.0 mm, subround, poorly sorted; gravel concentrated in lenses; channel trends to the southwest; approximately 60.0 feet below Glen Rose Limestone.
 54. Sycamore Sand in roadcut on Farm Road 573, 4.7 airline miles southwest of Mullin, Mills County (lat 31°31'N; long 98°44'W).
Sandy pebble conglomerate: calcitic immature orthoquartzite; well cemented; pebbles, 2-256 mm, median 16-32 mm, limestone, calcareous sandstone, calcareous mudstone and some quartz; sand, range 0.12-1.0 mm, median 0.25-0.50 mm, subround; 10.0 feet.
 55. Sycamore Sand exposed in road cut across from Oakview Cemetery, Mullin, Mills County (lat 31°33'N; long 98°40'W).
Muddy sandstone with lenses of sandy pebble conglomerate; immature orthoquartzite; red-brown; pebbles, range 2-32 mm, median 8-16 mm; caliche nodules abundant in sandstone.
 56. Glen Rose Formation on west side of Farm Road 573, 75 yards north of its junction with U. S. Highway 84 and U. S. Highway 183, Mills County (lat 31°34'N; long 98°39'W).
Limestone, gray medium-bedded, containing chert nodules up to 5 inches diameter; total about 2.0 feet.
 57. Glen Rose Formation northeast of the junction of U. S. Highway 84 with Farm Road 1029, Mills County (lat 31°32'N; long 98°35'W).
Very fine sandstone, arenaceous limestone, mudstone and muds.
 58. Pennsylvanian and Sycamore Sand exposed on south side of Farm Road 574, 6.0 airline miles west of its junction with U. S. Highway 183, Mills County (lat 31°27'N; long 98°40'W).
Pennsylvanian mud and thin-bedded mudstone overlain by Sycamore Sand; sandy pebble conglomerate: calcitic, submature, calcithite (?); thin to medium, irregular-bedded; 8-32 mm, median 5 mm, limestone and chert, limestone predominant; sand, range 0.125-1.0 mm, median 0.25-0.50 mm; some beds show weak graded bedding; 4.0 feet.
 59. Paluxy Sand and Walnut Clay on south side of Farm Road 574, about 1.3 miles west of its junction with State Highway 16, Mills County (lat 31°28'N; long 98°35'W).
Walnut Clay
Limestone, thin to medium irregular-bedded fossiliferous; total of 4.0 feet.
Paluxy Sand
Fine sandstone: mature orthoquartzite; light tan weathered dirty brown to dark gray; calcitic, medium-bedded; well sorted, subround to subangular, friable; compact.
 60. Sycamore Sand exposed southwest of road, 5.3 airline miles north-northeast of Ebony Cemetery and 6.7 airline miles northwest of Ridge Cemetery, Mills County (lat 31°33'N; long 99°57').
Sandy conglomerate, light red-brown; pebbles, range 2-35 mm, median 7 mm, quartzite, quartz, limestone, and calcareous sandstone.
 61. Walnut Clay, Paluxy Sand, and Glen Rose Limestone exposed uphill along Old Lometa Highway, 0.5 miles south of its intersection with U. S. Highway 183, Mills County (lat 31°34'N; long 98°33'W).
Walnut Clay
Limestone, brown, thin-bedded, highly fossiliferous -----2.0
Paluxy Sand
Fine sandstone, gray friable, compact, medium- to massive-bedded, with sandy mud -----24.0
Glen Rose Limestone
Interbedded arenaceous limestone, mud, and mudstone, with fossils micrite at base, yellow-brown to gray; micrite contains gastropods and pyrite nodules -----81.0
 62. Paluxy Sand and Walnut Formation on east side of U. S. Highway 183, 7.9 airline miles south of its junction with State Highway 16, Mills County (lat 31°21'N; long 98°30'W).
Fine sandstone: mature orthoquartzite; light gray weathers dark, thin-bedded, friable, compact, well sorted, subround; overlain by highly fossiliferous limestone; base of limestone wavy; total of 4.0 feet.
 63. Glen Rose Limestone on both sides of U. S. Highway 183, 11.1 airline miles south of its junction with State Highway 16, Mills County (lat 31°19'N; long 98°29'W).
Sparite and biosparite overlain by calcareous very fine-grained sandstone or siltstone; 4.0 feet.
 64. Pennsylvanian-Cretaceous contact and Sycamore Sand, exposed in road cut 21.75 airline miles south of Goldthwaite and 11.25 airline miles west-southwest of Scallorn, Mills County (lat 31°18'N; long 98°34'W).
Sandy conglomerate with interbedded coarse sandstone, mottled pink, gray, and red-brown, calcitic; gravel, range 2-200 mm, median 20 mm, limestone, quartz quartzite, dolomite, and sandstone; 15.0 feet.
 - 65*. Elliot Creek section, Mills County (lat 31°18'N; long 98°31'W).
Total Sycamore Sand section is 154.0 feet. Section begins in Elliot Creek 1,000 yards south of Old Lometa Highway and continues up the creek 883 yards north of the road. Section is offset 1,000 yards north-northeast to tributary of Elliot Creek at north boundary of plowed field, and continues up the creek until the creek makes a sharp bend to north, and then continues up the hill to southeast.
 - 65-E
Glen Rose
Calcareous medium sandstone grading upward into argillaceous limestone, brown and gray, limestone contains biomicrite pebbles and large *Turritella* sp (?) -----2.0
Sycamore Sand
8 Covered -----4.0
7 Arenaceous limestone, greenish yellow-brown, thin-bedded -----2.0
6 Mudstone, orange-brown, calcitic, massive-bedded -----10.5
5 Medium sandstone, red-brown, calcitic, medium-bedded, friable and partially indurated -----5.5
4 Covered -----12.0
3 Mudstone, purplish, calcitic, irregular-bedded -----4.5
2 Mud, red-brown mottled gray and purple, calcitic, partially indurated, caliche abundant -----7.0
1 Calcareous medium sandstone grading upward into arenaceous limestone, red-brown mottled yellow-brown, gray and purplish-red, irregular, medium-bedded -----13.5
Total -----59.0
 - 65-D
Sycamore Sand
2 Arenaceous limestone pebble conglomerate grading upward into a pebbly arenaceous limestone, with arenaceous limestone pebbly lenses, gray mottled pink, cross-bedded; pebbles, range 4-150 mm, median 32-64 mm, limestone, quartz, quartzite, chert, and dolomite, subround to round -----15.0
1 Arenaceous limestone, red-brown mottled gray and yellow-brown, irregular-bedded, weathers nodular, crystalline calcite stringers throughout -----17.0
Total -----32.0
 - 65-C
Sycamore Sand
6 Mud, red-orange to red-brown, calcitic, contains great amount of caliche -----2.5
5 Argillaceous limestone, light yellow and red-brown, irregular-bedded; contains small nodules of hard limestone and crystalline calcite stringers; calcite stringers contain small pellets -----2.0
4 Argillaceous limestone mottled red-brown, gray, and yellow-beige, crystalline calcite stringers -----2.0
3 Arenaceous limestone, mottled pink, red-brown, gray, and yellow-brown, thin to medium irregular-bedded, weathers blocky; possibly burrowed (?) -----7.5
2 Mud, mottled pink, gray and purplish, calcitic -----2.2
1 Pebbly sandstone, gray, cross-bedded, lenses of sandy pebble conglomerate and sandstone occur throughout; gravel, range 2-100 mm, median 10 mm, chert, quartz, quartzite, limestone, dolomite; sand fraction calcite with some quartz -----13.0
Total -----29.2
 - 65-B
Sycamore Sand
3 Sandstone, tan, irregularly medium-bedded; sand fraction predominantly calcite with some quartz -----3.0
2 Covered -----4.0
1 Arenaceous limestone, red-brown mottled pink, 88 percent carbonate; pink relic pebble structures (?) cut by calcite stringers, relic pebble structures (?) 10-35 mm -----4.5
Total -----11.5
 - 65-A
Sycamore Sand
5 Conglomerate limestone, yellow-beige to pink, 95 percent carbonate, pebbles etched and altered in part; unit porous and vuggy, surface pitted on weathering -----13.5
4 Covered -----5.5
3 Limestone, purplish-gray to gray, crystalline calcite stringers and vuggy fillings, red-brown mud fills box-work structure in upper part -----10.0
2 Arenaceous limestone, pink to gray mottled red-brown, irregularly thin-bedded to irregularly medium-bedded, crystalline calcitic vuggy fillings and stringers, sand concentrated in red-brown areas, trace of pebbles in lower part -----2.0
1 Sandy very large pebble conglomerate grades upward through calcareous pebbly sandstone to slightly pebbly arenaceous limestone, pink, red-brown, gray and brown, calcitic, indurated, medium to thick irregular-bedded in lower part, cross-bedded in middle part and massive-bedded in upper part, sandstone lenses occur in lower part; pebbles, range 2-512 mm, median 32-64 mm, dolomite, chert, quartz, quartzite, limestone, sandstone, rounded with angular thin-bedded sandstone blocks 64-512 mm; 80 percent carbonate in upper part -----25.0
Total -----56.0
 66. Bear Cove section, Taylor County (lat 32°18'N; long 99°44'W).
Section measured up northern tip of mesa on west side of Bear Cove, 5.4 airline miles southwest of Potosi.
Walnut Clay
Limestone, cream, nodular -----
Antlers Formation
Upper Sand Unit
5 Covered -----13.5

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, median 0.12-0.25 mm, subround -----	3.0
3	Sandy mud, gray mottled-yellow-brown; sand 41.1 percent, range 0.06-0.50 mm, median 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 caliche in lower part, upper part friable, compact; sand 85 percent, range 0.06-1.0 mm, median 0.12-0.25 mm, subround, moderately sorted in lower part, well sorted in upper -----	6.0
	Total -----	45.0
Redbed Unit		
	Sandy mud with interbedded muddy fine sandstone; red-brown, gray and red-brown, and purple, blocky with some fissility in lower part; sand 53.8 percent, range 0.06-1.0 mm, median 0.06-0.12 mm with 0.12-0.25 mm in middle part, subround, moderately sorted -----	66.0
Lower Sand Unit		
7	Fine sandstone with muddy pebbly sandstone in lower part and muddy fine sand in upper: immature orthoquartzite; gray with red-brown and purple, pebbly lenses and mud blebs in lower part, scattered pebbles in middle and muddy lenses in upper part; pebbles 7.1 percent, range 2-6 mm, median 4 mm, chert and quartz, chert predominant; and 77.1 percent, range 0.06-2.0 mm, median 0.12-0.25 mm, subround, moderately sorted; mud 16 percent -----	9.5
6	Medium sandstone with muddy sandy 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 supermature medium sandstone with few pebbles randomly scattered throughout; pebbles, 25.3 percent, range 2-18 mm, median 4 mm, becoming smaller upward, subround, 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, subround, 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 subround, chert and quartz, chert predominant; 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, subround, 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, subround, chert and quartz, chert predominant; sand 52.5 percent, range 0.06-2.0 mm, median 0.25-0.50 mm, subround, moderately sorted, mud 20.5 percent -----	5.0
2	Covered -----	2.5
1	Muddy pebble conglomerate becoming muddy sandy pebble conglomerate upward: 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, 50 percent, range 2-32 mm, median 6 mm, subround, chert and quartz, chert predominant, mud 40.5 percent, muddy sandy pebble conglomerate; pebbles 71.1 percent, range 2-17 mm, median 4 mm, subround, 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
Pennsylvanian		
67.	Mud, dark red-brown, with thin indurated sandstone beds. Cut on north side of road on lower part of hill, 0.6 mile east of its junction 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 2-64mm, median 8mm, 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.

APPENDIX II

SUBSURFACE LOCATIONS¹

Well No.

101. Mid-Continent Petroleum Co., #1 Squaw Creek Cattle Company, Hood County. (lat 32°22'N; long 97°49'W).
102. B. W. Fitzgerald, #1 Van Morrison, Hood County. (lat 32°22'N; long 97°45'W).
103. K-B Oil Company, #1 M. M. Bunt, Somervell County. (lat 32°17'N; long 97°42'W).
104. Jess Hickey Oil Corp., #1 Buie, Bosque County. (lat 32°10'N; long 97°35'W).
105. American Liberty Oil Co., #1 Elmer Smith, Bosque County. (lat 32°06'N; long 97°45'W).
106. C. M. Stoner, #1 Cedar Valley Ranch, Somervell County. (lat 32°11'N; long 97°52'W).
107. Roy Burgin, #1 Mrs. W. W. Roberson, Erath County. (lat 32°07'N; long 98°02'W).
108. Texas Water Wells, #15 City of Stephenville, Erath County. (lat 32°14'N; long 98°12'W).
109. W. H. Woods, #1 R. J. Sikes, Erath County. (lat 32°19'N; long 98°15'W).
110. Dale Smith and Louisiana Machine Co., #1 Kiker, Erath County. (lat 32°11'N; long 98°17'W).
111. Frank Buttram, #2 Withfield, Erath County. (lat 32°10'N; long 98°25'W).
112. H. B. Ownby Drilling Co., #1 R. C. Crouch, Erath County. (lat 32°05'N; long 98°24'W).
113. John W. Bartlett, #1 D. E. Steel, Comanche County. (lat 31°57'N; long 98°45'W).
114. Coastal States Gas Producing Co., #1 S. L. Rankin, Brown County. (lat 31°55'N; long 98°52'W).
115. Humble Oil and Refining Co., #1 J.M. Foreman, Comanche County. (lat 31°45'N; long 98°41'W).
116. United North and South Development Co., #1 Fred Johnson, Mills County. (lat 31°42'N; long 98°40'W).
118. R. K. Stoker, #1 Fletcher, Mills County. (lat 31°28'N; long 98°31'W).
119. Bryon Hoffman, #1 J. S. Owens, Mills County. (lat 31°28'N; long 98°22'W).
121. American Manufacturing Co., #1 T. W. Winters, Hamilton County. (lat 31°30'N; long 98°07'W).
123. J. L. Myers & Sons, #2 City of Hamilton, Hamilton County. (lat 31°42'N; long 98°07'W).
124. Amerada Petroleum Corp., #1 L. S. Burney, Hamilton County. (lat 31°50'N; long 98°05'W).
125. Jones Brothers, #1 D. M. Proffitt, Hamilton County. (lat 31°55'N; long 98°60'W).

Well No.

126. Amerada Petroleum Corp., #1 John Briscoe, Hamilton County. (lat 31°49'N; long 97°57'W).
127. C. M. Stoner, #1 City of Meridian, Bosque County. (lat 31°55'N; long 97°39'W).
128. American Liberty Oil Co., #1 Reichert, Bosque County. (lat 31°45'N; long 97°29'W).
129. O. C. Proffitt, #1 J. W. Henry, Bosque County. (lat 31°38'N; long 97°36'W).
130. C. M. Stoner, #4 George Adams, Bosque County. (lat 31°43'N; long 97°45'W).
131. J. L. Myers & Sons, #1 City of Turnersville, Coryell County. (lat 31°36'N; long 97°44'W).
132. C. M. Stoner, #1 Jonesboro Water Supply Corp., Coryell County. (lat 31°37'N; long 97°52'W).
133. Amerada Petroleum Corp., #1 N. F. Tate, Coryell County. (lat 31°34'N; long 97°56'W).
135. J. L. Myers & Sons, #3 Gatesville School for Boys, Coryell County. (lat 31°29'N; long 97°43'W).
137. General Crude Oil Company, #1 Ernest Day, Coryell County. (lat 31°20'N; long 97°26'W).
138. J. L. Myers & Sons, #2 City of Moody, McLennan County. (lat 31°19'N; long 97°21'W).
139. C. M. Stoner, #1 Spring Valley, McLennan County. (lat 31°23'N; long 97°18'W).
140. Hervie Meadows and Sons, #2 City of McGregor, McLennan County. (lat 31°25'N; long 97°25'W).
141. Falcon Oil Company, #1 Henry Mattlage Jr., McLennan County. (lat 31°32'N; long 97°30'W).
142. Hervie Meadows, #1 McKethan, McLennan County. (lat 31°34'N; long 97°21'W).
143. H. W. Bass & Sons, #1 Delmar Ranch, McLennan County. (lat 31°38'N; long 97°23'W).
144. Hervie Meadows, #1 S. F. Foster, McLennan County. (lat 31°40'N; long 97°19'W).
145. R. C. Smith and Falcon Oil Corp., #1 H. C. McKethan, McLennan County. (lat 31°29'N; long 97°17'W).
146. J. L. Myers & Sons, #1 Dr. Barnes, McLennan County. (lat 31°29'; long 97°10'W).
147. J. L. Myers & Sons, #1 Youngblood, McLennan County. (lat 31°28'N; long 97°06'W).
148. Golinda Co-op, #1 Water well, Falls County. (lat 31°22'N; long 97°06'W).
149. Layne Texas Company, #1 City of Dublin Test Hole, Erath County. (lat 32°05'N; long 98°20'W).

¹Refer to figure 2 for well locations.

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