Geology of the Waxahachie Quadrangle, Ellis County, Texas[1]

By William Wirt Peabody[2]

ABSTRACT

In the Waxahachie Quadrangle, in the northern part of Ellis County, Texas, the Cretaceous Austin and Taylor formations crop out. The contact between these units is uncomformable and marked by a one-inch red clay bed containing phosphate pebbles. Much of the eastern part of the area is overlain by terrace deposits.

Structurally, the quadrangle is part of the homoclinal coastal plain, but is broken by normal faults with throws of up to 100 feet. Most of the faults strike northeast and dip steeply northwest. A few of these dip southeast and a few faults strike northwest. Southwest of Rockett a northeast-trending graben of Taylor in Austin chalk is well exposed along Brushy Creek. Joints with northeast and northwest trends are numerous.

INTRODUCTION

The Waxahachie Quadrangle is in the north-central part of Ellis County, Texas, 21 miles south of Dallas. It is bounded by parallels 36° 22' 30" and 36° 30' N. and by meridians 96° 45' and 96° 52' 30" W.

The topographic setting is one of low, wide hills that slope gently downward to generally flat valley-floors with meandering streams. Along the eastern border of the area fragments of a relatively flat terrace reach widths greater than two miles. To the west of this surface is a succession of rolling hills well advanced in maturity.

Two Upper Cretaceous formations, the Austin Chalk and the Taylor Marl, form the bed rock in the Quadrangle. Both formations, as well as the terrace fragments, weather to form a rich, dark soil ideally suited to the raising of the principal crop of the area, cotton.

Waxahachie, in the extreme southwest corner, is the only large town. From this town a network of roads makes all parts of the area easily accessible by automobile.

The entire area is drained by southeast-flowing intermittent streams and their dendritic network of tributaries. When imposed upon Austin terrain the tributaries are normally quite deeply in-

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cised, whereas upon topography underlain by either Taylor Marl or terrace gravels they tend to be quite shallow. Due to the non-resistant nature of the Taylor, there has been extensive gullying near some creeks, as along the lower reaches of Grove Creek.

The geology was mapped during the winter and spring of 1956-1957 with the aid of a Brunton compass, and was plotted on aerial photographs which scaled approximately four inches to the mile.

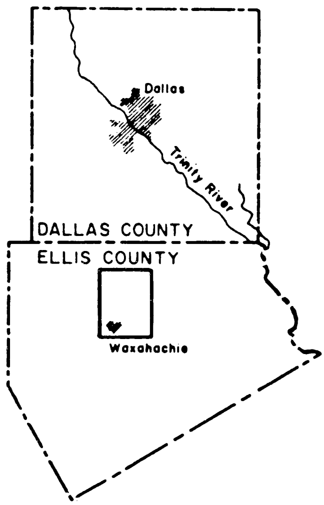

FIG. 1. Geographic Location of the Waxahachie Quadrangle.

This report is part of a project, sponsored by Southern Methodist University, which has as its goal a regional map of the surface geology in this portion of north-central Texas.

Grateful acknowledgment for advice and assistance is made to the following members of the geology faculty of Southern Methodist University: Professors Arthur Richards, James E. Brooks, and David L. Clark. Thanks also go to Louis C. Reed, who mapped the adjoining quadrangle to the west, for helping to measure one section. Finally, special thanks are due Edgar Tobin Aerial Surveys, Inc., who furnished large-scale photo-mosaics which facilitated the construction of an accurate base map.

STRATIGRAPHY

Six mappable stratigraphic units crop out in the Waxahachie Quadrangle, the lower three of which are members of the Upper Cretaceous Austin Chalk. The lower few feet of the Taylor Marl, also Upper Cretaceous, lie disconformably on the Austin Chalk, and Pleistocene terrace gravels remain in scattered patches throughout the eastern and southern portions of the area. The youngest material is Quaternary alluvium.

AUSTIN CHALK

Lower Member.—The oldest stratigraphic unit in the Waxahachie Quadrangle is the lower member of the Austin Chalk. This unit outcrops in the Lancaster Quadrangle immediately to the north, which was mapped by Jerome J. C. Ingels (1959), and projections of the dip and strike indicate that this unit underlies two hills in the extreme northwest corner of the Waxahachie Quadrangle.

Although the unit is 200 feet thick at its maximum (Dallas Petroleum Geologists, 1941), only the uppermost 10-20 feet are present in the Waxahachie Quadrangle and are here very poorly exposed.

As observed near the southern border of the Lancaster Quadrangle, the unit is made up of a sequence of yellow-white chalk beds, one to one and one-half feet thick, which alternate with dark gray to gray-blue marl beds of equivalent thickness.

Middle Member.—The middle member of the Austin Chalk is 220 feet thick (Dallas Petroleum Geologists, 1941) and is the lowest complete stratigraphic unit in the Waxahachie Quadrangle. It consists of a sequence of marly chalk to chalky marl beds, one to two feet thick, that form the resistant units between two to four foot beds of marl. The foregoing are occasionally divided by very thin brown clay seams. The more resistant beds are blue-gray and weather yellow-white to buff. The soft shaly marl units are predominantly a dark blue-gray color on weathered and fresh surfaces alike.

When exposed to weathering, outcrops disintegrate rapidly. This is facilitated in many cases by vertical jointing which loosens large blocks of the more resistant strata. The resistant units weather into small, soft subconchoidal chips, cohering loosely to the outcrop, while the marl units, possessing many closely-spaced horizontal laminations, disintegrate into very small soft chips with earthy fractures. Weathering of thin marl units forms deep recesses, but where these units are thicker than two feet they form slopes of 50-70 degrees between the chalk ledges.

There are at least two stratigraphic positions within the middle member where three foot massive beds of yellow-white chalk occur. These are similar to the massive beds in the upper member of the Austin.

Numerous concretions of rounded, nodular marcasite are found in an advanced stage of disintegration, forming pockets of rusty, incoherent limonite.

Local occurrences of very hard shell breccias with limestone matrices and seldom more than one foot in thickness occur at various horizons within the middle member. The angular nature of the fragments, as well as the relatively coarse nature of the limestone matrix, suggests that these beds are limestone coquinas (Pettijohn, 1949, p. 301). The extreme resistance to erosion of these units usually leaves them as projecting ledges or as beds along which streams bottom.

The middle member contains a fauna that includes *Inoceramus* sp., *Exogyra* sp., and occasional specimens of *Gryphaea* sp. Prisms of *Inoceramus* sp. are abundant throughout almost all the beds and occur in unoriented assemblages.

Upper Member.—The upper member of the Austin Chalk grades somewhat sharply downward into the more marly and readily distinguishable middle member. This relationship is clearly displayed in Red Oak Creek, one and one-half miles northwest of Rockett (Loc. 1, Pl. I). Here three-foot beds of upper chalk rest on thinner interbedded marls and marly chalks that resemble the middle Austin member.

The upper member of the Austin Chalk thins southwest along the strike from an assumed maximum thickness of 180 feet (Dallas Petroleum Geologists, 1941) to approximately 150 to 160 feet in the extreme southeast and south-central portions of the Quadrangle. The variance in thickness is possibly a consequence of sub-aqueous erosion following the deposition of the Austin Chalk.

Two dissimilar lithologies make up the upper Austin member: a massive-bedded lower unit and an upper marly unit. The lower massive unit is composed of blocky chalk beds, one to five feet thick, that alternate with thin clay to marl seams that are seldom thicker than one foot. The thicker beds weather yellow-white to white, while fresh surfaces are generally creamy-white to light gray. The thin marl units are gray to blue on both weathered and fresh surfaces.

The highly indurated chalks of the lower massive unit weather into small subconchoidal chips, and outcrop surfaces, when this weathering process is carried to an extreme, resemble the chipped surfaces of arrowheads but on a much larger scale. A five-foot bed approximately 20 feet above the contact with the middle Austin member has been weathered in this manner to such a degree that it can be used as a marker bed.

The thickness of individual chalk beds is dependent upon the amount and intensity of weathering. Fresh outcrops appear massive except for thin, widely-spaced and barely discernible lines which can be traced horizontally along the bedding face. As weathering proceeds, these thin lines, which apparently are tiny marl or clay seams, are etched ever deeper, until the originally "homogenous" chalk becomes a series of one-to two-foot beds divided and deeply recessed by the marl or clay seams.

The 60-foot upper marly unit (Smith, 1955) resembles many sections of the middle Austin member. This unit contains two- to four-foot gray-blue marl beds separated by more resistant beds of yellow-white marly chalk to chalky marl which average 1½ feet thick. Weathering of these resistant beds causes them to break down into small chips of brittle chalk.

Within the lower massive unit there are scour and fill structures with the bottom beds in these channels averaging one foot thick. At one locality in Red Oak Creek, about one-half mile west of Rockett (Loc. 2, Pl. I), a part of one of these channel structures is exposed for a width of 45 feet. Low-velocity turbidity currents, as explained by Kuenen (1950, p. 510), are suggested as a possible cause for the channels.

Hard, highly resistant shell breccias similar to those found by the author in the middle Austin member, but generally only three or four inches thick, occur at various horizons within the sequence of lower massive chalk beds. One such breccia was examined in polished section and was found to contain many small angular shell fragments. *Inoceramus* prisms are the most abundant constituent and are embedded in a matrix of relatively coarse, pink, crystalline limestone. Curiously enough, the breccias observed by the writer form the basal few inches of massive chalk beds and separate these chalk beds from the underlying clay and marl.

As in the middle member, weathered nodules and concretions of marcasite stand out brilliantly against the white upper Austin rocks. The fauna of the upper Austin member is more sparse than that of the middle Austin member, although there are local exceptions in the upper massive and the upper marly units. *Exogyra* spp., *Gryphaea* sp., and *Inoceramus* sp. with fragmental prisms are the most common forms. A large "cartwheel" *Parapuzosia* was found three feet below the Taylor Marl in Grove Creek, approximately 600 feet west of Ike (Loc. 3, Pl. I), and several small weathered fragments of rudistids were found as float within, and near, the upper marly unit. The *Parapuzosia* was only partially recovered, and the imperfectly-preserved suture pattern prohibited further classification. Measurements of the fragments, however, indicate that it must be more than four feet in diameter.

TAYLOR MARL

Resting disconformably upon the Austin Chalk are the basal 80-100 feet of the Taylor Marl. At all outcrops within the Quadrangle the Taylor is a soft, incompetent unit which tends to slump on steep slopes.

The Taylor is uniformly thin-bedded with each stratum varying between one and three inches in thickness. On wet surfaces the color of the beds varies between dark gray and dark red-brown, with dry surfaces being somewhat lighter in tone. Vertical joints furnish access for percolating waters which leave dark yellow stains.

The Taylor shrinks when dried into small subconchoidal blocks which can easily be crumbled in the hand.

Unplowed fields underlain by Taylor have a characteristic brown soil that is easily distinguished from its darker gray counterpart formed by the Austin Chalk, and facilitates the tracing of the contact between the two formations where there are no outcrops.

Austin-Taylor Contact.—The contact between the Austin Chalk and the Taylor Marl can be found at several localities within the Waxahachie Quadrangle and is everywhere easily recognized and characteristic of a disconformable surface. Stratigraphic evidence for the disconformity is based upon noticeable thinning of the upper marly unit of the upper Austin member along strike to the southwest. In a north-facing cuesta which follows Red Oak Creek out of the area on the east (Loc. 4, Pl. I), at least 40 to 50 feet of the upper marly unit are exposed below the contact; while approximately three and one-half miles to the southwest, in Grove Creek about one mile northwest of Ike (Loc. 5, Pl. I), there are only 30 to 40 feet of this unit underlying the Taylor.

At almost every locality where the contact is well-exposed, a zone of unconsolidated phosphate pebbles and shell fragments replaced by phosphate lie along the contact. This is considered by Pettijohn (1949, p. 352) to be evidence of a disconformity.

Lying immediately on top of the Austin Chalk in most localities, and within the phosphate zone, is a red iron-stained marl or clay bed which is usually less than one inch thick. Although this marker bed is not noticeable in every locality where the contact is observed, its presence as float indicates definitely that the Austin-Taylor contact is near.

QUATERNARY DEPOSITS

TERRACE GRAVELS

Unconformably overlying the Upper Cretaceous formations in the area are remnants of a formerly widespread mantle of Pleistocene terrace deposits whose base is usually marked by a highly-indurated shell breccia with thicknesses up to two feet. The remainder of the terrace deposits is either a yellow sandy clay with the scattered, very well rounded quartz pebbles near the base, or is poorly-bedded, reworked Taylor clay.

QUATERNARY ALLUVIUM

The youngest deposit in the Quadrangle is dark brown unconsolidated alluvium which underlies the floodplains within the area. It is not uncommon to find friable, partially-decomposed chalk pebbles in great abundance near the base of this deposit.

STRUCTURE

The Black Prairie area of Texas, in which the Waxahachie Quadrangle is located, is part of a gentle homocline that dips southeast at the rate of approximately 60 feet per mile. The beds within the Quadrangle maintain the continuity of this regional dip except were local structural conditions distort the original attitude of the beds.

Normal faults are frequently encountered within the Quadrangle and they vary in throw from several inches to more than 100 feet. The larger faults are generally downthrown to the northwest, although several exceptions have been mapped. The majority of the faults strike northeast, as does the more prominent of two joint sets mapped in the area. This linearity parallels, and possibly is a part of, the Balcones or Mexia fault zones to the southwest (Weeks, 1945).

Minor grabens and horsts may be seen at several localities. Along the unnamed creek in the extreme northeast corner of the Quadrangle several of these structures occur within a horizontal distance of 300 feet (Loc. 6, Pl. I). The throw of the faults is too small and they are too closely spaced to be mapped on the scale used, so only their average trend has been included.

Stream channels tend, in many cases, to parallel the strike of faults; and often abrupt changes in stream direction are due to sudden abutment against a resistant fault scarp in the Austin Chalk. An example of his phenomenon can be seen in Grove Creek, slightly more than one mile northwest of Ike (Loc. 7, Pl. I).

Recrystallized calcite along fault planes is common in the Quadrangle. Preserved in the outer layers of these fault fillings (which sometimes are as much as four to six inches thick in the larger faults) are slickensides and mullion structure. At localities where the faults are completely within the Austin Chalk the calcite occurs as clear, colorless crystals, while near the Austin-Taylor contact red-brown tones are common.

Drag folds are common in association with the larger faults, and particularly with those having more than 10 feet of throw. Approximately one-third of a mile southeast of Sterrett, in the north-central portion of the area (Loc. 8, Pl. I), beds of the middle Austin member are dipping at 28 degrees into a large fault whose throw may be more than 100 feet. Similar drag folding can be seen at several other localities where faults are exposed.

The largest structure in the area is a graben that parallels Brushy Creek, running northeast into Rockett. Within this graben Taylor Marl has been dropped a minimum of 90 feet and rests against the lower massive unit of the upper Austin member.

Evidence that the south fault of the graben is continuous for at least two and one-half miles can be found at several localities on strike with this fault. In Grove Creek, to the southwest (Loc. 9, Pl. I), its continuation is seen in Taylor beds that have been dropped adjacent to the lower massive unit of the upper Austin member; to the northeast, in Red Oak Creek just above the bridge into Rockett on farm road 813 (Loc. 10, Pl. I), the Taylor is similarly displaced. South of this bridge (Loc. 11, Pl. 1), a contorted fault zone in the lower massive unit further substantiates the northeast extension. Dips of up to seven degrees in the northeast corner of the area (Loc. 12, Pl. I) suggest that the effects of this fault extend at least this far.

Two joint sets can be observed in the Quadrangle. Out of 92 joint trends recorded, 51 are oriented toward the northeast with an average strike of north 50 degrees east and 41 trend northwest with an average strike of north 40 degrees west.

The joints are vertical, or nearly so. Single joints are often broken into two *en echelon* joints when traversing incompetent marl units in cliff faces.

The fact that the joints roughly parallel the faults indicates that the same force, or forces, was responsible for both.

SUMMARY OF TECTONIC HISTORY

The depositional history of the Quadrangle is relatively uncomplicated, for the sedimentary suite indicates that stable environmental conditions must have existed throughout late Cretaceous time. The lithology of the chalk and marl suggests warm, shallow water as the depositional medium for the clay and calcium carbonate. The localized shell breccias are thought to be typical coquinas, while the scour and fill structures are probably the result of turbidity currents. The Bahama Banks are suggested as an equivalent modern area of sedimentation (Thorp, 1939).

There is no record of Tertiary sedimentation within the Waxahachie Quadrangle, but following this Period, and throughout the course of the Pleistocene Epoch, the streams became swollen and deposited gravels which still blanket many square miles of north-central Texas.

Since the retreat of the Wisconsin glaciers from the northern mid-continent, the streams have cut slowly headward and continued to denude the area while depositing a mantle of Quaternary alluvium during time of flood.

Faulting occurred before the terrace gravels were deposited but after the deposition of the Upper Cretaceous formations.

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Vertical Distribution of Foraminifera in the Lower Chalk Member of the Austin Formation, Southern Dallas County, Texas

By JOHN M. JACOBSEN

ABSTRACT

The Austin formation (Upper Cretaceous) in Dallas County is divisible into three members: a lower chalk, a middle marl, and an upper chalk. Because of the gentle dip of the Austin formation and the low surface relief of the area, stratigraphic sections of as much as 30 feet are rare, thus no complete surface section exists for any of the members. A composite stratigraphic section of the lower chalk member, 155 feet thick, was constructed from exposures in the upper reaches of Ten Mile Creek. Individual sections in excess of 10 feet were carefully measured and correlated by insoluble residues, in conjunction with bed thicknesses and weathering profiles, to obtain the composite section. The microfaunal content was examined at five foot intervals and points of significant lithologic change.

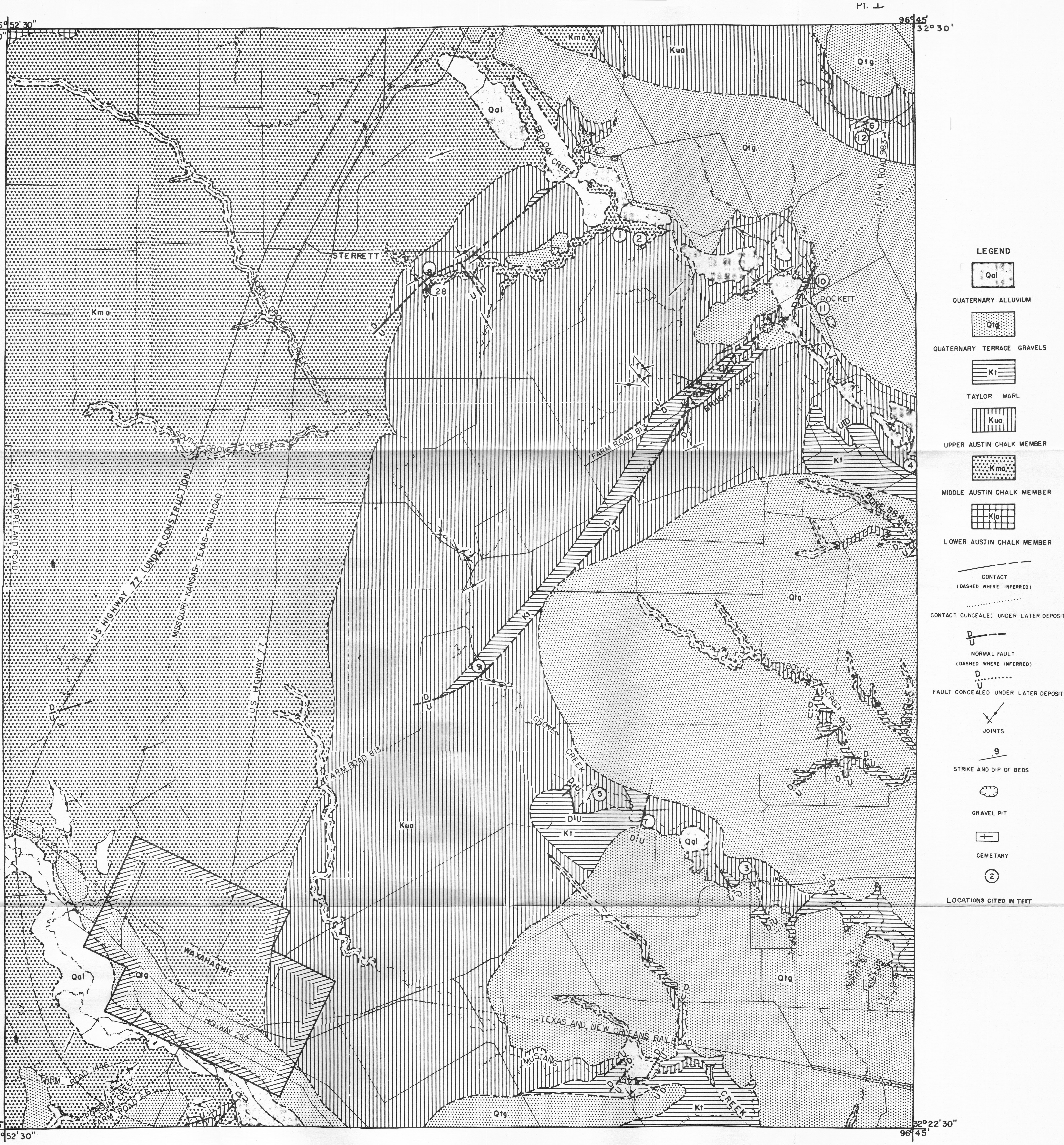
Approximately 50 species of Foraminifera, representing 26 genera and 9 families, are present in the lower chalk member. The dominant species are *Globigerina cretacea* d'Orbigny, *Globotruncana canaliculata* (Reuss), *G. marginata* (Reuss), *G. fornicata* Plummer, *Gümbelina striata* (Ehrenberg), and *Planulina* sp.; cf. *P. austinana* Cushman. *Globigerina cretacea* d'Orbigny is the most common and persistent. All of the above are planktonic except *Planulina*.

The only indications of limited vertical distribution within the lower chalk member were restricted occurrences of *Rectogumbelina hispidula* Cushman and *Pleurostomella watersi* Cushman. The former was observed only in a single sample taken approximately 8 feet above the Eagle Ford—Austin contact; the latter was found in samples of the uppermost 12 feet of the lower chalk section as one of the most common species; it probably, however, ranges upward into the middle and upper Austin.

INTRODUCTION

The purpose of this study was to obtain a clear, concise picture of the vertical distribution and frequency of occurrence of foraminiferal species in the lower chalk member of the Austin formation. Close stratigraphic control was prerequisite to such a study. I obtained this by the construction of a composite measured section, through lithologic correlation of a series of separate but overlapping stratigraphic sections from along Ten Mile Creek in southern Dallas County (see Figure 1 and Plate 1).

Little work has been published concerning the stratigraphic distribution of Forminifera in the Austin formation. The earlier studies



GEOLOGIC MAP OF THE WAXAHACHIE QUADRANGLE

ELLIS COUNTY, TEXAS

BASE MAP FROM PHOTO-MOSAICS

0 — 1 MILE — 2 MILES
SCALE

FIELD MAPPING BY WILLIAM W. PEABODY
WINTER AND SPRING, 1956-1957

DECLINATION 9° 30' E