Geology of the Dallas Quadrangle[1]

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ABSTRACT

In the Dallas quadrangle, the Eagle Ford shale and Austin chalk, both Upper Cretaceous, are concealed over about 30% of the area by alluvial deposits of the Trinity River. The late Cenozoic history of the area bas been one of progressive uplift with alternate episodes of channeling and filling along the Trinity and its tributaries. As a result, three and possibly four ancient floodplains now stand as terraces bordering the bottom-lands. The names and respective heights of these terraces above the Trinity River flood plain are as follows: Marsalis, 110 feet; Love Field, 70 feet; Travis School, 60 feet; and Union Terminal, 35 feet.

The Marsalis, Love Field, and Union Terminal terraces are well defined benches, but the Travis School terrace is poorly developed, and consequently, its relative age has not been satisfactorily determined. In this connection there are three possible alternatives. It may be merely a dissected portion of the Love Field terrace. Or it may represent a distinct terrace intermediate in age between the Love Field and Union Terminal. Finally it may be an alluvial fan of Turtle and adjacent creeks, possibly built out upon the Union Terminal level. Of these three possibilities, the first seems the most probable.

Introduction

The area here described embraces most of the city of Dallas. Bounded by parallels 32°45′00″ and 32°52′30″ N, and by meridians 96°45′00″ and 96°52′30″ W, the quadrangle covers approximately sixty-five square miles and is located near the geographic center of Dallas County (Figure 1).

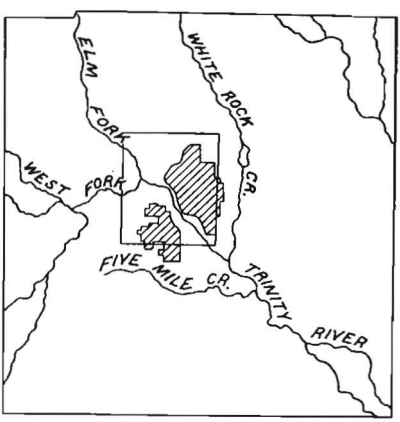

FIG. 1. Index Map of Dallas County, showing location of the Dallas Quadrangle.

As is usually the case in large cities, most natural surfaces have been concealed by roads, railroads, and buildings. Also the original contours of the landscape have been somewhat modified in the course of engineering projects.

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[2]My best thanks are due to Dr. Claude C. Albritton, Jr., for aid and direction, to Dr. Arthur Richards for help in the analysis of field problems; and to Mr. T. Wilson Bryan for help in mapping the quadrangle.

For example, streets rising from one terrace level to another may only approximately reflect the original breaks in slopes, because their grades in all cases must fall within a certain range specified by the engineers. Moveover, there have been artificial changes in connection with streams. A few of the minor streams draining the more thickly populated portions of the area have had their channels straightened, or else have been directed into underground tunnels.

This area, situated along the inner margin of the western Gulf Coastal Plain, is part of the Black Prairie. The Trinity River flows across the southwestern portion of the quadrangle. As can be seen on the map (Plate 1), the river has been diverted from its natural channel and runs in an artificial channel with high levees on either side. However, the old meanders still remain and receive the drainage of their original tributaries. The elevation of the Trinity River at Dallas is 367 feet, and the total relief of the Trinity valley in this area is about 200 feet (Shuler, 1935, p. 45). While on the south side of the river high bluffs of chalk rise directly from the border of the floodplain, to the north, three alluvial terraces form a stairway that leads from bottom-lands to uplands by gentle stages. The Trinity and its main forks, the West and the Elm, are perennial streams all of whose major tributaries are intermittent. The tributaries of these secondary streams in turn are mainly ephemeral. Dendritic stream patterns predominate, although some small streams have rectangular patterns adjusted to faults and joints.

The floodplain of the Trinity River is very broad near the western margin of the quadrangle, at the original junction of the West and Elm forks. In general, the widths of floodplains are directly proportional to the resistance that the underlying rocks offer to erosion (Dallas Petroleum Geologists, 1941, p. 76). The truth of this statement is well demonstrated by the constricted floodplain of the Trinity where the river crosses relatively hard layers of chalk in the southern part of the area.

The most prominent landmark in the Dallas quadrangle is the White Rock Cuesta, which has developed by differential erosion of the Austin chalk and the Eagle Ford shale. Only a small part of the cuesta is in this area. The back slope slants gently to the east, while the face of the cuesta

drops sharply to the floodplain of the Trinity River about 200 feet lower.

The Eagle Ford and Austin formations, both Upper Cretaceous, underlie the area. The regional strike is north-northeast and the dip is toward the east at about 60 feet per mile. Over much of the area the rocks of Cretaceous age are concealed by alluvium of floodplains and terraces.

Eagle Ford Shale

The Eagle Ford formation consists of clay shale and has an average thickness of about 475 feet within the county (Dallas Petroleum Geologists, 1941, p. 17). The type locality is a few miles beyond the southwestern corner around the town of Eagle Ford, an area described by Turner in 1950.

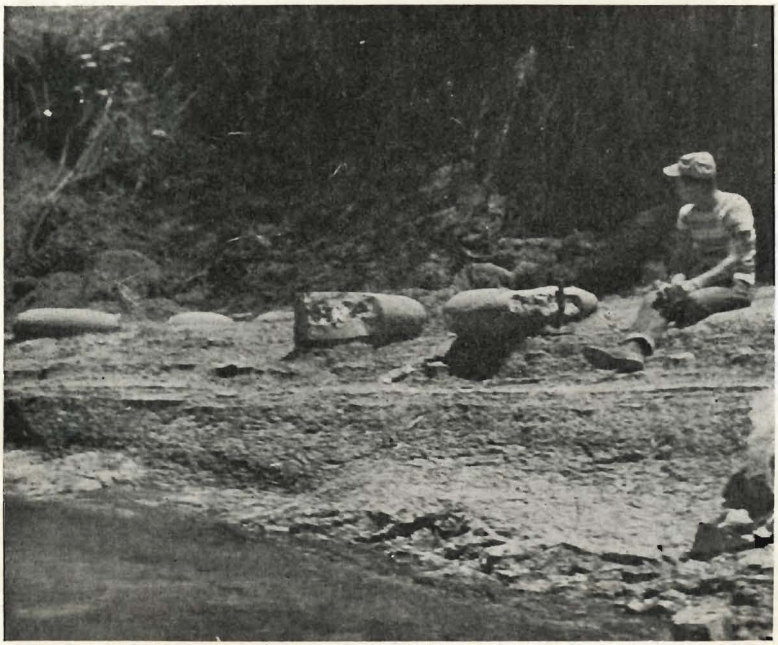

FIG. 2. Septarian concretions in the Eagle Ford at Station 1.

Croppings are largely restricted to two areas. The upper 20 to 30 feet of the formation is exposed northeast of Bachman's Creek, and approximately the upper 150 to 200 feet along White Rock Cuesta. In both areas the shale is mostly concealed by soil, but wherever the rock was seen in an unweathered conditions it appeared to be uniformly a dark bituminous clay that is bluish-gray when dry and black

when wet. It is commonly laminated, parting readily along the bedding. In weathered outcrops, bedding surfaces and joint planes are usually stained reddish-brown or yellow by limonite. The shale contains concretions that show a considerable variety in size, shape, and mineral composition. The most common are composed of shaly sand cemented by calcium carbonate.

Huge septarian concretions of shaly sand are concentrated along a horizon about 40 feet below the Austin-Eagle Ford contact. These concretions may be seen at the localities numbered 1 and 3 on the geological map, the best examples being in a cut bank of Comb's Creek in Stevens Park, Oak Cliff (Figure 2). These bodies average three feet long, about two feet wide, and about 8 to 10 inches in thickness. Weathered surfaces are yellowish brown, but fresh fractures show the original light gray color of the clastic material. This rock shows no concentric banding. All concretions that were broken contained calcite crystals near their centers. These crystals form aggregates that are as much as 6 or 8 inches across. The concretions appear not to have grown by concentric addition of layers about nuclei; in any event no nuclei were found, and the calcite at the center appears to fill spaces opened by shrinkage of the clastic material forming the concretions themselves. Calcite also forms veinlets filling the cracks and making a polygonal pattern on the surfaces of the concretions. On weathering these veinlets may stand in relief forming a honeycomb pattern of ridges. The concretions all lie with their two longer axes oriented parallel to the bedding planes, and the closely spaced beds in the surrounding shale can be seen to arch gently over and under them. In no case were laminae of shale found abutting against the concretions, although the boundary between concretion and shale is invariably sharp. Probably the concretions are epigenetic.

Marcasite nodules have subspheroidal, cylindrical, or irregular shapes while ferruginous claystone concretions form irregular slabs along bedding planes. At some horizons selenite crystals occur as individuals or as aggregates along bedding surfaces.

Austin Chalk

The Austin Chalk has an approximate thickness of 600 feet in Dallas County (Stephenson, 1937, p. 135). The lower 150 feet, designated the Lower Austin chalk, consists of massive chalk beds, averaging a few feet in thickness and parted by thin beds of calcareous shale or marl. Fresh exposures show that the chalk is an earthy rock of medium gray color which becomes harder and whiter upon weathering. Typically the lower 50 feet of the Austin chalk is the most resistant but the basal Austin chalk north of the Trinity River contains fewer thick and resistant beds of

FIG. 3. Polygonal, calcite-filled cracks of septaria in the Eagle Ford shale. (Station 1.)

chalk than the lower chalk south of the river (Dallas Petroleum Geologists, 1941, p. 81). Shuler (1918, p. 19) has the following to say about the Austin chalk in Dallas County: "Although the formation is called the Austin chalk, only a few layers near the base are properly termed chalk, and even these beds carry only about 85% of lime carbonate." Characteristically the lower division also contains numerous marcasite concretions which, upon weathering, leave iron

stains on the outcrops. Often referred to as pyrite in literature (Dallas Petroleum Geologists, 1941, p. 46), these concretions tend to be ellipsoidal or cylindric in shape and appear to be most common in the shaly beds. Fossils are abundant. *Inoceramus* valves are especially common, and fragments of these coarsely prismatic shells commonly form lenses along bedding planes.

Streams flowing across this part of the formation have steep banks with fluted walls reflecting differential erosion of the harder chalk and softer seams of shaly material. Good exposures are found along White Rock Cuesta and in street- and road-cuts on the dip slope of the cuesta. Perhaps the best section of the lower division can be seen at Bluff View, where 70 feet of alternating massive limestone and thin shale layers are exposed in a cut bank of Bachman's Creek. Also along Turtle Creek there are numerous exposures of the lower chalk.

At Bluff View (Station 4), a buried channel occurs in the lower chalk. It appears as a shallow, symmetrical depression cut in horizontal beds of chalk and shale. The beds which fill this channel are lithologically similar to the beds truncated along the walls of the channel; they follow the sides of the channel and thus show a synclinal structure. The channel appears to have been about 20 feet wide and 4 feet deep. Similar structures have been noted by the author in the lower chalk immediately south of this quadrangle.

The middle or marly part of the Austin is about 250 feet thick. It contains fewer massive layers of limestone and is characterized by thick sequences of laminated marlstone (Shuler, 1918, p. 20). Only about 100 feet of this member is exposed along the eastern margin of the quadrangle. Typical exposures can be seen in stream gullies along the Northwest Highway, east of the Central Expressway.

Thin beds of coarse calcitic sandstone composed largely of shell fragments and fish teeth are locally present in the middle marl. These beds average about half an inch in thickness and cannot be traced along the bedding for more than a few feet.

The marl in the middle part of the Austin is not very resistant to erosion, and streams flowing over it cut broad, flat-bottomed channels (Figure 4). It was on the basis of

this characteristic that the contact line between the lower chalk and middle marl was drawn.

Contact between Eagle Ford and Austin Formations

In this part of Texas the Austin and Eagle Ford formations are separated by an unconformity (Adkins, 1932, p. 424). An excellent exposure of the contact can be seen in the quarry of the Lone Star Cement Company. Less spectacular but more accessible contacts can be observed along Comb's Creek (Station 2) and at Bluff View (Station

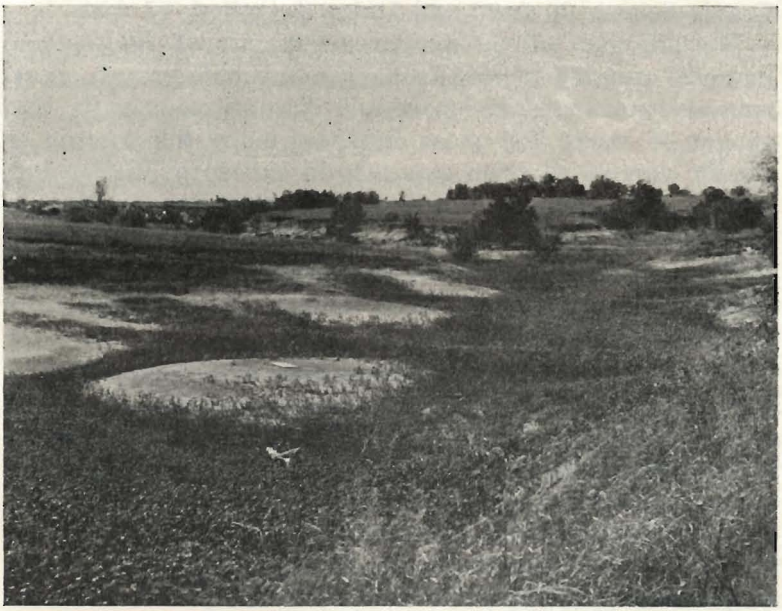

FIG. 4. Broad, flat-bottomed stream channels in the Middle Austin marl.

4) on Bachman's Creek. Characteristically, the contact is one of sharp lithologic change along a slightly undulatory surface, with the lower few inches of the Austin Chalk containing numerous small phosphatized pebbles, fish teeth, and shell fragments. Borings filled with chalky material extend down into the Eagle Ford for as much as 5 inches. About ten inches below the contact between the two formations is a narrow zone marked by abundance of oyster shells. Most of the valves are oriented with their convex sides upward.

Alluvial Deposits of Cenozoic Age

About 30% of the Dallas quadrangle is covered by alluvial deposits of the Trinity River. These deposits are present as remnants of ancient floodplains, recording alternating episodes of downcutting and aggradation of the Trinity valley. Four terrace levels have been mapped in this area, to which Shuler (1935) and Kelsey (1935) have already assigned names. The names of the terraces and their approximate heights above the floodplain from highest to lowest are as follows: Marsalis, 110 feet; Love Field, 70 feet; Travis School, 60 feet; and Union Terminal, 35 feet.

The alluvium of the terraces consists of fragmental material ranging in size from clay to cobble gravel, occurring as interfingering lenses and discontinuous units that cannot be traced for great distances along the outcrop or readily correlated from exposure to exposure (Dallas Petroleum Geologists, 1941, p. 64). Since the terraces occur in the main business, industrial, and residential districts of Dallas, it is hard to trace the terrace levels through certain parts of the quadrangle. Lack of outcrops prevented a detailed study of the lithology.

Marsalis Terrace.—This name was applied by Kelsey (1935, p. 54) to alluvial remnants northeast and southwest of Cliff Park, especially along Marsalis Avenue. This terrace is the highest within the city of Dallas, the main body being located directly south of this quadrangle. At its highest point on the corner of Marsalis Avenue and Opera Street, it is 112 feet above the floodplain of the Trinity River. A long extension of the terrace runs parallel to Marsalis Avenue, between it and Ewing Avenue. On Seventh Street, between Lancaster Avenue and Ewing Avenue, this extension of the Marsalis terrace is 110 feet above the floodplain of the Trinity River as determined by plane-table traverse.

Kelsey (1935, p. 55) tentatively correlated the Marsalis terrace with the Love Field terrace north of the river, on the basis of similar heights above the present floodplain of the Trinity River. However, our plane-table traverses show that the Love Field terrace is 40 to 50 feet lower than the Marsalis; hence these are two separate and distinct terraces (Plate 1).

Love Field Terrace.—Named by Shuler in 1935, the Love Field is the highest terrace extensively developed in the area. It was named for Love Field Airport, and represents the oldest alluvial deposit north of the river. It has been reported to be between 100 and 120 feet above the floodplain (Shuler, 1935, p. 48); but our traverses in the Love Field area indicate that it is only 50 to 70 feet above the Trinity floodplain. The inner margin of the terrace is eroded and therefore lower now than originally. For example, at the corner of Concord Street and Lovedale Avenue the terrace is only 51 feet above the floodplain, but air-photos show this point to be located near a small creek and at the edge of an indention cut back into the Love Field terrace. Farther up Lovedale at its intersection with Cedar Springs Avenue, the terrace appears to be uneroded; here it is about 65 feet above the floodplain and may rise 5 feet higher up to an indefinite contact with the Austin chalk. East of Turtle Creek the Love Field terrace is 70 feet above the floodplain at the corner of Allen and Munger streets, but undoubtedly rises higher farther back on the terrace. So far, no fossils other than those reworked from the Cretaceous have been found in the terrace material at this level.

Travis School Terrace.—This terrace, also named by Shuler, is typically developed along McKinney Avenue on the east side of Turtle Creek. Near Travis School on McKinney Avenue, the alluvium is a brick-red, sandy loam standing about 50 to 65 feet above the floodplain of the Trinity River. This terrace is nowhere well exhibited as a flat surface of any extent, but is dissected and thus difficult to correlate from place to place. This is especially true of the two exposures of this terrace northwest of Turtle Creek. For this reason the correlation of the terrace on this side of the creek is doubtful and this uncertainty has been indicated on the map by a question mark following its symbol (Qt_2?).

Union Terminal.—Youngest and lowest of the terraces in the Dallas quadrangle is the Union Terminal terrace, named by Shuler for its development near the Union Terminal at the east end of the Houston Street viaduct. This terrace stands between 25 and 35 feet above the floodplain of the Trinity River, and is extensively developed in east Dallas northwestward through the downtown district of

Dallas nearly to the lower end of Turtle Creek. Another segment extends from Inwood Road to Bachman's Creek and beyond. On Grauwyler Road the Union Terminal terrace rises 25 feet above the floodplain, while near the intersection of Field Street and Cedar Springs Avenue it is approximately 35 feet above the floodplain. In the southeastern part of the area the Union Terminal is 25 feet above the floodplain.

Age of the Terraces.—Only relative ages can be assigned to the higher terraces since fossils have only been found in the Union Terminal. Bones of land animals found beneath this level have been assigned the tentative age of mid-Pleistocene by Hay (Shuler, 1935, p. 52), and it is from this information that the higher terraces have been assigned the relative age of older than mid-Pleistocene. Shuler (1935, p. 53) believed that the Love Field terrace may be as old as late Tertiary.

Channel Filling.—Channel fillings, located on divides between existing streams, occur in the middle Austin marl. These broad, flat-bottomed channels are filled with brown, compact clay which assumes a buff hue when dry. The upper portion of the fillings is spotted white by abundant caliche nodules up to an inch in diameter. Chalk, marl, and shale fragments are scattered through the deposits.

The only filling located within this quadrangle is on Northwest Highway in a road-cut at Station 5. The width of the filling in this area is about 195 feet, and the depth is at least 12 feet. The bottom and one side of this channel are not exposed.

Remarkably, these troughs resemble the stream channels cut in the middle marl of the Austin formation today. Ham (1941, p. 18) offers the following hypothesis in regard to their origin: "Troughs containing fillings are thought to be remnants of a stream system dismembered by piracies attending the development of subsequent streams with the progressive down cutting through the Austin formation."

Structure

Structurally, the area is a part of a great homocline dipping gently toward the Tyler Basin on the east. Regionally the Cretaceous rocks of Dallas County strike north-northeast and dip eastward at about 60 feet per mile.

Joints and minor faults are abundant in the Cretaceous rocks of the area, especially in the Austin formation. Faults with displacements of 2 or 3 feet are common in the lower chalky part of the Austin formation. These faults are of the normal type and have surfaces inclined mostly between 45 and 60 degrees. Most fault surfaces in the chalk show slickensides, and wherever the cracks along faults were filled with veins of calcite, the veins preserve on their outer surfaces the minutest details of grooves and striations.

Shuler (1918, Fig. 6) found through a study of fault strikes in Dallas County that there are two maxima, respectively 45 degrees east and west of north. Blakemore (1939, p. 61) found that faulting in the Lower Austin chalk was a controlling factor in the development of streams on the margin of White Rock Cuesta. He found that obsequent streams developed on the face of the cuesta have two dominant directions, N 10° W and N 65° E.

Faults in the Eagle Ford and Middle Austin are not nearly so common as they are in the Lower Austin chalk, and displacements can seldom be measured. Differential compaction of the Eagle Ford shale is thought to be responsible for the extensive minor faulting in the lower chalk, and could account for the small flexures seen at some places in the county.

Joints of two kinds may be seen in the Cretaceous rocks, the first of these being characterized by smooth surfaces of fracture that may be curved or plane, and the second type having irregular surfaces that define blocks of rock loosened by weathering. Ham (1941, p. 18-19) found two sets of master joints in the lower chalk trending N 30° E and N 80° W. Less prominent sets trend N 58° W and N 5° W. The prevailing trend of the joints in the middle marl seems to be N 15° E and N 85° W.

Geologic History

The shales of the Eagle Ford were deposited in marine waters, as indicated by the fossilized remains of Foraminifera and ammonites. The depth of the water probably did not exceed 600 feet (Scott, 1940, p. 322). The disconformity between the Eagle Ford shale and Austin chalk probably represents an interval during which the bottom was scoured by currents which deposited no fine sediments but allowed

organic remains to accumulate slowly. These latter remained along this horizon or became reworked into the basal limy muds of the Austin formation.

Reasoning from paleontological evidence, Scott (1940, p. 322) concluded that the calcareous muds of the Austin were deposited in water between 20 and 100 fathoms deep. That the bottoms were occasionally scoured by submarine currents is indicated by the buried channels and occasional lentils of shell débris.

Toward the end of the Cretaceous period the sea retreated and subaerial erosion ensued. Probably during late Cretaceous or early Tertiary time the newly formed Cretaceous rocks began adjustments which led to extensive faulting in the lower chalk of the Austin.

From the time of emergence, drainage channels were in the process of development and at some time during the Quaternary, or possibly the late Tertiary, the gravels of the Marsalis terrace were deposited by the Trinity River. At that time the floodplain was about 110 feet higher than it is today. Thereafter the river began to cut its valley deeper until it once more began aggradation at a level 40 or more feet lower. As a result, the Marsalis terrace was largely destroyed and the Love Field terrace developed as a broad floodplain.

The history of the area immediately following the deposition of the Love Field alluvium is conjectural, because the relative age of the Travis School terrace has not been satisfactorily determined. There are three alternatives. The Travis School terrace may be merely an outer dissected band of the Love Field terrace. Or it may represent a distinct terrace, intermediate in age between the Love Field and the Union Terminal. Or, finally, it may be an alluvial fan of Turtle and adjacent creeks, possibly built out upon the Union Terminal level. The irregular surface, the position near the mouths of tributaries, and the crudely lobate pattern all suggest that the Travis School alluvium may have been deposited as an alluvial fan.

Regardless of the age of the Travis School terrace, the next down cutting of the Trinity River formed the Union Terminal floodplain about 35 feet below it. Fossil bones of land animals found below this horizon have been identified tentatively as belonging to a fauna which lived in mid-Pleis-

tocene time. How soon after mid-Pleistocene the river began its final down cutting is not known but following the deposition of the Union Terminal alluvium the river lowered itself at least 35 feet and formed what is now the present Trinity River floodplain. After this last episode of degradation the Union Terminal horizon became the lowest and youngest of the terraces present in the area today.

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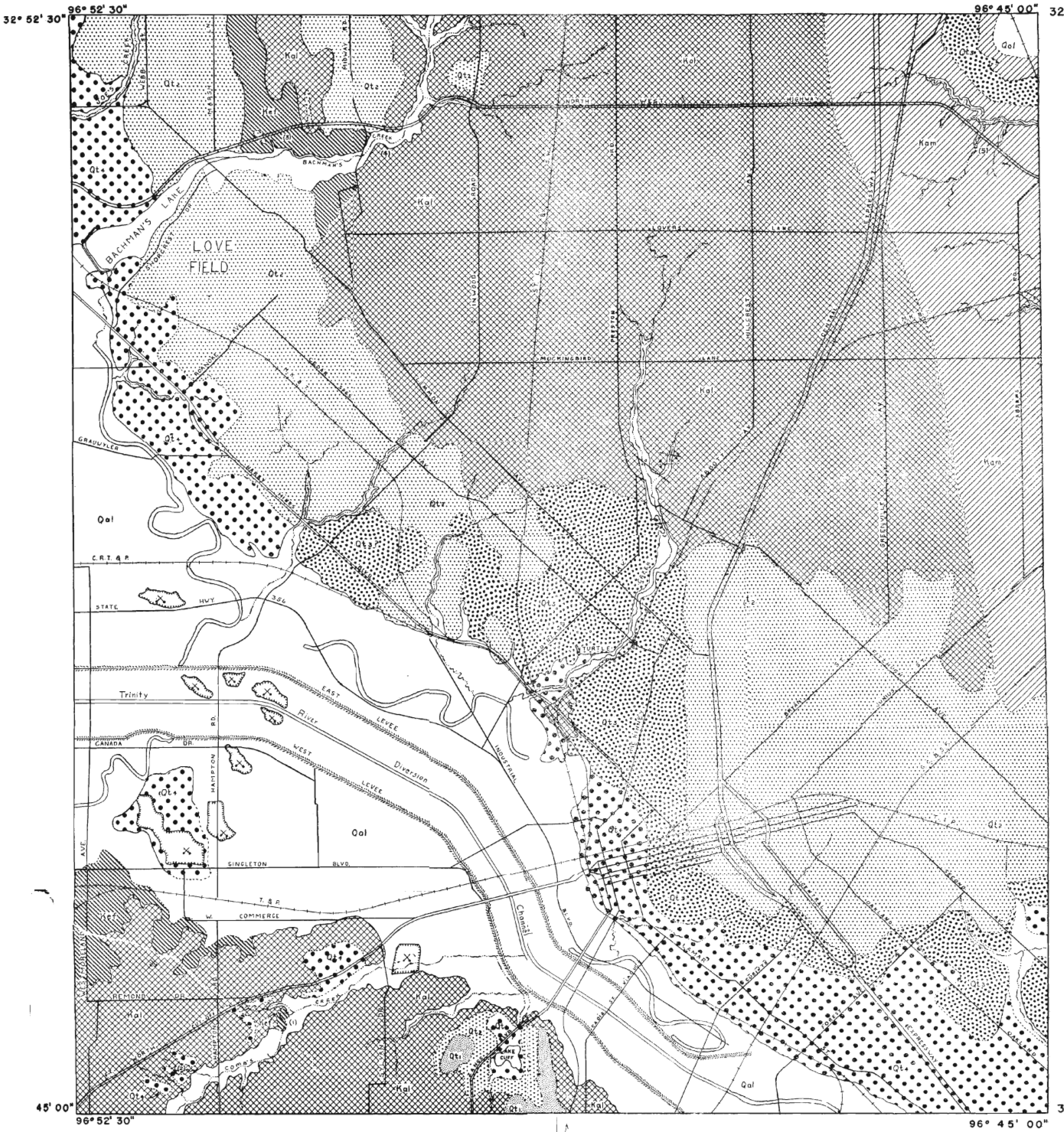
PLATE 1 ROBERTS, Field & Laboratory, Vol. 21, No. 1, pp. 21-33, 1953.



EXPLANATION

QUATERNARY

- RECENT ALLUVIUM (Qal)
- UNION TERMINAL TERRACE (Qt4)
- TRAVIS SCHOOL TERRACE (Qt3)
- LOVE FIELD TERRACE (Qt2)
- MARSALIS TERRACE (Qt1)

UPPER CRETACEOUS

- MIDDLE AUSTIN MARL (Kam)
- LOWER AUSTIN CHALK (Kal)
- EAGLE FORD SHALE (Kef)

- FAULT
- EXPOSED CONTACT
- INDEFINITE CONTACT
- GRAVEL PIT
- (3) REFERS TO LOCATION MENTIONED IN TEXT

AREAL MAPPING BY
C. N. ROBERTS
SUMMER 1952

BASE MAP FROM DALLAS
RAILWAY & TERMINAL CO.
1952

DECLINATION
9° 30" E

GEOLOGIC MAP OF DALLAS QUADRANGLE

DALLAS COUNTY, TEXAS

SCALE

0 2 MILES