Geology of the Midlothian Quadrangle, Ellis County, Texas

Louis C. Read

ABSTRACT

The Midlothian quadrangle in northwest Ellis County, Texas, is underlain by the Eagle Ford Shale and Austin Chalk, both of Upper Cretaceous age. The upper 75 to 100 feet of Eagle Ford shale crops out within the quadrangle. It is predominantly a dark gray clay containing flaggy detrital limestone beds.

Separating the shale from the overlying chalk is a six-inch conglomerate bed containing black phosphate pebbles, phosphatized fish teeth and molluscan shells, glauconite, quartz, gypsum, and calcareous foraminifera tests.

The lower Austin Chalk consists of massive chalk beds interbedded with thin beds of marl or bentonitic shale. In the upper 30 or 40 feet of this unit the beds are less massive. Above the lower chalk there is a 30-foot transition zone in which the rock is intermediate in lithology between the chalk and the middle marl unit above. The middle marl unit contains thick beds of marly chalk and chalk.

Terrace deposits consisting largely of chalk gravel are probably correlative with the Marsalis Terrace of Dallas County.

A northeast-striking fault with a throw of at least 90 feet is exposed along Long Branch in the east-central part of the quadrangle near Sardis. There are three other faults of similar trend with throws of at least 25 feet, in the area. These faults are probably related to the Balcones Fault system. Northeast- and northwest-trending joints are numerous.

The Midlothian Quadrangle, as shown in Fig. 1, is in northwest Ellis County. It is bounded by the parallels 32° 22′ 30″ and 32° 30′ 00″, and by the meridians 96° 52′ 30″ and 97° 00′ 00″. The towns within the quadrangle are Midlothian, Sardis, and Lone Elm, of which Midlothian is the largest with a population of 1,177. Most of the area is readily accessible by a network of roads. U.S. Highway 287 runs diagonally across the quadrangle from southeast to northwest, while farm roads 663 and 664 run north-south and farm roads 1387 and 375 run east-west through the area. All other roads, except U.S. Highway 67, which passes through the northwestern corner of the quadrangle, and farm road 1446, which is in the southeastern corner, are secondary chalk gravel or dirt roads.

Almost all of the bedrock in the area is Austin Chalk, but in the far northwest corner the underlying Eagle Ford Shale crops out. These formations are of Upper Cretaceous age.

Over portions of the area, especially within and near the recent floodplains of the larger streams, the Cretaceous bedrock is covered by alluvium.

The quadrangle is in the Black Prairie, a part of the Gulf Coastal Plain. It is drained to the southeast by intermittent Waxahachie Creek and its tributaries.

The mature topography of the area is broken only by the prominent White Rock Cuesta. Relief along the cuesta of about 200 feet has developed by differential erosion of the weaker underlying Eagle Ford Shale and the more resistant Austin Chalk.

Field work was done during the summer and fall of 1956. Areal geology was plotted directly on aerial photographs and then transferred to a controlled mosaic.

The writer wishes to thank Mr. Eugene Simmons for help in the field work. Thanks are due Dr. Arthur Richards, Dr. James Brooks and Dr. David Clark for their help during the course of this investigation; and to the Tobin Aerial Surveys for providing the aerial mosaics. For typing of the manuscript, I owe thanks to my sister, Mrs. Douglas E. Speed, and to my aunt, Miss Lorene Pollard.

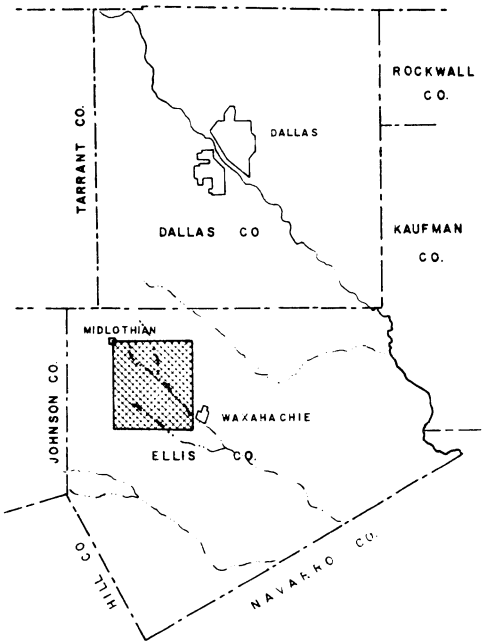


FIG. 1. Index Map, showing location of the Midlothian Quadrangle.

Stratigraphy

Eagle Ford Shale.—The Eagle Ford Shale crops out in and to the west of the town of Midlothian, in the far northwestern corner of the quadrangle. South of Midlothian the trend of the contact with the Austin Chalk is slightly west of south so that it lies west of the quadrangle boundary.

W. L. Moreman (1927) subdivided the Eagle Ford, from oldest to youngest, into the Tarrant, Britton, and Arcadia Park units. Adkins (1932) called these units formations,

and elevated the Eagle Ford to the rank of Group. Turner (1951) was unable to use this classification for field-mapping purposes, and divided the Eagle Ford from bottom to top into the following lithologic units: (1) clayey-marl, and (2) clay, within which flaggy detrital limestone beds occur. The portion of the Eagle Ford exposed in this quadrangle belongs to Moreman's Arcadia Park or Turner's unit 2.

There are only small sections of Eagle Ford exposed within the limits of the quadrangle. On fresh exposure the shale is dark to light bluish-gray, bituminous, and laminated. On weathered outcrops it is light to olive-gray with local streaks of yellow and light brown due to the oxidation of iron sulphide to limonite. Selenite gypsum is locally common along bedding planes. The average thickness of the formation in this vicinity is 432 feet (Watkins, 1954), but only the upper 75 to 100 feet crop out in the quadrangle.

Austin Chalk.—In Dallas County the Austin formation has been divided into four units: a basal pebble conglomerate, a lower chalk, a middle marl, and an upper chalk (Dallas Petroleum Geologists, 1941). All but the upper chalk crop out within the area.

The basal pebble conglomerate, averaging 6 inches thick, is well exposed directly above the Eagle Ford Shale west and southwest of Midlothian about 300 yards west of the quadrangle boundary. Fresh exposures are dark bluish-gray, weathering to buff. The conglomerate is composed of black phosphate pebbles, fish teeth, casts of molluscan shells, and silt scattered through a marly matrix. It averages 44% insoluble in dilute hydrochloric acid.

In thin section, the rock shows numerous calcareous tests of foraminifers, quartz, marcasite, gypsum, abundant glauconite, and bony material such as fish teeth which has been replaced by collophane.

Previous workers (Moreman, 1927, Stephenson, 1929, Dallas Petroleum Geologists, 1941) have cited the presence of the following in this basal Austin bed as being indicative of a disconformity: (1) phosphate pebbles, (2) undulation of the contact surface, (3) tubular burrows filled with marl extending down into the shale, (4) fish teeth, (5) dark casts of molluscan shells, (6) fragments of reworked shale, and (7) glauconite.

The disconformity developed after deposition of the shale

when, during a pause in sedimentation, submarine currents scoured the sea floor causing subaqueous erosion and accumulation of organic remains. Sedimentation slowly began again, and currents reworked the first limy beds to be deposited mixing with them the organic remains that had collected along the sea floor.

Above the basal pebble conglomerate the Austin appears as massive beds of chalk interbedded with thin beds of marl or bentonitic shale. Those lower chalk beds are dark bluish-gray to gray when fresh, weathering white, light gray, or buff.

The upper 30 to 40 feet of the lower chalk varies somewhat from the rest of the unit. In this portion massive beds are not as prominent, and the interval as a whole becomes more thinly bedded when compared to the beds which make up the basal 160 to 170 feet.

The lower chalk covers more than 50% of the area mapped. It averages 200 feet in thickness (Dallas Petroleum Geologists, 1941). This unit crops out at numerous places along all the major streams and their tributaries, but in particular there are good exposures northeast of Sardis on Long Branch (Stations 1 and 2, Pl. 1), west of Sardis on Waxahachie Creek (Station 4, Pl. 1), and southwest of Lone Elm on South Prong Creek (Station 5, Pl. 1).

Pelecypods and ammonites are found in the scoured lower Austin exposed along creek bottoms. The giant pelecypod *Inoceramus undulato-plicatus* Roemer is very common. Southeast of Midlothian on North Prong Creek (Station 6, Pl. 1) many small *Gryphaea* were found imbedded in a clastic limestone bed one inch thick that marks the bottom of a scour and fill structure similar to the ones described in Dallas County by Bryan (1953), Hall (1953), Overmyer (1953), and Watkins (1954). The structure is exposed on only one side of the creek and appears to have a northeasterly trend. The clastic limestone bed can be traced for a distance of 25 feet. Above the clastic bed, the rock is composed of thinly-bedded marly limestone which has a thickness of 4 to 5 feet.

Marcasite concretions are common in both the lower and middle units of the Austin, but are most common in the middle unit. Most of these concretions are round or oblong shaped with radiating internal structure. Close examination

shows small crystals on their surfaces. Southeast of Midlothian on North Prong Creek (Station 7, Pl. 1) there are large marcasite concretions up to 3.5 inches in diameter.

The middle marl unit consists of 220 feet of marl interbedded with marly chalk and chalk (Dallas Petroleum Geologists, 1941). The marl beds are the most massive and frequent of the two types, but the marly chalk and chalk beds, especially near the base, may appear to be dominant if the exposure is restricted to a small section.

There is no sharp demarcation between the lower and middle units of the Austin. There is an interval of approximately 30 feet in which the rock has an intermediate appearance. Because of the slight dip of the Austin this interval may crop out over a relatively large area. Small outcrops of this zone were arbitrarily mapped as middle Austin if the soft marly beds were six inches or more thick.

There are no exposures of middle Austin in the northeastern portion of the area. Its contact with the lower chalk unit in the northeast was placed, on field evidence found, north and east of the northeastern corner of the quadrangle. Farther south the middle Austin crops out northeast of Sardis on Long Branch (Station 8, Pl. 1) and southeast of Lone Elm on a tributary of Waxahachie Creek (Stations 9, 10, and 11, Pl. 1).

The middle Austin contains the pelecypods *Inoceramus undulato-plicatus* Roemer, *Inoceramus subquadratus* Schlüter, and *Gryphaea aucella* Roemer. *Exogyra ponderosa* Roemer were also noted in this unit though none was found within the immediate limits of the quadrangle.

Quaternary Alluvium.—The Alluvium consists of two lithologic types which for mapping purposes have been designated Alluvium 1 and Alluvium 2.

Alluvium 1 is composed of chalk gravel in a matrix of yellow clay. Along Waxahachie Creek it stands as benches more than 50 feet above the recent floodplain. In Dallas County Kelsey (1935) and Taggert (1953) defined the highest level terrace associated with the Trinity River drainage as the Marsalis Terrace and described it as being partially composed of chalk-gravel. These benches may be remnants of the same terrace level.

Alluvium 2 is composed of dark brown to black clay with lenses of fresh chalk fragments which are up to boulder size.

Locally this alluvium is dominantly a chalk gravel with a striking resemblance to Alluvium 1.

Channel fillings of alluvium resembling those described by Ham (1941), Bryan (1953), and Roberts (1953) in Dallas County were found in the lower chalk northeast of Sardis on Long Branch (Station 12, Pl. 1), northwest of Sardis on North Prong Creek (Station 13, Pl. 1), and south and southwest of Lone Elm on South Prong Creek (Stations 14 and 15, Pl. 1). The fill in these structures is lithologically the same as that of the alluvium mapped as Alluvium 1. In the ones which are more fully exposed (Stations 14 and 15, Pl. 1) there is a gradation from large pebbles at the base, to medium and small pebbles at the top. There is no stratification, and they show steep sides that sharply truncate the bedrock.

Ham (1941) describes channels resembling these in the middle Austin and suggests they were formed by streams that were entrenched in the middle marl. As these streams cut through the marl into the lower chalk, their courses became modified in adjustment to the joint and fault pattern. Because of this adjustment many streams were beheaded and those beheaded portions were filled by slope-wash and slump material. Later down-cutting has preserved them on inter-stream divides. The channels described here probably had a somewhat similar origin.

Structure

The regional structure is that of a southeastward-dipping homocline. The Cretaceous beds strike north-northeast and dip uniformly at about 60 feet to the mile toward the east (Dallas Petroleum Geologists, 1941).

Faults.—The lower Austin contains numerous small normal faults with throws of less than 10 feet. These faults are filled with calcite casts of the slickensided surfaces.

It has been suggested that similar faults in Dallas County are due to differential compaction of the incompetent Eagle Ford Shale with resultant breaks occurring in the overlying competent Austin Chalk (Dallas Petroleum Geologists, 1941).

Four normal faults with throws of more than 25 feet were mapped. The largest of these, the Sardis Fault (Station 8, Pl. 1) has a minimum throw of 90 feet. This figure

was arrived at by assuming the lower Austin on either side of the fault to be equivalent and projecting the dip of the beds into the dip of the fault plane. The beds immediately north of the fault, on the downthrown side, are middle Austin and dip at 25° into the fault. The lower Austin beds to the south of the fault show no perceptible dip. The dip of the middle Austin beds is anomalous, for being on the downthrown side of the fault normal drag would make them dip away from the fault rather than into it. At the base of the cliff the fault strikes N. 65° E. and dips 60° to the NW. It cannot be traced to the southwest, but northeastward can be traced for 60 yards. Approximately 450 feet northwest of the fault, lower Austin dipping 15° to the SE. crops out, indicating that the drag on the fault extends at least this far from the fault. Minor faults paralleling the main fault break these southeast-dipping beds.

Of the three other large faults mapped, only the one west of Sardis on Waxahachie Creek is well exposed (Station 3, Pl. 1). It strikes N. 30° E. and dips 54° to the SE. On the downthrown side of the fault relatively thin beds which are characteristic of the very upper portion of the lower Austin are exposed; on the upthrown side characteristic massive beds of the lower Austin crop out.

The fault south of Lone Elm on South Prong Creek (Station 14, Pl. 1) has a strike of N. 45° E. and appears to dip toward the southeast. The fault east of Sardis on a tributary of Waxahachie Creek (Station 16, Pl. 1) has an apparent strike of between N. 60° and N. 80° E. Due to the poor exposure, the strike could only be approximated and the dip of this fault could not be determined.

The origin of the force that caused this faulting is unknown. Personal communication with other students doing field mapping to the northeast and east of this area in Ellis and Dallas counties (Mr. J. J. C. Ingels, Mr. D. F. Reaser, and Mr. W. W. Peabody) indicates that there are other faults with northeast trends. This trend is the same as, and on strike with, that of the Balcones Fault zone which has been traced from Uvalde County as far north as McLennan and Hill counties (Sellards and Baker, 1934), and is postulated to extend as far north as Grayson County (Fohs, 1923). It is probable that this faulting is a northward extension of the Balcones zone.

If these faults are an extension of the Balcones Fault zone, the zone probably extends into southeastern Dallas County where most of the area is covered by alluvium of the Trinity River.

Joints.—Both the lower and middle units of the Austin show prominent vertical jointing. The lower Austin Chalk in particular is highly jointed and commonly breaks off in massive blocks. Some of these joints are in stream bottoms

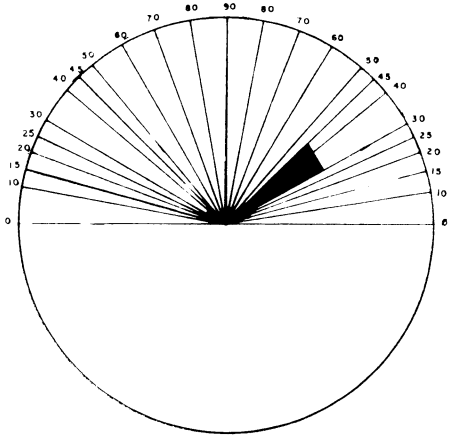


FIG. 2. Strike Diagram of 105 vertical joints in the Midlothian Quadrangle.

where outcrops of the chalk are so small that they are not shown on Plate 1. The trends of 105 joints were taken and plotted (Fig. 2). Two definite trends, one to the northeast and one to the northwest, were found. Of the total number taken, 80 had a northeasterly strike and 25 had a northwesterly strike. The dominant strike of the northeasterly trending joints is between N. 30° and N. 45° E. Fifty-four of the 80 had such strikes. The dominant strike of the northwesterly trending joints is between N. 30° and N. 45° W. Twelve of the 25 had such strikes.

Summary

The bedrock of the Midlothian Quadrangle is composed of Eagle Ford Shale and Austin Chalk, both of Upper Cretaceous age. These formations were deposited in marine waters belong to an infraneritic zone whose depth variance was between 20 and 80-100 fathoms (Scott, 1940). Only small, poorly exposed sections of the upper 75 to 100 feet of

Eagle Ford Shale crop out within the limits of the quadrangle. With the change in environment that accompanied the cessation of the deposition of the Eagle Ford, there was a pause in sedimentation at which time currents swept the sea bottom causing subaqueous erosion and the formation of a disconformity. The presence of phosphate pebbles, undulation of the contact surface, tubular burrows filled with marl extending down into the shale, fish teeth, dark casts of molluscan shells, fragments of reworked shale, and glauconite in the basal bed of the Austin Chalk are evidence for the existence of this disconformity.

Within the area there are many good exposures of the lower chalk and middle marl units of the Austin Chalk. The lower chalk is the most prominent unit. It consists of massive beds of chalk interbedded with thin beds of marl or bentonitic shale. In the upper 30 or 40 feet the beds are less massive.

Above the lower chalk there is a transition zone of approximately 30 feet in which the rock is intermediate in appearance between the chalk and the middle marl unit above.

In the middle marl unit, marl beds are the most massive and common, but the unit does contain massive beds of marly chalk and chalk.

The alluvium of the quadrangle is of two lithologic types. Standing as benches, which are probably indicative of an old terrace level, is an alluvium composed of chalk gravel (Alluvium 1). This terrace may be correlative with the highest level terrace of Dallas County, the Marsalis Terrace. Dark brown to black clay with lenses of fresh chalk fragments makes up Alluvium 2. Often this alluvium is dominantly chalk gravel with a striking resemblance of Alluvium 1.

The Austin beds are broken by numerous small normal faults with throws of less than ten feet. Also in the quadrangle are four normal faults which have more than 25 feet of throw. The largest of these (the Sardis Fault) has a minimum throw of 90 feet. These faults have the same trend (NE.) and are on strike with the Balcones Fault zone. This faulting is probably a northward extension of the same zone and if so, its trend would indicate that the zone passes through Dallas County where most of the bedrock is covered by alluvium of the Trinity River.

Lower and middle units of the Austin both contain prominent vertical joints. There is a primary set which trends between N. 30° and N. 45° E., and a secondary set which trends between N. 30° and N. 45° W.

Scour and fill structures are present in the lower Austin of the quadrangle and were probably cut by sub-marine currents during Cretaceous times. Channel and fill structures were probably formed by Quaternary streams older than the present drainage.

LITERATURE CITED

ADKINS, W. S., 1932, "The Mesozoic Systems in Texas" in "The Geology of Texas, vol. 1, Stratigraphy": *Texas University Bull. 3232*, pp. 239-518.

BRYAN, W. T., 1953, "Geology of the Oak Cliff Quadrangle, Dallas County, Texas": *Field and Laboratory*, vol. 21, pp. 21-23.

DALLAS PETROLEUM GEOLOGISTS, 1941, "Geology of Dallas County, Texas": *Field and Laboratory*, vol. 10, pp. 1-134.

FOHS, F. JULIUS, 1923, "Structural and Stratigraphic Data of Northeast Texas Petroleum Area": *Economic Geology*, vol. 18, pp. 709-731.

HALL, GEORGE W. B., 1953, "Geology of the Preston Hollow Quadrangle (Dallas, Collin, and Denton Counties, Texas)": *Field and Laboratory*, vol. 21, pp. 104-111.

HAM, W. O., JR., 1941, "Origin of some channel fillings in the Austin formation around Dallas, Texas": *Field and Laboratory*, vol. 9, pp. 17-26.

KELSEY, LOUIS, 1935, "The Marsalis Terrace: a high level terrace of the Trinity River, Dallas Texas": *Field and Laboratory*, vol. 3, pp. 54-56.

MOREMAN, W. L., 1927, "Fossil zones of the Eagle Ford of North Texas": *Journal of Paleontology*, vol. 1, pp. 89-101.

OVERMYER, D. O., 1953, "Geology of the Pleasant Grove Area, Dallas County, Texas": *Field and Laboratory*, vol. 21, pp. 112-119.

ROBERTS, C. N., 1953, "Geology of the Dallas Quadrangle, Dallas County, Texas": *Field and Laboratory*, vol. 21, pp. 21-33.

SCOTT, GAYLE, 1940, "Paleoecological factors controlling the distribution and mode of life of Cretaceous ammonoids in the Texas area": *Journal of Paleontology*, vol. 14, pp. 299-323.

SELLARDS, E. H. & C. L. BAKER, 1934, "The Geology of Texas, vol. 2 Structure": *Texas University Bull.* 3401, pp. 49-62.

STEPHENSON, L. W., 1929, "Unconformities in Upper Cretaceous series": *American Association of Petroleum Geologists Bull.*, vol. 13, pp. 1323-1334.

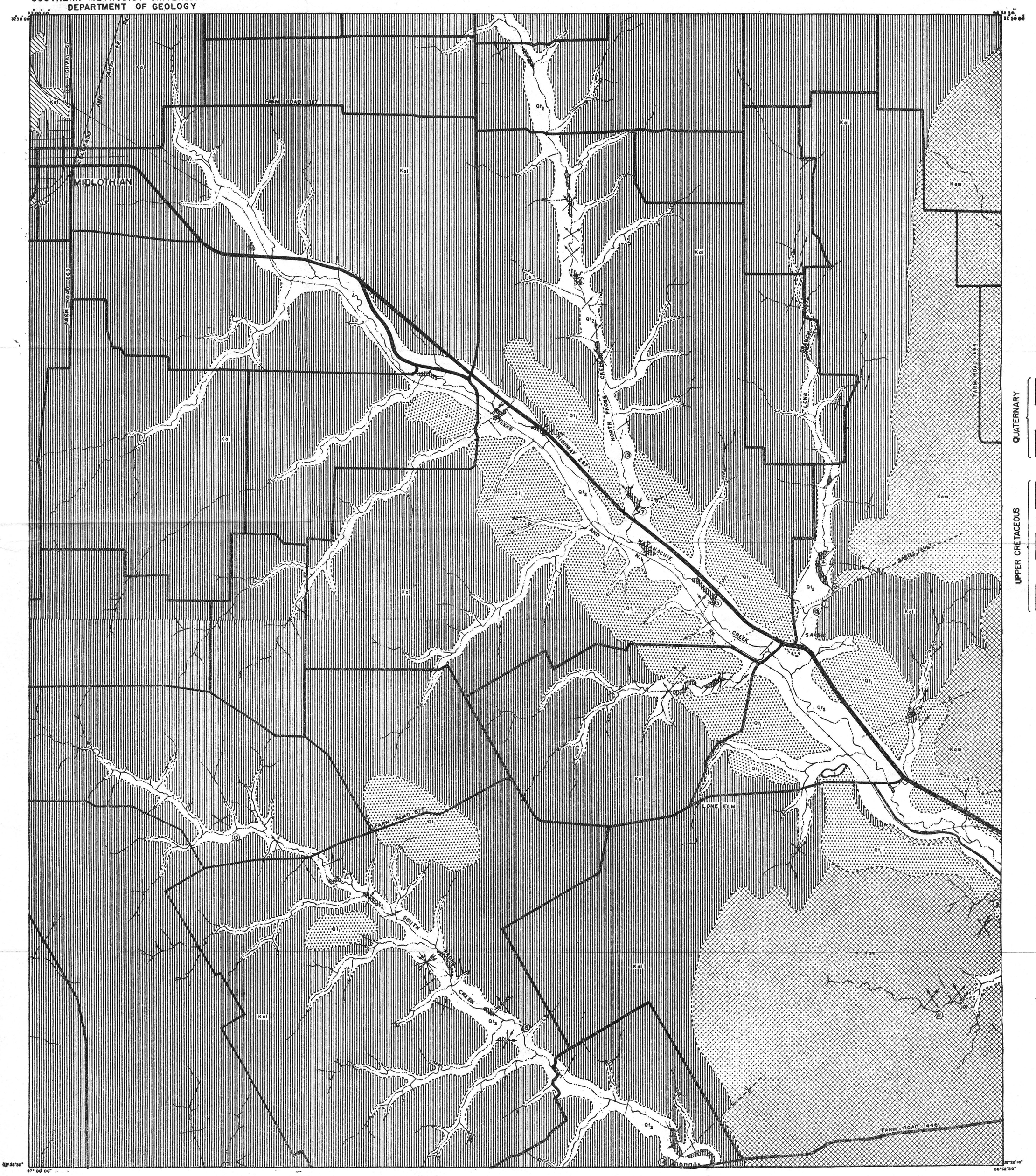
TAGGERT, JAMES N., 1953, "Problems in Correlation of Terraces along the Trinity River in Dallas County, Texas": Unpublished Thesis (M.S.), Southern Methodist University.

TURNER, W. L., JR., 1951, "Geology of the Eagle Ford Quadrangle": *Field and Laboratory*, vol. 19, pp. 51-65.

WATKINS, JACKIE L., 1954, "Geology of the Cedar Hill Quadrangle, Dallas and Ellis Counties, Texas": *Field and Laboratory*, vol. 22, pp. 70-78.

SOUTHERN METHODIST UNIVERSITY
DEPARTMENT OF GEOLOGY

PLATE 1



EXPLANATION

QUATERNARY

Q_{12} ALLUVIUM 2

Q_{11} ALLUVIUM 1

UPPER CRETACEOUS

K_{am} MIDDLE AUSTIN MARL

K_{al} LOWER AUSTIN CHALK

K_{ef} EAGLE FORD SHALE

CONTACT

INFERRED CONTACT

U D MINOR

801 U D MAJOR

KNOWN FAULT

INFERRED FAULT

FAULT CONCEALED BY LATER DEPOSITS

VERTICAL JOINT

① STATION REFERRED TO IN TEXT

GRAVEL PIT

GEOLOGIC MAP OF MIDLOTHIAN QUADRANGLE, ELLIS COUNTY, TEXAS

0 1000' SCALE 1 MILE

BASE MAP FROM CONTROLLED MOSAIC BY TOBIN AERIAL SURVEY

MAPPED BY LOUIS C. REED SUMMER AND FALL 1956

N

DECLINATION 9° 30' E.